JOINT FUSIONS IN PALAEOPATHOLOGY: DIAGNOSIS AND EPIDEMIOLOGY

PH.D. DISSERTATION

DOCTORATE IN FRENCH-HUNGARIAN CO-TUTORSHIP
THESE DE DOCTORAT EN COTUTELLE FRANCO-HONGROISE

LÁSZLÓ PAJA

OLIVIER DUTOUR
CO-SUPERVISOR
École Pratique des Hautes Études

GYÖRGY PÁLFI
CO-SUPERVISOR
University of Szeged

DOCTORAL SCHOOL OF ENVIRONMENTAL SCIENCES
DEPARTMENT OF BIOLOGICAL ANTHROPOLOGY

DOCTORAL SCHOOL, ÉCOLE PRATIQUE DES HAUTE ÉTUDES
MENTION: SYSTÈM INTÉGRÉS, ENVIRONNEMENT ET BIODIVERSITÉ

UNIVERSITY OF SZEGED
FACULTY OF SCIENCES AND INFORMATICS

ÉCOLE PRATIQUE DES HAUTE ÉTUDES

SZEGED
2012

"The History of every major Galactic Civilization tends to pass through three distinct and recognizable phases, those of Survival, Inquiry and Sophistication, otherwise known as the How, Why and Where phases."

Douglas Adams

Table of contents

List of abbreviations

AS: ankylosing spondylitis
CMC: carpometacarpal
CC: *cribra cranii*
CO: *cribra orbitalia*
CT: computed tomography
CV: cervical vertebra
DISH: diffuse idiopathic skeletal hyperostosis
DIP: distal interphalangeal
DOA: degenerative osteoarthritis
ECL: endocranial lesion(s)
F: female
H&E: hematoxylin and eosin
HV: hypervascularization
LEH: linear enamel hypoplasia
LV: lumbar vertebra
M: male
MCP: metacarpophalangeal
OA: osteoarthritis
OCL: ossification of capsular ligament
OACSL: ossification of the anterior costosternal ligament
OALL: ossification of the anterior longitudinal ligament
OISL: ossification of the interspinous ligament
OITL: ossification of the intertansversal ligament
OLF: ossification of the ligamentum flavum
OPLL: ossification of the posterior longitudinal ligament
OSSL: ossification of the supraspinous ligament
PIP: proximal interphalangeal
PO: periostitis
RF: rheumatoid factor
SD: spondylosis deformans
SNSA: seronegative spondylarthropathy
TB: tuberculosis
TV: thoracic vertebra
U: undetermined sex

1. Introduction

Osseous joint ankyloses are quite rare, but easily recognizable pathological conditions. Fusions of joints may occur as a result of several diseases (e.g. trauma, infection, developmental defects, metabolic diseases, seronegative arthropathies), but the development of them is rarely described in developed countries, thanks to diagnostic techniques that allow early detection and treatment of the underlying disease. Evidence of the natural history and progression of the disease is now primarily studied through the observation and analysis of osteoarchaeological specimens, and medical reports or books dating from the pre-antibiotic era. In cases of bony fusions the joints or surrounding soft tissue elements becomes rigid, fibrous, later bony ankyloses develop.

1.1. Joints

A joint is defined as the juncture at which two or more bones make contact for the purpose of movement and mechanical support of the musculoskeletal system. So, normal joint function is defined as a joint's ability to move throughout its range of motion, bear weight and perform work.

The most typical classification points of view to make sub-groups are the different types of the anatomical elements of a joint (structural classification) and the movement possibilities in the articulations (functional classification); beside these ones biomechanical approaches are also present. We have to note that in practice, there's a significant overlap among the categories.

1.1.1. Structural classification of joints

The structural classification based on two criteria; the presence or lack of the space between adjacent bone surfaces and the type of the connective tissue that connects the concomitant bony elements. The three categories of the structural classification are (Bullough, 1992):

- fibrous joints: bones are connected by dense irregular fibrous connective tissue that is rich in collagen fibers, the articular cavity is missing;
- cartilaginous joints: bones are connected by cartilage, the articular cavity is missing;
- synovial joints: synovial cavity is present between the adjacent bony ends, the bones are united by articular capsule that is built from dense irregular connective tissue.

Fibrous joints are also called “fixed”, because they do not allow any or a very controlled movement. Three types of this joint category are the sutures, the syndesmoses and the gomphoses.

Sutures connect the bones of the skull, they are bound together by strong collagenous fibres known as Sharpey’s fibres. Only a very small degree of movement of these joints is permitted, these tiny movements contribute to the elasticity and compliance of the cranium, this range of movement decreases with age.

The term syndesmosis derives from the Greek “syn” (means “with”) and “desmos” (means “band”), it refers to presence of interosseous ligaments. Syndesmoses are found between of those long bones of the appendicular skeleton (e.g. distal tibiofibular joint), where the distance between the bones are bigger than in case of cranial bones, and the connective tissue forms ligaments. These joints' mobility is bigger than the sutures, but not as great as synovial joints' movement, minor degrees of movement permitted by stretching of ligaments.

Gomphoses (“gomphos” is a Greek expression meaning bolt) are the joints that connect the teeth and the osseous sockets of the mandible and maxillae. This is the only type of the articulations, when a bone does not joint to another one, because teeth are not bones technically. As a result of the presence of a peridontal ligament the motion of the joined elements in gomphosis is minimal.

Cartilaginous joints are connected by fibrocartilage or hyaline cartilage; these articulations allow more movement than a fibrous joint, but less than a diarthrosis.

Primary cartilaginous joints known as synchondroses are present at the growth plates of the bones, where the epiphysis and diaphysis will become united by the end of the growth. Other cases of this type of articulations are the costo-sternal joints, where the first ribs and the sternal manubrium

contact, and the sphenooccipital joint. The connective tissue of these articulations change with ageing as well, the cartilaginous tissue is changed by osseous tissue.

In symphyses (or secondary cartilaginous joints) the bony ends are covered by hyaline cartilage, but the union is realized by a plat-like disc of fibrocartilage. These joints are situated in the mediansagittal plane, and permit some movement of the bones (semi-mobile joints). Examples would be the the manubriosternal joint (between the body and manubrium of the sternum), the pubic symphysis and the intervertebral discs. The intervertebral disc shows a special structure, it can be divided into two components. The outer layer (*anulus fibrosus*) contains fibrous layers developed in concentric circles; each of them extends from vertebral body to vertebral body, the fibers of one layer run in a direction opposite to that of the next layer. This special structure provides that motion of them universal in direction, but decreased in degree. The fibrous tissue is anchored to the endplates of the adjacent vertebrae. The thickness of the *anulus fibrosus* is not equal everywhere, thicker and stronger in the anterior and lateral aspects, while the posterior part of it is thinner. As a result of this structure, the innermost gelatinous material of the intervertebral disc (*nucleus pulposus*) occupies an eccentric position; it is closer to the posterior margins of the vertebral body. In the material of the core the matrix is loose and fibrous, scattered small stellate cells and occasional chondrocytes in clumps are visible in the microscopic picture (Bullough, 1992).

Synovial joints (also known as diarthroses) are the most movable articulations in the human body, permanent and additional elements take apart in their structure. Among the permanent structures the bony ends covered by hyalin cartilage, the articular cavity and capsule and the synovial fluid are present, while ligaments, articular discs, fat pads, bursae and tendons may be mentioned as additional structures (Tortora and Derrickson, 2007).

The highly innervated and vascularized articular capsule is attached to the periosteum of articulating bones, and contains two layers. The outer layer (stratum fibrosum) is built of dense fibrous tissue and may contain ligaments. The inner layer (stratum synoviale) secretes the synovial fluid, which has an important role in lubrication of the articulated bony ends, shock absorption and nutrition supply; this layer is usually described as synovial membrane. Synovial membrane varies in different joints, but usually has two layers. The outer layer (referred as to subintima) is highly vascular and innervated, and built of loose connective tissue, while the inner layer (called intima) consists of different types of cells.

Among them, cells type A, which are like macrophages and have a phagocytic function; these cells remove undesirable substances from the synovial fluid. Cells type B (fibroblasts) excrete the hyaluronic acid (long chain sugar polymer) which molecule makes the synovial fluid egg-white-like, and together with a molecule called lubricin are responsible for the lubrication of articular surfaces (Waldron, 2009).

The articular surfaces are covered by hyaline cartilage that contains no neural or vascular elements. The colour of this tissue is pearly bluish in young people, opaque and yellowish in older individuals. The structure of the hyaline cartilage is simple; on the typical microscopical pictures oval or elongated chondrocytes are situated in lacunae, these cells produce the extra-cellular matrix, which is mainly made up of type-II collagen and chondroitin-sulfate (Milgram, 1990). It is often described as a four-layer structure; these are the superficial, intermediate, deep and calcified zones. In the first layer the cells are flat; in the second zone the cells frequently form radial groups that follow the special pattern of collagen disposition. The deep zone shows the typical picture of the cartilage with spared cells, while in the fourth layer cells are apparently nonviable, the extracellular matrix is partly calcified (Bullough, 1992).

Many articulations may contain additional structures. Joint discs (or menisci) are pads of fibrocartilage between the adjacent joint surfaces; articular fat pads are special adipose tissues that protect the joint surfaces. Several articulations contain accessory (extra- or intracellular) ligaments built of dense regular connective tissue; these ligaments may prevent the joints from the dangerous results of extreme movements. Tendons composed of parallel bundles of collagen fibers, bursae (sac-like elements filled with fluid that is similar to synovial fluid) may decrease the friction in some joints (Tortora and Derrickson 2007).

1.1.2. Functional types of the joints

Joints may also be classified functionally, on the basis of the degree of the articulation's mobility they allow. The three categories of the functional classification are:

- synarthroses allow no or very limited mobility of bones, most of them are fibrous joints;

- amphiarthoses permit slight mobility (e.g. vertebrae);
- diarthroses allow a variety of mobility and movements, and as all diarthroses are synovial joints, the terms “synovial joint” and “diarthrosis” are used as synonyms. (Tortora and Derrickson 2007).

1.2. Ankyloses

1.2.1. Term of ankylosis

The term ankylosis (or anchylosis) derives from Greek (*aykylos*, bent, crooked) is a stiffness of a joint due to abnormal adhesion and rigidity of the bones of the joint, which may be the result of injury, disease or surgical intervention. The term ankylosis may be approached from different viewpoints. It may be interpreted in a functional aspect, when joints lose their mobility in a complete or partial way, and in addition to this, osseous lesions, alterations of soft tissues can also result in this phenomenon. On the other hand, it may refer to a certain anatomical alteration, when the bony ends of joints are fused together by an osseous bridge that results in complete loss of the articulation’s mobility. The terms ‘true ankylosis’ and ‘false ankylosis’ are also used, in the first category some disease results in reduced joint mobility, while in the latter type complete immobility is present. Concerning the involved elements, intraarticular and extraarticular ankyloses can be distinguished. (Miller *et al.,* 2003).

Ankyloses may involve not only human remains, some authors reports the development of joint fusions in other species as well. Among these specimens recent and extinct species are also found, e.g. fossils of dinosaurs exhibited complete osseous ankyloses (Molnar, 2001). Concerning the human skeletal alterations, both modern and osteoarchaeological samples exhibit characteristic joint fusion. In the latter category mainly osseous ankyloses can be observed, distortion of the articulations’ bony elements or fusion of the adjacent joint surfaces can be recognized. The analysis of predilection sites and typical macroscopic symptoms can help investigators to find the correct aetiology of the alterations.

1.2.2. Aetiological background of ankyloses

Numerous different diseases or injuries may be found in the aetiological background of ankyloses, it may be caused by developmental disease (e.g. segmentation defect), trauma, non-specific and specific (e.g. tuberculosis, leprosy, syphilis) infections, rheumatoid arthritis, metabolic disease or seronegative arthropathies, etc. Except the developmental defects the presence of the ankylosis may be interpreted as a special response to a disease, and it may be identified as a sign of the healing process.

Developmental defects can be classified in various ways; the morphological and morphogenetic approaches are the most frequently utilized. The majority of them manifests before the birth (also known as congenital defects), but they may also occur during the childhood or adolescence. Genetic (intrinsic) or environmental (extrinsic) factors may also play important role in the development of the defects (Barnes, 1994).

Among the diverse subcategories of the developmental failures, fusion abnormalities may result in joint ankyloses. Craniosynostosis is a term used for premature closure, when the deformity of the cranial shape appears as a result of one or more premature cranial suture closure (Al-Tubaikh and Reiser, 2009).

The segments of the axial skeleton present two developmental subcategories. One of them is the presence of transitional vertebrae, when the involved segments become similar to each other. It develops in the atlantooccipital, cervicothoracic, thoracolumbar, lumbosacral and sacrococcygeal junctions, the condition usually involves the vertebral arch or transverse processes. One of the most common transitional defects is the fusion of the occipital bone and the first cervical vertebra (also known as occipitalization), it is often manifested as complete bilateral fusion (Jayanthi et al., 2003; Kalla et al., 1989). The prevalence of the defect in modern populations is between 0.25 and 0.4 % (Jeanneret and Magerl, 1990). This condition is known in paleopathological literature, several case reports are available. Easily recognizable transitional defect is the sacralization, when the 5th lumbar vertebra or the 1st coccygeal segment may fuse partly or completely to the sacrum (Zimmerman and Kelley, 1982). The prevalence of the disease depends both on different diagnostic criteria and the examined population,

and results between 4 and 35 % were found. Population analyses suggest no significance difference between the two sexes. (Bron et al., 2007; Campillo and Rodríguez-Martin, 1994).

Classical congenital vertebral fusions (also known as *synostosis vertebralis*) may develop in any vertebral connection. The cervical spine is the most involved generally, and tends to be familial (Barnes, 2008). Klippel – Feil syndrome is one of the syndromes in which one or more congenital cervical blocks are present, it has an autosomal dominant mode of inheritance. It was Maurice Klippel and André Feil who described the syndrome first in 1912. The affected individual presented extensive cervical and thoracic fusions with the classical triad of the syndrome: short neck, low posterior hairline and decreased mobility of the neck were recognizable (Klippel and Feil, 1912 in Dávid *et al.,* 2002). Additional developmental defects are frequently found in the involved individuals; e.g. Sprengel-deformity (relatively high position of the clavicle), asymmetric skull, deformed bones, etc. are recognizable. Due to different manifestation of Klippel-Feil syndrome, three types are decribed. Type I is characterized with cervical or thoracic vertebral block incorporated two or more vertebrae, other major developmental alterations are also present (Barnes, 1994). In the cases of Type II syndrome two or three cervical vertebrae are involved in a single block in most of the individuals, occipitalization and hemivertebrae may present in some cases (Resnick and Kransdorf, 2005). Type III individuals exhibit cervical block vertebrae with other segmental errors in the thoracic and/or lumbar spine (Barnes, 1994). Rare alterations may also be in association with the Klippel-Feil syndrome, Pany and Teschler-Nikola (2007) found special cranial lesions in the individual diagnosed with probably Klippel-Feil syndrome.

Congenital fusions may also appear in the extraspinal skeleton. Congenital ankyloses of the ribs may involve the heads, the neck or the tubercles, but merged ribs at the mid-shafts are also observable (Barnes, 2008). The fusion(s) may develop as a single alteration, and the 1st and 2nd ribs are involved the most (Aufderheide and Rodriguez-Martin, 2006), However, the coexistence with other congenital deformities of the thorax is not uncommon (Tsirikos and McMaster, 2005).

Sternum includes three parts; the sternal manubrium, the sternal body and the xiphoid process may unite in all possible combination. Special form may develop, when the coexistence of the mesomanubriosternal fusion and the misplaced mesomanubriosternal joint are recognizable in the same specimen. Contradictory analysis results are available in the medical literature; while in the

opinion of Trotter (1934) the fusion is not age-related, Romanes (1972) found association between the mesomanubriosternal fusions and ageing. Cameron and Fornasier (1974) reported that the synostosis occurs at the manubriosternal joint in 14% of adults, and an increasing number of cases is found with increasing age.

Characteristic developmental alteration is the proximal radioulnar fusion, fibrous or bony fusion between the two bones, the proximal radioulnar joint is involved usually (Aufderheide and Rodriguez-Martin, 2006). Familial analyses suggest that the disease has an autosomal dominant mode of inheritance; the rotation of the forearm is impeded (Al-Tubaikh and Reiser, 2009; Anton and Polidoro, 2000).

Carpal bones may present ankyloses of developmental origin. The most involved bones are the lunate and the triquetral, but other sites may also be affected. The fusion may be in association with other developmental defects, but single appearance is also possible (Aufderheide and Rodriguez-Martin, 2006).

Congenital ankyloses may involve the big, weight-bearing joints as well. In particular cases, segmentation failure or other developmental diseases (Miller, 1922; Ryan *et al.*, 1978; Mittal 1995; Eylon *et al.*, 2007; Madadi *et al.*, 2010) result in the fusion of large joints, in these cases the original joint surfaces are not visible, or they are recognizable in a partly developed form.

Haematological disorder may play the key role in some joint fusion, e.g. Elayan and Hamdan demonstrated ankyloses of the lower extremities as a secondary response to complications of sickle cell disease (Al Elayan and Al Hamdan, 2012).

Fibrous or osseous fusion may develop among the tarsal bones. This congenital condition is known as tarsal coalition, and the most involved joints are the talocalcaneal and calcaneonavicular joints. The tarsal coalition is bilateral in 50 % of the cases, and it is a common factor in the background of the flatfoot's development (Al-Tubaikh and Reiser, 2009). We have to note, that the tarsal coalition

may also associated with extrinsic factors (e.g. trauma, infectious processes) (Aufderheide and Rodriguez-Martin, 2006).

Traumatic effects can lead to the development of an ankylosis, multiple processes may be recognizable in the background. Immobilization caused by a traumatic event (e.g. fracture) may result in fibrous adhesions both in intra- and extra-articular areas. These fibrous bands can thicken with time, bony fusion may develop at the disused joint (Resnick and Kransdorf, 2005; Ebnezar, 2010). If trauma is associated with nerve damage, the lack of sensation is present. This condition may lead overuse the broken bone, and retareded healing together with the development of a Charcot joint are possible. Traumatic events may cause degenerative joint, the healing may result in bony ankylosis. We have to note, that in lot of these cases the presence of some infection cannot be excluded (Ortner and Putschar, 1981).

Special forms of the ankyloses are the vertebral fusions followed a vertebral fracture; they may be caused by macro- or microtraumatic effects. The lumbar spine is the most commonly affected, and decrease of the vertebral body height is common. The vertical collapse may involve the entire vertebral body, but as a result of the protective role of the posterior elements, the anterior part of the body presents a more serious decrease (Aufderheide and Rodriguez-Martin, 2006). If the fracture is associated with osteoporosis, concavity on both the involved and other spinal segments' plates is recognizable in most of the cases. Spinal fractures associated with osteoporosis appear in more females than in males, an increasing tendency with age is recognizable (Old and Calvert, 2004).

Degenerative processes may be responsible for osseous ankyloses. The most important predilectional area of the phenomenon is the spine; both the intervertebral discs and posterior zygapophyseal joint can be involved. These degenerative processes present an increasing tendency with ageing in their prevalence. Concerning the degenerative disc disease (spondylosis deformans), vertical osteophytosis is common, the most involved regions are the lower cervical, lower thoracic and lower lumbar vertebrae. If the size of the osteophytes becomes too large, osseous ankylosis may appear. Zygapophyseal joints may also be involved (Aufderheide and Rodriguez-Martin, 2006).

Non-specific pyogenic arthritis is one potential cause that may lead to the osseous ankylosis of the joints. All the joints can be involved by pyogenic arthritis but the disease rarely affects the small joints of the fingers and toes. In more than 50 % of the cases it involves the knee and in 20 % the hip. Septic arthritis may rarely develop polyarticularly; nevertheless, it is typical monoarticular disease (Maddison *et al.*, 1993). Although the pathogens are various, most frequently bacterium species (*Staphylococcus sp.*, *Streptococcus sp.,* etc.) are responsible for the infection. The pathogens can reach the joint through different ways but the most common route of the infection is the haematogenous spread (Bullough, 1992). The bacteria infiltrate the synovial membrane first; the lumen of the joint will be infected later. If the infection remains untreated, severe destruction of the joint, later ankylosis develops (Waldron, 2009). The bacteria may reach the joint from the bone as well, in these cases infectious traces in the bones (periostitis, ostitis and osteomyelitis) can also visible. When osteomyelitis is present, cloacal opening(s), sequestrum and involucrum are not uncommon (Ortner, 2008).

Among the specific infections tuberculosis is one of the potential candidates that may result in bony ankylosis. Human TB pathogens (mainly *Mycobacterium tuberculosis* and *Mycobacterium bovis*) usually infect the lungs and respiratory tracts first; however other organs may also be involved including the lymph nodes, pericardium, skin or skeletal elements. The route of infection is usually through the respiratory tract, although infection occasionally occurs through the intestinal tract. Osseous alterations are associated with only 1-3 % of the TB cases (Tuli, 2004; Vanhoenacker, 2009). Bone alterations develop slowly after the haematogenous dissemination from the remote septic foci. Spinal segments are the most important sites, where carious lesions, later collapse and fusion of the vertebral bodies may develop (referred to as Pott's disease). Beside these sites, weight-bearing joints, like the hips and knees, are the most frequently involved areas, but all of the joints may be affected. In a small percentage of the cases, not only destructive lesions appear but, bony ankylosis may also be present as a sign of the healing process (Resnick and Krandsorf, 2005; Sorrel and Sorrel-Déjerine, 1932). The disease is well-known in paleopathological literature, classical skeletal TB cases are easily recognizable, numerous publications (e.g. Pálfi *et al.,* 1999; Rothschild and Martin, 2006) demonstrate the presence of the TB in the past. As the skeletal TB present various manifestation forms (Harisinghani *et al.*, 2000), the recognition of the disease may be difficult in osteoarchaeological specimens without pathognomic signs; the lack of laboratory tests, missing anamneses may result misdiagnosed tuberculous cases. The development of molecular biological techniques helps the analysis, detection of mycobacterial DNA or mycolic acid fragments provides new diagnostic tool for the scientists (Haas *et al.*, 2000; Minnikin *et al.*,

2011, Masson *et al.*, 2012). On the other side, due to the development of diagnostic criteria in the field of the palaeopathology, new possibilities have been introduced in the recognition of TB-associated skeletal TB (Pálfi *et al*., 1999, Maczel, 2003, Bereczki *et al.*, 2009).

The pathogen of the leprosy is another Mycobacterium species (*Mycobacterium leprae*), which attacks mainly the soft tissues (e.g. skin, mucous membranes, and nervous system), but osseous changes can develop, too. Its characteristics in dry bones are destruction of the nasal bones, septum and hard palate, widening and rounding of the nasal aperture (saddle-nose), and partial resorption of the premaxillary alveolar region. Destruction of sensory nerves leads to slowly progressive atrophy of phalanges, metatarsals and metacarpals (Ortner and Putschar, 1981). Loss of sensation may also lead to recurrent trauma to the joints of the lower limbs, these cases and frequent secondary pyogenic infections may result in osseous ankyloses (Rogers and Waldron, 1995). Detection of the fragments of the pathogen's DNA in osteoarchaeological samples was reported (e.g. Haas *et al*. 2000).

Additional specific infections may also cause ankyloses, e.g. brucellosis, neuropathic degeneration associated with syphilis or special fungal infections may also lead to the development of bony fusions (Aufderheide and Rodríguez-Martin, 1989).

Bony ankyloses may be in association with metabolic diseases. Vertebral block can develop in the cases diagnosed as Paget disease; concerning the distribution of sex, strong male predominance and association with DISH are reported (Marcelli *et al.*, 1995).

Diffuse idiopathic skeletal hyperostosis (DISH) or Forestier's disease is one of the metabolic disorders that recognisable in the connective and supportive tissues. Pathophysiologically it is characterized by calcification and ossification of soft tissues, especially ligaments and entheses, and it was first described by Forestier and Rotes-Querol in 1950 (Forestier and Rotes-Querol, 1950). Later Resnick and his colleagues investigated the correlation between the spinal alterations related to DISH and extraspinal ossification and calcification findings, and in 1976 published their results (Resnick *et al*., 1976, Resnick and Niwayama 1976). In the second publication Resnick and Niwayama postulated three criteria for the diagnosis of DISH, these are now widely used in literature, and they may help in

differentiation of this disease from other spinal disorders, such as ankylosing spondylitis or spondylosis deformans. The spine has two anatomopathologic spinal types (Cammisa *et al.*, 1998), Type I is related to DISH. It is characterized by irregular ligament calcification, particularly the anterior longitudinal ligament of the spine. The entire spinal column may be involved, but the most typical sites are the mid-low cervical and the mid-low thoracic vertebral segments, bony ankylosis may develop. Radiologically a special view can be seen; as a result of the non-homogenous calcification a radiotransparent band is visible between the vertebral body and the outer layer of the ligament. The calcification appears usually on the right side of the spine. The left side is typically spared or less involved, which is probably attributable to the pulsating aorta. We have to note that zygapophyseal joint gaps and intervertebral spaces are not affected, the original width of these elements are not usually decreased (Olivieri *et al.*, 2009).

Concerning extra-spinal alterations, bony spurs develop at entheses, the most affected sites are the patellae, calcanei and the ulna's olecranon. Ligament ossification, such as sacro-iliac ligament ossification may results in sacro-iliac fusion. DISH appears more often in males than females, and the frequency increases in individuals over 40 years of age (Olivieri *et al.*, 2009).

Although the aetiology of DISH is not clear, several conditions seem to be associated with the disease. These include obesity, hyperlipidemia, hyperuricemia, hyperinsulinemia and late onset (Type II) diabetes (Burner and Rosenthal, 2009). Not only recent population studies or case reports show correlation between obesity and DISH, but palaeopathological studies also reported some association between the two diseases. A high prevalence of DISH cases has been recognized in ancient clergymen, and it has been hypothesised that the „monastic way of life" might be a predisposing factor of DISH (Rogers and Waldron, 2001, Verlaan *et al*., 2007). Other paleopathological studies point out that development of DISH has a correlation with higher social status (Jankauskas, 2003; Giuffra *et al.*, 2010). In recent populations dysphagia is also found in correlation with DISH in several cases (Oppenlander *et al.;* 2009, Seidler *et al*.; 2009, Miyamoto *et al.*; 2009, Masiero *et al.*; 2010), and increased affinity to fracture of the fusioned spine is also mentioned in the recent medical literature (Westerveld *et al*., 2009).

Concerning the most frequently used methods in recent populations, the diagnosis of DISH is generally based on radiologic analyses. The widely used diagnostic criteria of Resnick and Niwayama (Resnick and Niwayama, 1976) are at least four vertebral bodies' fusion, the preservation of the intervertebral disc, the absence of zygapophyseal and sacro-iliac joint changes. According to Arlet and Mazières three involved contiguous vertebrae at the lower thoracic spine is sufficient for the diagnosis (Arlet and Mazières, 1985). In the opinion of Julkunen et al. bony bridges between two vertebral bodies in at least two sites of the spine have to be characteristic for DISH (Julkunen et al., 1975). However, another set of criteria, defined by Utsinger as probable DISH, lowered the threshold for spinal alterations to the fusion of three adjacent vertebral bodies, but added the presence of extra-spinal enthesopathies to the diagnostic measures (Utsinger, 1985).

In Waldron's opinion the operational definition for DISH in paleopathological analysis means the presence of the ossification and fusion of four adjacent vertebral bodies, which are associated with the ossification of extraspinal entheses and ligaments (Waldron, 2009).

Biochemical analyses also carried out to make a proper diagnosis for DISH. Denko *et al.* demonstrated a significant increase in serum growth hormone, insulin-like growth factor –I and insulin in Caucasoid females diagnosed with DISH. In males only growth hormone and insulin were higher than normal controls (Denko and Malemud, 2005, Denko *et al*., 1996).

The category of rheumatic (inflammatory) diseases incorporates about two-hundred diseases, they involve joints and the connective tissue, all of them are characterized with inflammatory character (Isenberg et al., 2004). Here we underline those ones, which may demonstrate ankyloses.

Rheumatoid arthritis (RA) is one of the most important diseases in this group. Its aetiology is unclear, genetic, environmental and immune factors may be responsible for the immune response given for some unknown antigen-stimulus (Huizinga and Breedveld, 2009). Rheumatoid factor is known to be one of the diagnostic criteria of rheumatoid arthritis, but, it is not pathognomic for RA. It may appear as a concomitant of rheumatic fever, but the greatest part of the disorder forms between 30 and 70 years of age, its presence is three times more common in females than males. Symmetrical, polyarticular

changes are recognizable in the skeleton, which may attack any synovial joint, but the most common sites are the small articulations of hands, feet and spine. The changes affect the PIP and MCP joints of the hand and wrist most commonly; they are followed by the MTP joints of the feet (Posalski and Weisman, 2009). The development of typical erosive changes begins at the margin of the joint, later bony thinning; rarely eburnation may be seen on the affected surfaces. Bony ankylosis is not common, except occasionally at carpals and at mesomanubriosternal joint (Lapis, 1989, Khong and Rooney, 1982).

Spontaneous osseous ankylosis can occur in weight-bearing joints as a rare late stage manifestation of rheumatoid arthritis (Ojima *et al.*, 2005); however, the most common predilectional sites affected by the disease are the small joints of the hands and feet. Bilateral marginal erosions of the proximal interphalangeal joints and also of the metacarpo-phalangeal and metatarso-phalangeal joints are visible in most affected patients, moreover, osteoporosis is also noted around the affected joints (Waldron, 2009).

Ankylosing spondylitis (AS) is a progressive inflammatory disease of unknown aetiology, genetic and environmental factors are thought to have key roles. The disease is the most important and most frequent member of the complex seronegative spondylarthropathies (SNSAs). The majority of the patients have a tissue antigen referred to as HLA-B27 antigen in their blood; the overall estimated prevalence of AS is 1.9%, however there is a wide variation according to geographic areas (Braun et al., 1989). The peak onset of the disease is in the early 20s. (Sieper *et al.,* 2002). It affects more males than females. One of the characteristics is the syndesmophyte – ossifications leading to fusion of the spine, the lumbar vertebrae are the most involved. Vertebrae become ‘squared’ radiographically, so-called ‘bamboo-spine’ without skip lesions is recognizable. Uni- or bilateral sacroiliitis, symmetrical fusion of the sacroiliac joint is possible, sometimes costovertebral fusions appear (Waldron, 2009).The disease can also affect other joints of the extremities (e.g. knee, hip, shoulder and ankle), however the lack of spinal involvement in any of these skeletons, and presence of periosteal reaction (not associated with ankylosing spondiylitis) rules it out as a causative agent (Bilsel *et al.*, 2003).

Other members of the SNSAs may also result in ankyloses, both reactive and psoriatic arthropathies may be in association with skeletal fusions, special distinctive pattern according to

vertebral and sacroiliac involvement is seen in these diseases (Waldron, 2009, Mease and Helliwell, 2008).

2. Aims

Osseous ankyloses are quite rare in the modern medical practice, thanks to diagnostic techniques that allow early detection and treatment of the underlying disease. Evidence of the natural history and progression of the diseases is now primarily studied through the observation and analysis of osteoarchaeological specimens and medical reports or books dating from the pre-antibiotic era.

My PhD-studies focus on diagnostic and epidemiological approaches of the phenomenon of ankyloses. After making the database of ankyloses the osteoarchaeological investigations planned to be done on the following axes:

- Is it possible to find special characteristics during a systematic analysis of ankyloses, which can help both confirm our previously established diagnosis and find the exact aetiological background?
- How can the utilization of medical imaging techniques help us to clarify the characteristics of different ankylosis cases? How can we integrate the results of recent medical imaging technique studies into the palaeopathological context?
- Are histological analyses informative for us to make a proper description of development of the ankylosis? Can we differentiate different types of ankylosis cases on the basis of histological differences?
- In case of the co-existence of joint ankylosis and other pathological conditions in osteoarcheological material, the analysis of the associations among these diseases may be helpful in the understanding of the interaction and development of human diseases?
- Is any difference between our results and those found in medical/palaeopathological literature according to the epidemiological characteristics?

3. Material and methods

3.1. Archaeological and historical background

During our analysis, anthropological materials from the Great Hungarian Plain were examined. Except for three series (Sárrétudvari - Hízóföld, Biharkeresztes - Ártánd - Kisfarkasdomb, Magyarhomorog - Kónyadomb) our analytical samples are originating from the southern part of the Great Hungarian Plain (Fig. 3.1.).

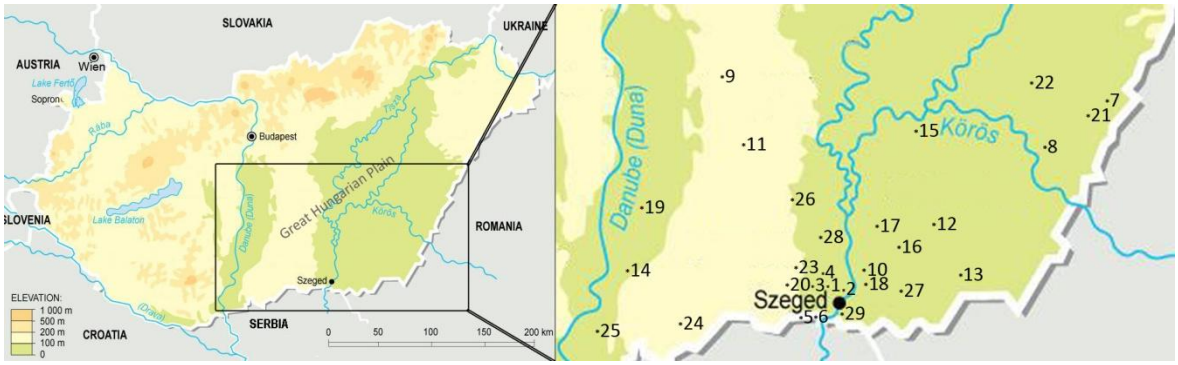


Figure 3.1.Geographical localization of the examined series (1. Madaras – Halmok; 2. M5 motorway - Kiskundorozsma, site 26/60; 3. M5 motorway - Kiskundorozsma, site 26/72; 4. M5 motorway - Kiskundorozsma, site 26/78; 5. M5 motorway - Röszke, site 48/60; 6. M5 motorway - Röszke, site 48/75; 7. Biharkeresztes - Ártánd – Kisfarkasdomb; 8. Bélmegyer - Csömöki domb; 9. Hetényegyháza - site 72; 10. Hódmezővásárhely - Kopáncs III. Homokbánya; 11. Kunszállás – Fülöpjakab; 12. Orosháza Béke TSZ; 13. Pitvaros – Víztározó; 14. Sükösd – Ságod; 15. Szarvas - site 68; 16. Székkutas – Kápolnadűlő; 17. Derekegyház – Ibolyásdomb; 18. Hódmezővásárhely - Nagysziget, 19. Homokmégy – Székes; 20. M5 motorway - Kiskundorozsma, site 26/78; 21. Magyarhomorog – Kónyadomb; 22. Sárrétudvari – Hízóföld; 23. Szatymaz- Vasútállomás; 24. Bácsalmás –Homokbánya; 25. Bátmonostor – Pusztafalu; 26. Nyárlőrinc - Hangár út; 27. Óföldeák; 28. Ópusztaszer – Monostor; 29. Szeged – Vár).

The Great Hungarian Plain (also known as Alföld or Nagy Alföld) is a plain occupying the southern and eastern part of Hungary, but it continues toward Slovakia, Ukraine, Romania, Serbia, and Croatia. It is an alluvial plain, as a result of the its rich soil and moderate climate, it is an inhabited area from the Upper Palaeolithic era (Visy, 2003).

The skeletal remains represent five archaeological periods of the Carpathian Basin; the oldest specimens are dated back the Sarmatian period (1-5th c. AD). In our analysis this period was followed by the era of the Gepids (5th c. AD), the Avar period (7-9th c. AD) and the Conquest period / mid-Árpád age (10-12th c. AD). The most present series are dated back to the late

Middle Ages and the early modern times, but these cemeteries were used for the longest period, and in lot of cases - as a result of the reutilization of the graves or the lack of grave goods – more precise dating was not possible. We have to note that three cemeteries (Nyárlőrinc-Hangár út, Óföldeák, Ópusztaszer – Monostor) have been utilized for a longer period, but the majority of the graves was dated back the late-Middle ages and the early modern times. Thus these three series were inserted into the latter 'archaeological' category.

Concerning the number of skeletal remains from different periods, the poorest representation belongs to the Gepids (42 individuals), while the majority of the series is from the Avar period and the late-Middle Ages/early modern times (2184 and 6895 individuals, respectively). Summarizing the data, we can say that skeletal remains of 10976 individuals have been included the examined material (Fig. 3.2.).

cemetery /archaeological site (abbreviation)		datation		number of individuals
		archaeological period	precise datation	
1.	Madaras - Halmok (MHA)	Sarmatian period	2nd-5th c. AD	464
2.	M5 motorway - Kiskundorozsma, site 26/60 (KD 26/60)	Sarmatian period	3rd-4th c. AD	3
3.	M5 motorway - Kiskundorozsma, site 26/72 (KD 26/72)	Sarmatian period	2nd-3th c. AD	21
4.	M5 motorway - Kiskundorozsma, site 26/78 (KD 26/78)	Sarmatian period	4th c. AD	57
5.	M5 motorway - Röszke, site 48/60 (RO 48/60)	Sarmatian period	3rd-4th c. AD	14
6.	M5 motorway - Röszke, site 48/75 (RO 48/75)	Sarmatian period	3rd-4th c. AD	2
7.	Biharkeresztes - Ártánd - Kisfarkasdomb (BAK)	Gepids	5th c. AD	42
8.	Bélmegyer - Csömöki domb (BCS)	Avar age	6-8th c. AD	239
9.	Hetényegyháza - site 72 (HE 72)	Avar age	6-8th c. AD	256
10.	Hódmezővásárhely - Kopáncs III. homokbánya (HVK)	Avar age	7-8th c. AD	210
11.	Kunszállás - Fülöpjakab (KFJ)	Avar age	8th c. AD	50
12.	Orosháza Béke TSZ (OHB)	Avar age	8th c. AD	100
13.	Pitvaros - Víztározó (PVT)	Avar age	7-9th c. AD	226
14.	Sükösd - Ságod (SUS)	Avar age	7-8th c. AD	171
15.	Szarvas - site 68 (SZ 68)	Avar age	7-9th c. AD	414
16.	Székkutas - Kápolnadűlő (SZK)	Avar age	8th c. AD	518
17.	Derekegyház – Ibolyásdomb (DID)	Árpád age	11-12th c. AD	56
18.	Hódmezővásárhely - Nagysziget (HVN)	Conquest period / early Árpád age	10-11th c. AD	131
19.	Homokmégy - Székes (HSZ)	Conquest period / early Árpád age	10-11th c. AD	185
20.	M5 motorway - Kiskundorozsma, site 26/78 (KD 26/78)	Conquest period	10th c. AD	4
21.	Magyarhomorog - Kónyadomb (MHK)	Conquest period / Árpád age	10-12th c. AD	368
22.	Sárrétudvari - Hízóföld (SUH)	Conquest period	10th c. AD	264
23.	Szatymaz- Vasútállomás (SZA)	Conquest period / Árpád age	10-12th c. AD	286
24.	Bácsalmás -Óalmás (BA)	early modern times	16-17th c. AD	481
25.	Bátmonostor - Pusztafalu (BMP)	late Middle ages	14-15th c. AD	3782
26.	Nyárlőrinc - Hangár út (NYL)	Árpád age / late Middle ages	12-16th c. AD	483
27.	Óföldeák (OF)	Árpád age / modern times	11-18th c. AD	419
28.	Ópusztaszer - Monostor (OPM)	Árpád age / modern times	11-18th c. AD	1089
29.	Szeged - Vár (SZV)	Árpád age / late Middle ages	14-15th c. AD	641
			Total	10976

Figure 3.2. Distribution of the examined osteoarchaeological series according to dating and size.

The examined series, except for skeletal remains of one excavation material, are stored at the Department of Biological Anthropology, University of Szeged (Hungary). The osteoarchaeological series of the Hódmezővásárhely – Kopáncs III Avar age cemetery is placed at the Tornyai János Museum (Hódmezővásárhely, Hungary).

3.1.1. Sarmatian period

Madaras - Halmok

Madaras (Bács-Kiskun County) is situated south to Bácsalmás, near to the present Serbian border. The first represented archaeological period is the late-paleolithic era, but the biggest excavation connected with the Sarmatians in the area. The two-phased archaeological excavation of Madaras-Halmok started in 1957, and after an interval of five year, continued in 1963. The digging was carried out under the direction of Mihály Kőhegyi (archaeologist, Türr István Museum, Baja), and the 12-year-long excavation resulted in the biggest completely known Sarmatian cemetery on the Great Hungarian Plain (Kőhegyi 1971; Kőhegyi and Vörös 1996). The number of the graves is 635, but among these not only Sarmatian, but some Hunnian and Árpád Age burials were found as well. On the basis of grave goods, the Sarmatian cemetery seems to have been utilized between the 2nd and the 5th centuries AD. Circle shaped ditches surrounded most of the graves. In lots of cases, as a tradition from the steppes, the earth from ditches was heaped over the graves; the size of these mounds may reflect the social status of the dead. Although well preserved coffins were not found, but traces of wooden coffins carved from one piece of log were visible in a significant part of the burials. The majority of the graves were ravaged by contemporary robbers, the areas of the hip and skull were devastated mainly (Kőhegyi, 1994; Vörös and Kőhegyi, 2001).

Preventive excavations along the M5 motorway (Csongrád County)

It was 1993, when protective archaeological excavations began in Csongrád County, along the 48 km long trace of the M5 motorway. During the 7-year-long project more than 100 archaeological sites from the Bronze Age to the Middle Ages had been discovered in Csongrád County (Szalontai, 2003). In case of five sites (Kiskundorozsma -site 26/60, Kiskundorozsma – site 26/72, Kiskundorozsma – site 26/78, Röszke – site 48/60, Röszke – site 48/75) details of both settlements and cemeteries were unearthed. Most of the skeletal remains were found in individual inhumations, and with the exception of some case, the graves had a southern-

northern orientation. The dating of the sites' utilization is based on ceramics, the coins and the pieces of jewellery found in the inhumations, and the cemeteries seems to be utilised between the 2nd and 4th centuries (Bozsik, 2003; Korom, 2003; Szalontai and Tóth, 2003a; Szalontai and Tóth, 2003b).

The archaeological site of Kiskundorozsma Site 26/72 is situated on the banks of Maty-ér, near the western boundary of Kiskundorozsma. An overall area of 55.099 square meters was unearthed under the direction of Csaba Szalontai and Katalin Tóth (Móra Ferenc Museum, Szeged and Tornyai János Museum, Hódmezővásárhely, respectively) objects dated back to the Bronze Age, the Sarmatian period and the late-Middle Ages were identified. Among the Sarmatian settlement objects beehive-shaped food storage and waste pits, open-air ovens, traces of small buildings were the most typical elements. Although the settlement seems to have been long-lived (2nd-5th c. AD), the small cemetery including 24 burials was utilized between the late 2nd and the early 3rd centuries AD. At four graves of circular ditches surrounded the inhumations, in one case, on the basis of the special structure of graves, familiar connections are not excluded either (Szalontai and Tóth, 2003a).

The site Kiskundorozsma 26/78 is situated on the northern side of a small hill, at the riverbank of Maty-ér. The area was an important place in different archaeological periods, the area (with 4.500 square meters of size), beside the partly unearthed Sarmatian cemetery, upper Pleistocene archeozoological findings (skeletal remains of an aurochs), some Celtic tell objects and grave, four graves dated back to the Hungarian Conquest period, objects from the Árpád Age and the late Middle Ages also were dug out. During the two years of excavation 60 graves were unearthed (Katalin Bozsik; Móra Ferenc Museum, Szeged), 16 burials were surrounded with circular-shaped ditches that vary in their size. The earth of the ditches was heaped over the graves that may be associated with the social status of the individual in the population. These mounded inhumations had in a special, central position of the cemetery, the rest of the burials were found in the peripheral part; they formed rows or located in a disperse way. All of the skeletons laid on their back with outstretched limbs, the orientation of them was northern-southern or northwest-southeast. The majority of the graves were robbed out, but even nice and interesting findings were found in the burials. On the basis of them (e.g. Roman

coins, pearls, bracelet, tools and ceramics) the cemetery seems to have been utilized in the 4th century AD (Bozsik, 2003).

It was the summer of 1999, when a preventive archaeological excavation was carried out under the direction of Bozsik Katalin and Kürti Béla (Móra Ferenc Museum, Szeged). At the site of M5 motorway - Röszke 48/60 beside the objects of an Avar age settlement, two graves dated back to the Sarmatian period also were unearthed. The inhumations had a southeastern-northwestern direction, on the basis of the typical Sarmatian jewellery (big amount of pearls) found in the burials, the skeletal remains belong to female individuals. The cemetery continued eastward, but these graves have not been excavated yet. The cemetery seemed to be utilized between the 3rd and 4th centuries AD.

The excavation summaries of the sites Kiskundorozsma 26/60 and Röszke 48/75 are not published yet, but on the basis of the verbal information of the archaeologists, graves in both site are dated back to the late Sarmatian period (3rd-4th centuries AD).

3.1.2. The Gepids

Biharkeresztes - Ártánd - Kisfarkasdomb

The site of Kisfarkasdomb is situated close to Biharkeresztes, about 600-800 meters from the Romanian border. The first excavational stage resulted in 26 graves and was carried out by Károly Mesterházy in 1966. The second excavation phase belongs to Ibolya Nepper, she and her colleagues dug out another 24 graves in 1971. Only 44 inhumations contained skeletal remains, on the basis of grave goods the cemetery seems to be utilized in the 5th century AD. The dating has changed in two instances later, so only 42 individuals were examined in our analysis (M. Nepper and Sz. Máthé, 1972).

3.1.3. Avar age

Bélmegyer - Csömöki domb

The triangular shaped Csömöki-domb (Csömöki hill) is situated about three kilometers south-east of Bélmegyer (Békés County). In 1985, as a result of agricultural activity human skeletal remains became unearthed. Under the direction of Medgyesi Pál (archaeologist, Munkácsy Mihály Museum, Békéscsaba) a 5-year-long excavation began, and an extensive cemetery dated back to the late-Avar period had been dug out. The total number of the graves is 243, in the opinion of the archaeologist, the cemetery regarded as being completely excavated. The people lived a settled lifestyle, and on the basis of the grave goods, the population seems to be utilized the cemetery between 670 and 800 AD. The cemetery had a special structure, the deepest and richest burials were found, in one case not only human remains, but a complete horse skeleton with its rich harness were also unearthed. These phenomena led us to draw the conclusion that the most rich and most influential people used this part of the cemetery. In a male skeleton partly healed trephination can be seen, the appearance of this surgical event is not common, but present in the osteoarchaeological series dated back to the Avar period (Medgyesi, 1991, 1998).

Hetényegyháza – site 72

Hetényegyháza – site 72 is situated between the Danube and Tisza rivers, about 7 km far from the centre of Hetényegyháza (Bács-Kiskun County). As a result of the two-phased excavation, 263 graves had been dug out between 1994 and 1995. Although the majority of the inhumations was disturbed (consequences of erosion and spoliation were found), significant amount of grave goods (e.g. jewelry, tools) helped H. Tóth Elvira (archaeologist) to make the precise dating. On the basis of the above-mentioned objects, the cemetery belongs to the Avar age (H. Tóth, 1995).

Hódmezővásárhely - Kopáncs III. homokbánya

In the sand mine of Kopáncs (located about two kilometers south of Hódmezővásárhely (Csongrád County) rescue excavation started in the first part of 2008. The first excavation period was carried out under the direction of Katalin Tóth (Tonyai János Museum, Hódmezővásárhely), and it resulted in 12 graves. All of the burials contained one skeleton (Tóth, 2009). In the second excavational period the digging continued in the second part of 2008 and next spring, under the direction of Gergely Bóka (Munkácsy Mihály Museum, Békéscsaba) and Gábor Bácsmegi (archaeologist, former Field Service for Cultural Heritage, Szeged). As a result of the second excavation, 217 burials have been unearthed, so the total number of the graves is 229, these formed separated rows. Beside the individual graves in five cases duple burials also were found, and some inhumation with horses are present in the cemetery. The skeletons laid on their back; in the typical situation outstretched arms and legs were visible, but in some individuals the arms were flexed to the pelvis or the chest. Based on the grave goods (ceramics, tools, jewellery, horse harness) the cemetery was utilized between the 7th and 8th centuries AD (Bácsmegi and Bóka, 2010).

Kunszállás - Fülöpjakab

It was H. Tóth Elvira (archaeologist, Katona József Museum, Kecskemét), who unearthed a Sarmatian settlement and a part of a cemetery at the region of Kunszállás – Fülöpjakab (Bács-Kiskun County) during a two-phased excavation (1967, 1970-1978). Concerning the cemetery, 50 graves from the late Avar Age (8th century, AD) were found (Horváth *et al*, 1988; Székely, 1988). The inhumations' dating was based on rich grave goods, beside utensils bronze, silver and gold coins also helped the precise dating (H. Tóth, 1968, 1971, 1981).

Orosháza - Béke TSZ

In 1967 human burials were found during the opening of a sand mine, beside the skeletal remains ceramics and pearls also were unearthed. The sand mine is located about 5 kilometers north from Orosháza (Békés County). The archaeological excavation started

immediately after the detection under the direction of Irén Juhász (archaeologist, Szántó Kovács Museum, Orosháza), Gyula Török (archaeologist, National Museum of Hungary, Budapest) also took part in this digging. As a result of the earth removal several graves have damaged or destroyed, but the rescue of 44 burials' archaeological and anthropological material was successful. The second excavation campaign started in 1968, when the plans of sand mine's extension came up. Unfortunately, 50 graves of the cemetery have been destroyed by trucks and clamshells, but during the three stages of the excavation the archaeologist saved 108 graves. The project is completed by summer 1969, and as a result of these efforts, the southeastern and northeastern parts of the cemetery had been unearthed. The graves appeared in groups, but within the groups lines were formed. In eight cases the individuals were buried with their horses, these inhumations formed a line on the eastern part of the cemetery. The dating of the burials based on the grave goods, the cemetery was used in the 8th century AD (Juhász, 1995).

Pitvaros - Víztározó

The Pitvaros - Víztározó cemetery is located about 1,5 km southeast from Pitvaros. Preparation works of a reservoir started in 1993. The graves of the cemetery are situated on the western shore (a former river shore) of a lake. During the two stages of the excavation (1993-1994 and 1996) archaeological examination of about 5.000 square meters was carried out, 225 burials have been unearthed. As a result of the excavation the archaeologists (under the direction of Lívia Bende – Móra Ferenc Museum, Szeged) found the northern, eastern and southern boundaries of the cemetery, but the traces of inhumations continued westward, so the cemetery is partly excavated. The burials formed lines, and although different grave types were found, but the orientation of the burials is uniform, northwestern – southeastern direction can be seen. Beside the individual graves both double inhumations and horse graves were found in 5 and 3 cases, respectively. The dating of the cemetery was based on the uniform appearance of grave-goods (ceramics; jewellery: necklaces, pearls, bracelets, earrings; metal belt decorations, bronze and iron rattles), these objects suggested that the cemetery was

utilized from the last third of the 7th century to the second half of the 9th century (Bende, 1996, 1997, 1998, 2000).

Sükösd - Ságod

Sükösd is situated about 15 km north fom Baja (Bács-Kiskun County), and at the end of the 1960's an excavation began under the direction of Mihány Kőhegyi (archaeologist, Türr István Museum, Baja), which resulted in a partly excavated cemetery dated back to the Avar period. In the first phase 165 graves were dug out. Particular separation of the burials can be seen in the cemetery; the graves of women and children form a close group, while inhumations belonging to males can be found in another group, in some distance from the group of women and children. The precise dating point out that the cemetery could be utilized by three generations between 640-660 and 750 AD (Kőhegyi and Marcsik, 1971, 1976). After the first excavation stage a long break began, and the digging continued between 1979 and 1981 under the direction of György Székely and Erika Wicker archaeologists. As a result of this latter phase archaeological and anthropological material of 171 graves was unearthed (Wicker and Kőhegyi, 1997).

Szarvas – Site 68

The site of Szarvas-68 is situated south-east from Szarvas (Békés County). After the removal of the upper layer of the soil, grave patches were visible in the area of a to-be agrochemical plant and train rails. A preventive excavation started in 1983 under the direction of Juhász Irén (archaeologist, Tessedik Sámuel Museum, Szarvas), and as a result of the 3-year-long digging, 422 inhumations were unearthed. Concerning to the burial habitats, very varied burials were found; beside the individual graves double burials, complete or partial, real or symbolic horse inhumations also were dug out. The general orientation of the skeletons is northwest-southeast (Juhász, 1984, 1985, 1987). The burials were rich in grave-goods, the most interesting object was a needle-case carved from a piece of sheep bone from the 8th-century part of the cemetery (Juhász, 1983; Róna-Tas, 1985). The cemetery seems to have been utilized

between the beginning of the 7th century and the beginning of the 9th century AD (Szentpéteri, 2002).

Székkutas - Kápolnadűlő

Székkutas is situated north from Hódmezővásárhely (Csongrád County). The Kápolnadűlő cemetery was dug out between 1965 and 1986 under the direction of Katalin Nagy (archaeologist, Tornyai János Museum, Hódmezővásárhely). As a result of the more than 20-year-long excavation 555 graves were unearthed, the most of the burials dated back to the Avar period. In 22 cases graves are belonging the Sarmatian period, while in 30 graves the lack of the individuals was observable. Among the 503 Avar inhumations, 15 contained skeletal remains of two individuals (Bende, 2003).

3.1.4. Conquest period – Árpád age

Derekegyház – Ibolyásdomb

It was Hegedűs Katalin (archaeologist, Koszta József Museum, Szentes), who led the excavation at the Derekegyház - Ibolyásdomb between 1981 and 1982. As a result of the digging two Copper age (or neolith?) pit graves, a one-naved church from the Árpád age, 55 inhumations dated back to the Middle age, several ossuaries were found. On the hilltop shallower and older graves were excavated, these are belonging to an 11-12th century cemetery. The fact that the wall of the church has cut some of these burials demonstrates that the church itself is younger then these burials. Graves dated back to the Middle Ages surrounding the building were also excavated, most of the skeletons laid on their back. The limbs of them were outstretched beside the body, in some cases flexed position of the armes also were visible. The bigger part of the cemetery is still not excavated (Hegedűs, 1982).

Hódmezővásárhely - Nagysziget

The area called Nagysziget is one of the outskirts of Hódmezővásárhely (Csongrád County), and in the year of 1957 a 10-11th century cemetery was found here. The archaeological excavations were completed in several periods supervised by Gyula Gazdapusztai (Department Tornyai János Museum, Hódmezővásárhely) in 1957-1959 and László Révész (Herman Ottó Museum, Miskolc) and Katalin B. Nagy (Tornyai János Museum, Hódmezővásárhely) in 1982-1992. According to the archaeological reports, the cemetery includes 135 graves, the burials form well-described lines (B. Nagy, 1984; B. Nagy and Révész, 1986; Gazdapusztai, 1958, 1959; Kovács, 1979).

Homokmégy - Székes

Homokmégy is situated about 8 kilometers south-east from Kalocsa (Bács-Kiskun County). In the outskirt of the willage called Homokmégy-Székes an archaeological excavation was carried out under the direction of Zsolt Gallina (archaeologist, Thorma János Museum, Kiskunhalas). As a result of the digging a late-Bronze Age house, Sarmatian and Árpád Age settlements and a cemetery were unearthed. The burial site, based on the archaeologist's estimation, may include about 250-270 graves, during the four-year-long excavation (1996-2000) 215 grave were dug out. The cemetery's structure is associated with the soil: the burial site's most intense part was the western area, the graves formed lines in north-south direction. In the eastern part the burial-density was lower, while no inhumations were found in the south-western part. Based on the grave-goods the cemetery was utilized between the first third of the 10th century and first third of the 11th century AD (Gallina, 1998, 2000; Gallina and Hajdrik, 1998).

M5 motorway - Kiskundorozsma Site 26/78

See: Preventive excavations along the M5 motorway (Csongrád County)

Magyarhomorog – Kónyadomb

Magyarhomorog is situated in the southern part of Hajdú-Bihar County. In the outskirt of the village, the so-called Kónyadomb emerges from its surroundings and the area is a populated area from the Copper age. The most important archaeological period here is the Árpád Age. The first excavation began under the direction of Dienes István (Hungarian National Museum) and László Kovács (Hungarian National Museum), between 1962 and 1972 481 graves dated back to the Árpád Age were unearthed. Later, between 1985 and 1988 another 138 Árpád Age burials were dug out by László Kovács (Kovács, 1997). The 10-12th-century graves are one of the richest in coins dated back to the early Árpád age (Kovács, 2006).

Sárrétudvari - Hízóföld

Sárrétudvari - Hízóföld is situated about 60 kilometers from Debrecen (Hajdú-Bihar County), where 269 graves and 16 cremation urns had been unearthed with the leadership of M. Nepper Ibolya (archaeologist, Déri Museum, Debrecen). Concerning the dating, 5 graves is belonging to the Bronze Age, but the majority of the inhumations were dated back to the Conquest Period (10th c. AD). Some of the graves contained no skeletal remains, while in some of them more than one individual were found. In our analysis 264 skeletons were examined (M. Nepper and Sz. Máthé, 1972).

Szatymaz- Vasútállomás

As a result of a preventive archaeological excavation at the Szatymaz (Csongrád County) railway station (1957), 286 graves were dug out under the direction of Ottó Trogmayer (Móra Ferenc Museum, Szeged) and Gyula Farkas (Department of Anthropology, University of Szeged). The anthropological material in some cases – as a consequence of the lack of time – limited only to the long bones or the skull. The dating is based on the poor grave-goods, the cemetery seems to have been utilized in the early-middle Árpád age (10-12th c. AD) (Bálint, 1960).

3.1.5. Late Middle ages – early modern times

Bácsalmás – Homokbánya

Skeletal remains in the sand mine of Bácsalmás (located about 4 km from the town, Bács-Kiskun County) were excavated in three phases. The first excavation started in 1993 under the direction of Erika Wicker (Katona József Museum, Kecskemét), during which 91 graves were unearthed. After an interval of two years Zoltán Polgár and Pintér László (Damjanich János Museum, Szolnok) continued the digging, between 1995 and 1996 another 82 tombs were unearthed. Dating based on the rather poor grave goods, Wicker pointed out that the cemetery must have been utilized from the last third of the 16th century to second half of the 17th century (Wicker, 1999). The population seems to be that of a small, endogamic Slavic ethnic group, which arrived to this region from the south during the Turkish occupation (Wicker, 1999, 2002). The excavation third phase started in 2001 by Erika Wicker, during the 3-year long digging, when the western part of the cemetery was excavated, 311 graves were unearthed (Wicker, 2003).

Bátmonostor - Pusztafalu

Bátmonostor-Pusztafalu, where the medieval skeletal series originates from, is situated in the southern area of the Great Hungarian Plain, about 15 kilometers south from Baja (Bács - Kiskun County). The cemetery is located in the area of a gothic monastery. This clerical building built in the Árpád age (12th century), but it was destroyed by the Tatars (1242-1243). Later it was rebuilt again in 1245, and the monastery was used until the mid 15th century. The first archaeological excavation was started by Mihály Kőhegyi (archaeologist, Türr István Museum, Baja). Thus, 103 graves were unearthed by 1960; the majority of the graves was dug out by Piroska Biczó (archaeologist, Katona József Museum, Kecskemét) between 1977 and 1986. As a result of the two phases, the total number of graves is 3782, but, in the estimation of the excavator, about 20 percent of the cemetery is still not excavated. Although the digging is not complete and about one-fifth of the graves are still missing, but we can say that the medieval series of Bátmonostor - Pusztafalu is the biggest unearthed skeletal series in Hungary. Most of

the graves contained only one skeletal remain, but in almost 500 burials more than one individual was identified. However, we have to note that in case of 67 graves osteoarchaeological remains were not found (Biczó, 1981, 1984).

Nyárlőrinc - Hangár út

Nyárlőrinc is situated about 17 km north from Kecskemét (Bács-Kiskun County), and the first archaeological excavation in and around the medieval church in the village centre has been started in 1982. As a result of the 11-year-long digging, 541 graves were unearthed. Although the first found archaeological period is the early Árpád age, but graves from this period were not found. The earliest graves dated back from the 12th century AD, and the cemetery was utilized until the 16th century AD (Székely, 1987).

Óföldeák

The church of Óföldeák (Csongrád County) is situated on a small hilltop, and is one of those churches on the Great Hungarian, where the medieval building (it was typical characteristic in Transylvania) was surrounded a wall and a circle-shaped ditch. Small archaeological excavations were made five times in the second part of the 20th century, but the most comprehensive digging was carried out between 1990 and 1999 under the direction of Mária Béres (archaeologist, Koszta József Museum, Szentes). As a consequence of the excavation, graves from the 11th to the 18th centuries were unearthed, but the majority of the burials are belonging to the 15-16th centuries AD. These inhumations were found eastward from the apse, and a small, but well described area included only skeletal remains of the newborns and infants. The oldest graves were situated outside the building, some of them were found on the area of the ditch (Béres, 1994, 1995).

Ópusztaszer - Monostor

Ópusztaszer is situated about seven kilometers east from Kistelek, on the right side of the river Tisza. The area was populated from the Árpád Age, between 1970 and 1976 an excavation was carried out in and around the monastery dated back to the Árpád Age. The digging was led by Ottó Trogmayer (Móra Ferenc Museum, Szeged), and as a result of the excavation 961 inhumations were unearthed. On the basis of the grave-goods, the cemetery was utilized between the 11th and 18th centuries, the majority of the burials dated to the late Middle ages (Trogmayer and Zombori, 1980).

Szeged - Vár

The archaeological excavation at the former castle of Szeged started in 1999 under the direction of Ferenc Horváth (archaeologist, Móra Ferenc Museum, Szeged), as a result of the digging, rich archaeological material has been unearthed from the Árpád Age to the late Middle Ages. In the centre of the castle the archaeologist revealed a gothic church built in the first half of the 14th century, very dense burial area was found in and around the building. It was used first up to 1543, then after when the Turkish occupation has ended in Hungary (1686), again up to 1713 (Horváth, 2009). In 2007 Ottó Fogas (archaeologist, Móra Ferenc Museum, Szeged), continued the excavation, and up to now almost 1000 graves and several other objects (ossuaries, crypts) have been recovered (Horváth, 2009). As the consequence of the high density of the burial site, the mixed skeletal elements, human remains of the well separated graves were chosen for our investigation.

3.2. Anthropological analysis

The basic anthropological study consisted of the determination of sex and age at death was carried out at the Department of Biological Anthropology, University of Szeged and at the

National Cultural Heritage Protection Centre, Hungarian National Museum (former Field Service for National Heritage), Szeged.

3.2.1. Determination of sex

Determination of sex was based on anatomical sites/areas showing sexual differences. During the previous analyses the method of Éry and her colleagues (1963) was used, metric and non-metric characteristics both of the skull and the postcranial skeleton (at 12 and 9 anatomical areas, respectively) has been examined (Fig. 3.3). The sex determination was possible at adult and some juvenile individuals. On the basis of grave-goods, recognition of sex was available in some infant skeletal remains as well, but these results were not used in our analysis, children were examined as individuals with undetermined sex.

Skull	**Post-cranial skeleton**
Tuber frontale et parietale	*Pelvis maior*
Glabella, arcus superciliaris	*Pelvis minor*
Processus mastoideus	*Angulus pubis*
Protuberantia occipitalis externa	*Incisura ishiadica maior*
Squama occipitalis	*Sulcus praeauricularis*
Margo supraorbitalis et orbita	*Foramen obturatum*
Arcus zygomaticus	*Sacrum*
Facies malaris	Diameter of the *caput femoris*
Corpus mandibulae	*Linea aspera*
Trigonum mentale	
Angulus mandibulae	
Caput mandibulae	

Figure 3.3. Characteristics used for determination of sex.

3.2.2. Estimation of age at death

The estimation of age at death at subadult individuals was based on the phenomena of growth and development. These characteristics do not show a considerable variation from one individual to another. The age of foetuses, newborns and children was determined on the basis of the diaphyseal length of long bones, the eruption and sequence of tooth formation, and the

ossification of epiphyseal growth plates (Schinz *et al*, 1952; Olivier, 1974; Fazekas and Kósa, 1978; Ubelaker, 1978; Stloukal and Hanáková, 1978; Ferembach *et al*, 1979).

The age estimation of adult individuals may be more problematic. Since the utilized criteria are based on alterations related to aging, and these changes may considerably vary in a population, a greater chance of uncertainty may be reported. The method of Acsádi and Nemeskéri (1970) takes into consideration the ossification of endocranial sutures, the changes of the pubic bones' symphyseal surface, and the characteristics at the trajectory system of the proximal ends of femora and humeri. This method, as sawing of the bones is a destructive technique, and as the endocranial suture closure may vary from one individual to another (Hershkovitz *et al.,* 1997), was only partly used. Beside the examination of the pubic symphysis, fusion of the sphenooccipital synchondrosis, age-dependent changes in rib and clavicle ends (Loth-Iscan, 1989), tooth attrition (Brothwell, 1981) were taken into consideration. As additional information, the appearance of certain pathological changes which may be associated with age, helped us to estimate the age of death.

Results of the age estimation were categorized using the classification of Martin (Lipták, 1980). Whereas in some cases, as a result of the bad state of skeletal preservation or the incompleteness of skeletons, even the age groups were not identifiable, the age categories of Martin were completed with intermediate categories (Fig. 3.4).

During our analyses, when precise estimation of age at death was not possible, only age categories were used. In some cases, as the classification of certain age in some previously examined skeletal series was different from our classification, a simple regrouping was utilized, following our classification (Fig. 3.4).

Age categories	Age at death in years
Fetus /newborn	
Infans I.	**0-7 years**
Infans I. - Infans II.	
Infans II.	**7-14 years**
Infans II. - Juvenis	
Juvenis	**14-20 years**
Juvenis - Adultus	
Adultus	**20-40 years**
Adultus - Maturus	
Maturus	**40-60 years**
Maturus - Senium	
Senium	**over 60 years**
Adult	**20-x**

Figure 3.4. The age categories of Martin (Lipták, 1980, bold letters) completed with intermediate categories.

Basic anthropological data (sex, age at death, age categories) were available for us from previously carried out anthropological studies; the sources of these data can be seen in the Figure 3.5.

Cemetery /Archaeological site		Source of basic anthropological data
1	Madaras - Halmok (MHA)	Dimén, 2003; Marcsik and Paja, 2009; Marcsik, 2011
2	M5 motorway - Kiskundorozsma, site 26/60	Paja, 2003a; Paja and Marcsik, 2009
3	M5 motorway - Kiskundorozsma, site 26/72	Paja, 2003a; Paja and Marcsik, 2009
4	M5 motorway - Kiskundorozsma, site 26/78	Paja, 2003b; Paja and Marcsik, 2009
5	M5 motorway - Röszke, site 48/60	Paja, 2003a; Paja and Marcsik, 2009
6	M5 motorway - Röszke, site 48/75	Paja, 2003a; Paja and Marcsik, 2009
7	Biharkeresztes - Ártánd - Kisfarkasdomb	Csiszár, 1998; Csáki, 2004
8	Bélmegyer - Csömöki domb	Józsa, 1990
9	Hetényegyháza - site 72	Szoboszlai-Szabó, 1996
10	Hódmezővásárhely - Kopáncs III. homokbánya	Paja, 2012
11	Kunszállás - Fülöpjakab	Lipták and Varga, 1974; Varga and Marcsik, 1975
12	Orosháza Béke TSZ	Molnár, unpublished
13	Pitvaros - Víztározó	Molnár, 2000
14	Sükösd - Ságod	Kőhegyi and Marcsik, 1971, 1976; Jancsó, 1996
15	Szarvas - site 68	Molnár, 1992; Molnár and Marcsik, 2003
16	Székkutas - Kápolnadűlő	Pálfi, 1989
17	Derekegyház – Ibolyásdomb	Rácz, 2004
18	Hódmezővásárhely - Nagysziget	Bereczki, 2004
19	Homokmégy - Székes	Paja et al, 2007
20	M5 motorway - Kiskundorozsma, site 26/78	Paja, 2003; Paja and Marcsik, 2009
21	Magyarhomorog - Kónyadomb	Csányi, 2001; Szigeti, 2001
22	Sárrétudvari - Hízóföld	Oláh, 1990; Pálfi, 1993, Palfi, 1997
23	Szatymaz- Vasútállomás	Lipták and Farkas, 1967; Molnár *et al.* , 1996
24	Bácsalmás - Homokbánya	Békei, 1995; Gyurkó, 1995; Szécsi, 1998; Széplaki, 1998; Lovász, 2005
25	Bátmonostor - Pusztafalu	Farkas, unpublished; Farkas *et al.* , 2007
26	Nyárlőrinc - Hangár út	Balázs, 2005; Bölkei, 2005
27	Óföldeák	Csillag, 2000; Paja, 2000
28	Ópusztaszer - Monostor	Farkas, 1998
29	Szeged - Vár	Ősz *et al.* , 2009

Figure 3.5. Sources of the basic anthropological data (sex, age at death, age category) of the examined series.

3.2.3. Recording of ankyloses

During the recording of pathological conditions, we utilized specific record sheets. The three types of recording sheets include the skeletal representation of the spine, the upper extremities and the rib cage, and the lower extremities together with the pelvic region. In the inventory sheets, the chronological period, the site name (abbreviations), the grave/object and registration numbers, the age at death and sex were first registered. In addition, the pathological conditions (precise localization, laterality, type, description and developmental

stage) observed in the bones were recorded, in case of necessity a short description of the pathological alterations has been written too. Another written database is also made, it contains the localization and characteristics of ankyloses; the additional pathological lesions are also collected in this database (Appendix, II).

Concerning the examined specimens, we have analyzed only those joint ankyloses, which were available for our direct morphological investigations. Although we found some samples in earlier publications (e.g. in diploma works, articles or monographs) that were noted as joint fusion, but the concerned skeletal elements were lost between the first/previous and our analysis. Finally we excluded these samples from our basic and statistical analyses.

We have to note, that fusions of the cranial sutures and gomphoses were not examined, although we described in the database, if we found some alteration in them. The basic anthropological data (age at death, sex) contributed for the palaeodemographic characterization of the samples, providing a platform to the interpretation of the palaeopathological results. These data are seen in the Appendix (I).

3.2.4. Medical imaging techniques

Beside the macroscopic analyses results of medical imaging techniques were also taken into consideration during our analyses. Classical X-ray and computed tomography (CT) data were utilized. These methods help us to develop a new image of the examined object, give us a possibility to discover bony alterations that are not detectable by monitoring the surface. Using medical imaging techniques, those alterations can be seen as well, which are visible only by sawing or *post mortem* effects (e.g. fracture of the bone, destruction of the original surface). On the other hand, these techniques are not destructive in their nature; let the dry bone specimens in their original conditions.

Comparing the traditional 2D roentgenograms and CT, we have to note that in the first case, although X-ray images can be very informative for the differential diagnosis or for the confirmation of our previous diagnosis, but the fact, that three-dimensional anatomical

features are projected onto a single plain may hide some details. CT imaging virtually eliminates or minimizes the problem of superimposition, the examination of the affected bony element(s) may be analyzed from slice to slice from different directions, and we can insight into areas that were previously inaccessible. Beside this increased possibility for visualization and measurements, 3D virtual reconstructions are available as well; with the utilization of this technique we can gain more information about a given moment of the development of a disease (Chhem and Brothwell, 2008).

During our analysis X-rays and CT-scans (or the analytical result of them) made for some previous examinations and publications were also used. The roentgenograms and the CT-scans were made at three institutes, at the Department of Morphology, National Institute of Traumatology (Budapest), at the Health Centre of the Kaposvár University (Kaposvár) and at the Euromedic Diagnostics Szeged Ltd (Radiology Department, University of Szeged, Szeged, Fig. 3.6).

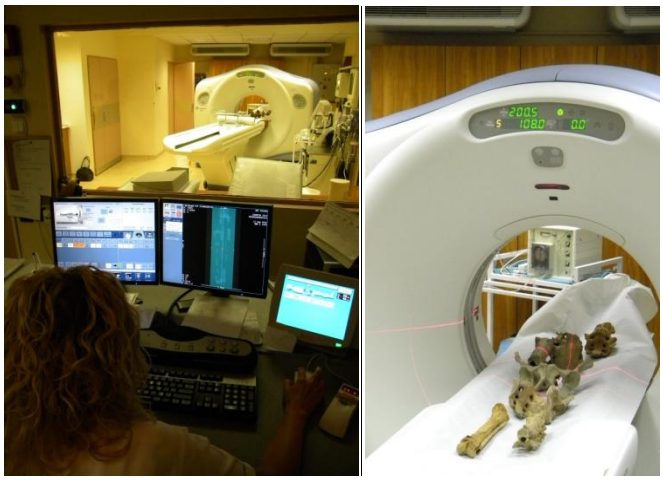


Figure 3.6. Scanning of the samples at the Radiology Department, University of Szeged.

Concerning our computed tomography examinations, in order to make more precise measurements and reconstructions, the specimens have been scanned with special parameters; the utilized CT-s and the settings of each scanning can be seen in the Figure 3.7. Original CT-data were adjusted, 2D and in some cases 3D reconstructions were also carried out using 'Treatment and Increased Vision for Medical Imaging' (TIVMI) software developed by Bruno Dutailly in the Research Unit UMR 5199 (PACEA - CNRS, University of Bordeaux 1 –

French Ministry of the Culture). The major asset of TIVMI is the use of the Half-Maximum Height (HMH) protocol for surface reconstruction (Spoor et al, 1993; Dutailly, 2009). This algorithm allows us to get an exact position of the interface between two areas of different densities that does not depend on the user. Moreover, the high precision of the reconstruction opens up new possibilities for approaching real anatomy.

CT type	Institute	Tube voltage (kV)	Current (mA)	Slice thickness (mm)
GE Lightspeed	Euromedic Diagnostics Szeged Ltd Radiology Department, University of Szeged)	140	78	0.62
Siemens Somatom Emotion 6	Health Center of the Kaposvár University	100	120	1.25

Figure 3.7. Parameters of the utilized computed tomography scans.

3.2.5. Histological analyses

In some of our specimens histological examinations were also done. The procedure was carried out taken by László Tiszlavicz and his colleagues at the Department of Pathology, University of Szeged. The samples were partly decalcified (trichloroacetic acid, 5%, 4°C, 2-3 days) and embedded in paraffin resin. Thin sections (4um) were prepared for histological analysis, hematoxylin and eosin (H&E) stain was used.

3.2.6. Additional analytical techniques

Concerning some cases additional analytical techniques, previous examinations (e.g. DNA analyses) were also carried out. These results were published in earlier publications and they helped to diagnose special bony alterations with uncertain aetiology or to confirm the previous diagnosis. We used these additional results during our analyses to diagnose our specimens in a more precise way. Concerning the molecular biological analyses of mycobacterial infections, DNA was extracted and amplified bypolymerase chain reaction by using various primer pairs recognizing DNA segments of different mycobacterial species. The amplification products of the samples were subjected to restriction enzyme digestion and/or

direct sequencing, it allowed to confirm the specificity of the analysis. (Haas et al., 1999; Haas et al., 2000a; Haas et al., 2000b).

3.2.7. Statistical analysis

During the statistical analyses the prevalence of a disease is one of the most important results, we can compare these data to results from another populations. In our analyses the calculation of a disease/alteration rate is impeded by some factors. To collect adequate samples of ankyloses, examination of numerous osteoarchaeological series is needed. These materials are very diverse in their completeness and state of preservation; this fact would make the data collection very difficult. Another factor is the nature that ankyloses except for the developmental defects appear only at the end-stages of certain diseases. Thus the prevalence of them would not be comparable with other statistical analyses that calculate the prevalence of a disease. Taking into consideration the above mentioned, we calculate only the crude prevalence of ankyloses belonging to different diseases.

4. Results

4.1. Ankyloses of different anatomical regions

4.1.1. Spine

This chapter presents the fusions localized to the spine; ankyloses of the atlantooccipital joints, costovertebral articulations and sacroiliac joints are also included in the analysis beside the fusions of the vertebral discs and the zygapophyseal joints. Concerning the axial alterations, large number of ankyloses were found in the examined material, pathological lesions resulted in bony fusion are present in the skeletal remains of 279 individuals. As pathological processes may involve more than one spinal segment, and more than one joint type may be affected in a single disease, we used the nosological groups of the diseases to present our cases (developmental alterations, degenerative alterations, traumas, infectious diseases, rheumatic (inflammatory) diseases and metabolic disorders) instead of the anatomical approach. The classification of cases into nosological groups was made on the basis of medical and palaeopathological references (Ortner and Putschar, 1981; Resnick and Krandorf, 2005, Chhem and Brothwell, 2008).

4.1.1.1. Developmental alterations

Developmental diseases of the skeleton incorporate those alterations that are produced by some pathological condition in the normal development. They can manifest during the intrauterine life (congenital malformations), but they can express during the infancy or adolescence. They may be genetically predisposed, but extrinsic factors may also responsible for the developmental diseases. (Aufderheide and Rodríguez-Martin, 1998). Among the developmental alterations only vertebral fusions were recognizable in our series.

Axial ankyloses of developmental aetiology were separated into two subgroups, transitional vertebrae were examined as an independent category beside the cases of classical *synostosis vertebralis*.

We found synostoses in 27 individuals, with the exception of one case (BMP-2504), the fusions formed single vertebral blocks. In the majority of the cases vertebral fusions involved two vertebrae, while in three instances at least three segments were included in the vertebral synostoses (Figure 4.2).

The ankyloses developed both in males and females, the sex distribution seems to be balanced (10 males, 11 females). In another 11 cases the determination of sex was not possible partly as a result of the skeletons' bad state of preservation, partly as a consequence of the young age at death.

vertebrae	specimen	age, sex	disc	zygapophyseal joint	
				right	left
CV1 - CV2	OPM-387	Ad, F	+	+	+
	OPM-R3d	ad, U	-	+	+
CV2 - CV3	H72 - 237	Sen, M	+	+	+
	MHK-310	Sen, F	+	+	+
	OPM-572	Sen, F	-	-	+
	BA-370	Ad, F	+	+	+
	BMP-859	Inf I	-	-	+
CV4 - CV5	SZV-264	Ad, M	+	+	+
CV5 - CV6	BMP-337	Mat, F	+	-	+
	BMP-1346	Mat, F	+	-	-
	SUS-319	Ad, M	+	+	-
	BMP-7B	Juv, M	+	+	+
CV6 - CV7	BMP-7B	Juv, M	+	+	+
CV? - CV?	BMP-925	Inf I	N	+	+
CV7 - TV1	SUS-319	Ad, M	-	-	+
TV2 - TV3	SZA-11	ad,F	+	+	+
	BMP-2504	Sen M	+	-	-
	BMP-1305A	Sen, M	+	+	N
TV3 - TV4	BMP-1305A	Sen, M	+	+	+
	SUS-202	Mat, M	+	+	+
	HSZ-286	Sen, F	+	+	+
	OPM-330	Juv, U	-	+	+
	BA-104	Ad, F	+	+	+
TV4 -TV5	BMP-1305A	Sen, M	+	+	+
	BMP-2504	Sen M	+	-	+
TV5 - TV6	BMP-2504	Sen M	+	-	-
	OPM-905	subadult	-	+	+
TV6 - TV7	HVN-87	Inf II	N	-	-
TV9 - TV10	BMP-63	Sen, F	+	-	-
	BMP-925	Sen, M	+	+	+
TV11 - TV12	BA-195	Sen, F	+	-	-
LV2 - LV3	SZV-164	Mat, M	+	-	-
LV3 - LV4	HVK-65-33	Ad, M	-	+	+

Figure 4.1. Distribution of the developmental block vertebrae according to sex, age at death and localization.

Concerning the affected joints, the fusion of the disc is seen 24 cases. No remarkable difference is seen between the two sides of the vertebrae; the left small facet joints are involved in 24 cases, while the right zygapophyseal joint fusion developed in 21 cases.

localization	number of cases
CV1 - CV2	2
CV2 - CV3	5
CV3 - CV4	0
CV4 - CV5	1
CV5 - CV6	4
CV6 - CV7	1
CV? - CV?	1
CV7 - TV1	1
TV2 - TV3	3
TV3 - TV4	5
TV4 -TV5	5
TV5 - TV6	5
TV6 - TV7	1
TV7 - TV8	0
TV8 - TV9	2
TV9 - TV10	0
TV11 - TV12	1
TV12 - LV1	0
LV2 - LV3	1
LV3 - LV4	1
LV4 - LV5	0

Figure 4.2. Distribution of congenital vertebral fusions according to localization.

Analyzing the localization of the synostoses, we can state, that the mid-lower (2^{nd}-3^{rd} and 5-6^{th}) cervical vertebrae and the upper thoracic spinal segments (3^{rd}-4^{th} vertebrae) are involved in the most (Fig. 4.2).

Among the developmental fusions more complex cases were also found.

The specimen Szeged – Vár 264 is belonging to an adult male individual. In this case the synostosis of the 4^{th} and 5^{th} cervical vertebrae is present. The complete union occurred between the articular facets, total fusion between the posterior elements was also detected (Fig. 4.3. a,c). The intervertebral disc space is disappeared, but small not fused areas in the anterior part are seen. In the skeletal remains of the individual SZV-264 other skeletal alterations were also found. Slight pathological lesions involving the upper limbs can be seen, e.g. deformation of the left scapula and shortened clavicles, distorted distal humeri and non-united sternal segments are also found (Ősz *et al.*, 2005, 2009).

The lateral direction roentgenogram reveals that the fusion of the posterior parts are complete, the radiolucent areas between the two vertebral plates suggests the rudimental

ankylosis (Fig. 4.1.1.2. b). On the basis of the skeletal alterations, type II Klippel-Feil syndrome is one of the possible candidates in the background of the alterations. According to the classic medical definition, ankylosis of at least two cervical vertebrae may due to a segmentation error be able to be classified as Klippel-Feil syndrome (Resnick and Kransdorf, 2005; Barnes, 1994).

Figure 4.3. The fusion of the 4-5th cervical vertebrae suggests possible presence of Klippel-Feil syndrome (SZV-264).

The anomaly may characterized by the presence of different additional deformity, such as malformation of the atlas and axis, scoliosis, Sprengel deformity (high position of the clavicle(s); other congenital anomalies may involve both the axial and appendicular skeletal parts (Fernandes and Costa, 2007). Although the classic clinical triad of the syndrome (low hairline, short neck, decreased mobility of the neck) is not examinable; the coexistence of the vertebral block and additional malformations may suggest that the Klippel-Feil syndrome can be a possible candidate in the background of the recognizable alterations; in this case we can present a disease that is rarely described in the palaeopathological literature.

In the case of the specimen Bátmonostor-Pusztafalu-1305A special developmental malformation is found. The synostosis includes four vertebrae, smooth fusion lines and no irregular surfaces are present among the segments (Fig. 4.4. a). Very slight lateral curvature via left side is found, it is associated with the presence of a triangular shaped fourth vertebra. The maldeveloped segment lodges between the third and fifth cervical vertebrae from the right side. As a result of this asymmetrical development four vertebral pedicles are visible on the fused spinal block's right side, contrary to the left side appearance (Fig. 4.4. b,c). The

background of this rare anomaly is that the mediansaggital direction notochord persists during the development of the vertebral body causing failure in normal ossification. It may result in serious mediansaggital cleft, in our case the right hemivertebral element of the vertebral body is also disappeared during the vertebral development (Barnes, 1994). As a consequence of the incomplete spine, on the basis of the morphological signs we cannot decide, whether a normal or supernumerary hemivertebra is found.

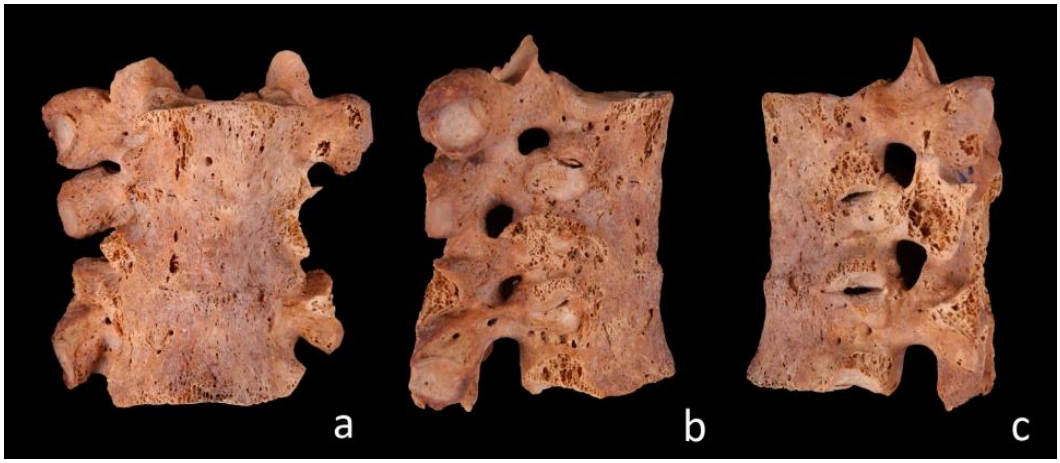


Figure 4.4. Fusion of four vertebrae of the specimen BMP-1305A. The presence of the right side triangular shape maldeformed vertebra results in slight scoliosis.

In one of the developmental fusions two blocks developed (Bátmonostor-Pusztafalu, grave 1305A) in the same spine; two and three vertebrae are included in the vertebral blocks, respectively. While the bodies and zygapophyseal joints are also involved in the fusion of the 2nd and 3rd vertebrae, only the bodies are fused congenitally in the 4-6th segments. The bodies of the five uppermost vertebrae are deformed; these malformations resulted in a severe scoliosis of about 90 degrees. The scoliosis via left side presented a very strict physical stress on the left lateral parts of the vertebral bodies.

As a consequence of the mechanical stress degenerative alterations – both osteophytes and new rim formations - developed on the margins of both the vertebral bodies and the zygapophyseal joint surfaces, later ankylosis of the left small facet joint formed.

The evidence of the changed statics of the spine is also seen in the lateral X-ray image. The very definite radiodense area at the angle of the scoliosis confirms the presence of a

sclerosis (Fig. 4.5. c), the strengthened structure may have played a preventive role (Aufderheide and Rodríguez-Martin, 1998).

Figure 4.5. Two blocks of vertebral fusion developed in the individual BMP-2504, the synostoses are associated with severe scoliosis and degenerative alterations.

Concerning the second subcategory of the developmental alterations, occipitalization and sacralization were found. Transitional vertebra at the atlantooccipital junction is seen in one specimen (Hetényegyháza, site 72 – 11), bilateral zygapophyseal fusions are recognizable in the skeletal remains of the Senium male individual.

Numerous cases of sacralisation were found during our analyses; the lumbosacral and sacrococcygeal borders are involved in 83 and 59 cases, respectively. Concerning sex distribution medical and palaeoanthropological sources state that no significant sexual difference can be seen in these cases, the prevalence is balanced (Barnes, 1994; Bron et al., 2007). In contrast with these data, very strong male predominance was found both in the lumbosacral and sacrococcygeal sacralisation cases; the distribution is seen in the Figure 4.6. The imbalance may be explained by fact that the determination of the sex was not possible in several cases.

	Males		Females		Undetermined sex		Total
	n	%	n	%	n	%	
VL5 - S1	44	53	28	34	11	13	83
S5 - VCc1	35	59	14	24	10	17	59

Figure 4.6. Distribution of the sacralisation according to the sexes.

In two of our cases sacralisation involved more than two segments, in the specimens SZA-101 (Adultus, female) and SZA-154 (Maturus, male) bony fusions of the first two coccygeal elements are also recognizable.

Concerning the coexistence of the developmental alterations, we have to say that in 64 individuals not only one ankylosis of developmental origin was found; from two to five easily detectable developmental defects are present in the same skeleton in 39, 19, 4 and 2 cases, respectively. The most frequently associated diseases involved the lumbar and sacral segments, spondylolysis, *spina bifida* of the lower lumbar vertebrae and partial or complete *sacrum bifidum* were found among these alterations.

4.1.1.2. Degenerative alterations

Degenerative alterations (osteophytosis, small facet joint distortion or osteochondrosis of the vertebral plates) in association with osteoarthritis (or osteoarthrosis) are the most frequent lesions both in the axial and appendicular skeleton. As medical and palaeopathological publications demonstrate, the disease presents an increasing tendency with ageing, and males are more often involved (Gömör, 2001; Waldron, 2009).

During our analyses, vertebral fusions caused by degenerative processes were found in 35 individuals. They developed only in adults, the majority of the cases belongs to skeletal remains of elderly individuals (Maturus and Senium age categories), this increasing tendency with ageing is consistent with the facts found in the literature. Focusing on both sexes, the increasing tendency with ageing is clearly recognizable. However, we can see that bony ankyloses found in females are developed at younger age as well; we found the same amount of cases in the Adultus age category.

	male	female	undetermined	total
Adultus	1	4	1	6
Adultus-Maturus	1	0	0	1
Maturus	9	4	0	13
Maturus-Senium	1	0	0	1
Senium	9	4	0	13
adult	0	0	1	1
total	21	12	2	35

Figure 4.7. Distribution of ankyloses of degenerative origin according age at death and sex.

Concerning the sex distribution, a very strong male predominance is seen, vertebral fusions associated with degenerative processes are found almost twice frequently in males than in females (21 and 12 cases, respectively) (Fig. 4.7.).

The development of vertebral fusions in association with degenerative diseases presents a particular distribution according to the localization. While we found no outstanding number of cases in the thoracic and lumbar spine, numerous cases are recognizable in the mid-cervical spine; the 2^{nd}-3^{rd} and the 3^{rd}-4^{th} vertebrae are involved the most (14 and 8 cases, respectively) (Fig. 4.8.).

The degenerative diseases involved the discs and the small zygapophyseal joints; there is no significance difference among the number of cases according to the localization (Fig. 4.9.). In those cases where vertebral bodies are affected, two different phenomena are seen. In the first form the disc spaces are disappeared, wavy contact lines between the margins of the vertebral bodies are seen (Fig 4.10. a). In the second type slight-moderate anterior and/or lateral bony bridge(s) developed between the vertebral bodies as a result of the osteophyte ossification; these bony exostoses played an important role in the protection of the original disc space (Fig 4.10. b).

We did not find difference in the number of zygapophyseal joint fusions according to their laterality, facet joint ankyloses characterized by irregular contact lines and bumpy fusion areas are developed (Fig 4.10. c) in almost the same number on the right and left side (27 and 25 cases, respectively).

Concerning the association among the degenerative vertebral fusions and other diseases in the skeleton, we can say that a strong correlation with spondylosis deformans and degenerative osteoarthritis of the facet joints is found. The first disease is seen in the 74.3 % of our degenerative spinal ankyloses, while the latter one is developed in the 65.7 % of the fusions.

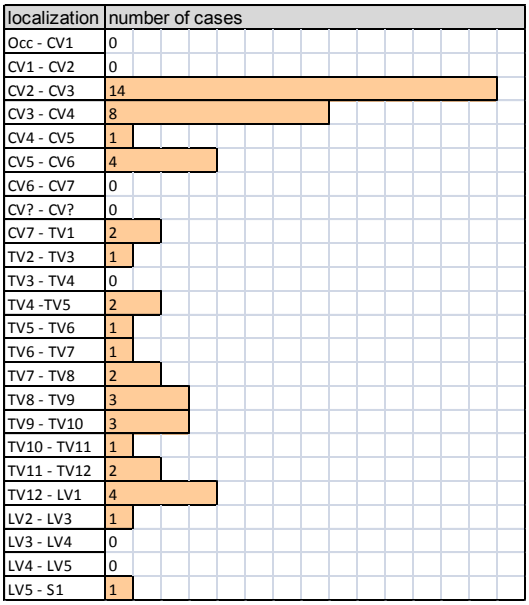


Figure 4.8. Distribution of the degenerative vertebral fusions according to spinal segments.

specimen	disc	zygapophyseal joint		SD	DOA
		right	left		
MHA-194	1	0	0	+	-
MHA-208	1	0	0	+	-
MHA-235	1	0	0	+	-
BAK-5	0	1	1	-	+
BCS-215	1	0	1	+	+
H72-11	1	1	1	+	+
HVK-45-13	2	1	2	-	-
PVT-49	1	1	0	-	+
SUS-202	3	2	2	+	+
SUS-218	1	0	0	+	-
SZK-292	1	0	1	+	+
SZK-350	0	1	1	+	-
SZK-399	0	1	N	+	-
HVN-48	0	0	1	+	+
HVN-88	0	1	0	+	-
HSZ-75	0	0	1	-	+
HSZ-210	0	0	1	-	+
SUH-81	1	N	N	+	-
SUH-182	2	2	2	-	+
SZA-132	0	1	0	+	+
BA-80A	1	1	0	+	+
BA-331	1	1	1	+	+
BA-368	0	1	0	+	+
BMP-220	0	0	1	+	+
BMP-373	1	1	1	-	+
BMP-545	3	0	0	+	+
BMP-1261	0	1	0	+	+
BMP-2153	2	2	2	+	+
BMP-2211	1	1	0	+	-
NYL-460	0	1	0	+	+
OF-93A	0	0	1	+	+
OPM-381	2	2	1	-	+
OPM-466	0	1	1	-	-
SZV-148	0	1	1	+	-
SZV-486	1	2	2	+	+
Total	28	27	25	26	23

Figure 4.9. Distribution of ankyloses of degenerative origin according to joint types (SD: spondylosis deformans; DOA: degenerative osteoarthritis of the facet joints).

Degenerative processes resulted in single vertebral blocks in most of the cases, but in 7 instances the ankylosis is more extensive. Among these cases vertebral fusions including three vertebrae are seen in three skeletons (specimens H72-11, OPM-381 and SZV-486), while two blocks of vertebrae containing two to three segments formed in four cases (specimens HVK-45-13, SUS-202, SUH-182 and BMP-545).

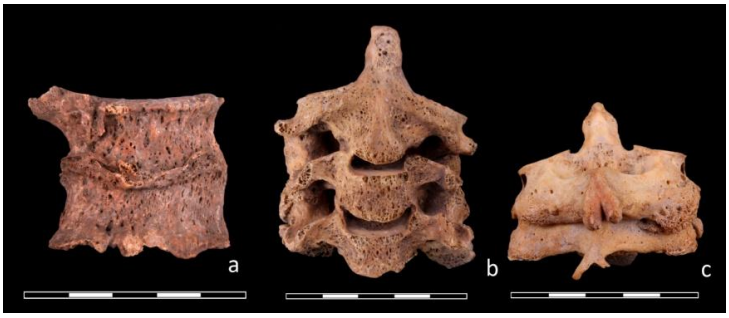


Figure 4.10. Three different types of the degenerative fusions are present, wavy contact lines between the vertebral bodies (a) (SUH- 381), bony bridges caused by the fusion of ostephytes (b) (OPM-381) and irregular contact lines between the zygapophyseal joint surfaces (c) (BMP-1261) are recognizable.

The 2nd-3rd and the 4-6th vertebrae are ankylosed forming two blocks in the specimen Hódmezővásárhely - Kopáncs III. 45-13 (Adultus, female). The bodies and all posterior parts are fused between the 2nd and the 3rd vertebrae, irregular fusion lines and undulating vertebral body surfaces are seen. The articulations between the 3rd and the 4th segments remained intact, only slight distortion of the small facet joint surfaces are visible; it refers to the presence of osteoarthritis. The 4th and the 5th vertebrae present partial fusion of the bodies and complete ankylosis of the left zygapophyseal joint, while the fusion involves the right facet joint between the 5th and the 6th vertebrae.

Figure 4.11. Fusions of two and three cervical vertebrae are present in the specimen HVK-45-13 (Adultus, female), the degenerative process resulting in ankyloses may be explained by the presence of a non-healed fracture in the vertebral body of the 5th vertebra.

Concerning the aetiology of this complex case, we have to note, that a non healed fracture in the body of the 5th cervical vertebra is recognizable, this fracture may have been responsible for the altered joint function. This malfunction may provoke degenerative processes that may resulted in ankyloses in the end-stage (Paja, 2012).

Skeletal remains of the individual Bátmonostor – Pusztafalu 373 present the coexistence of thoracic vertebral fusion of degenerative origin and the extensive ligament ossification associated with metabolic diseases. The degenerative processes led to the development of the fusion of the 5^{th}-6^{th} thoracic vertebral bodies (Fig. 4.11. a,b). The fusion line is wavy, slight protruding area characterized with irregular structure is seen. Other vertebral parts are not involved, neither the posterior arches, nor the zygapophyseal joint are affected. Slight-moderate osteophytes of degenerative origin are found on both the upper and lower margins of the vertebral bodies. Easily recognizable flowing ossification is seen on the right side of the 4-5^{th} and 6-10^{th} thoracic vertebrae (Fig. 4.11. c,d). Although the ossification did not ankylosed the vertebrae, the candle wax-like ossification together with the intact small facet joints and the preserved intervertebral disc spaces confirm the presence of the early-stage diffuse idiopathic skeletal hyperostosis as an underlying disease.

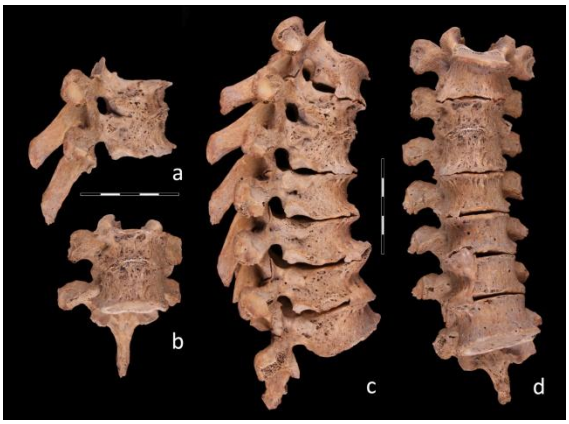


Figure 4.11. The coexistence of degenerative and metabolic diseases in the skeletal remains of the individual Bátmonostor – Pusztafalu 373 resulted in vertebral fusion of the 5-6^{th} thoracic vertebrae and in extensive ossification of the right anterior longitudinal ligament in the thoracic spine.

4.1.1.3. Traumatic alterations

Both micro- and macrotraumatic forces may develop fractures of the vertebrae; these processes may result in the ankylosis of any vertebral elements. During our analysis osseous fusions associated with compression fractures were found in 11 cases, while in the skeletal remains of the individual Bácsalmás - Homokbánya 331 the fusion of the last sacral and the first coccygeal segments may be explained by some other traumatic-degenerative causes.

Concerning the age distribution of the cases, we can state that only adults were involved in these ankyloses, all of the cases are belonging to the older age categories. Individuals belonging to the Maturus and Senium categories present 10 cases of posttraumatic fusions; a younger person is involved in a single case. Although the number of the cases is quite low, the sex distribution seems to be imbalanced, fusions developed after some traumatic event are present in seven males and in four females, in one case the determination of the sex was not possible (Fig. 4.12).

	male	female	undetermined	total
Adultus	0	1	0	1
Adultus-Maturus	0	0	0	0
Maturus	3	2	0	5
Maturus-Senium	1	0	0	1
Senium	3	1	0	4
adult	0	0	1	1
total	7	4	1	12

Figure 4.12. Distribution of the posttraumatic spinal ankyloses according to sex and age.

Except for the specimen BA-331, where the 5th sacral segment and the 1st coccygeal vertebra is involved, all of the fusions are characterized with decreased vertebral body height (Fig. 4.13. and Fig. 4.14.). There are two different appearance forms of these ankyloses, in the first case the intervertebral spaces are (partly) disappeared, the fusion areas of the joints are wavy, bumpy. The second typical osseous sign is the development of bony bridges between the vertebral bodies, these connections are formed as the complete fusion of marginal osteophytes. We have to say, that in all of the cases, where these second type connections are seen (specimens SZK-514, SUH-39 BA-80A), the presence of the biconcave vertebral bodies suggests that the compression fracture is a consequence of a previous osteoporosis, thus the ankyloses may developed as a result of the previously present osteophyte fusion.

specimens	localization				characteristics		
	segments	bodies	facet joints		decreased body height	osteophyte fusion	osteoporosis
			right	left			
SZ68 - 92	LV3 - LV4	1	N	N	+	-	-
SZK - 514	TV11 - TV12	1	1	1	+	+	+
DID - 6	TV? - TV?	1	N	N	+	-	-
MHK - 37	TV2 - TV5	0	3	3	+	-	+
MHK - 41	LV2 - LV3	1	1	1	+	-	-
SUH - 39	TV12 - LV1	1	0	0	+	+	+
BA - 80A	TV11 - TV12	1	1	0	+	+	+
BA - 331	S5 - CcV1	1	N	N	-	-	-
BMP - 2346A	LV3 - LV4	1	0	0	+	-	-
OPM - 605A	TV12 - LV1	1	0	0	+	-	-
SZV - 262	TV9 - TV10	1	1	1	+	-	+
SZV - 528	TV3 - TV4	1	1	N	+	-	-
total		11	8	6	11	3	4

Figure 4.13. Posttraumatic vertebral fusions according to localization and characteristics (+: present, -: not present, N: missing vertebral element).

Concerning the localization of the posttraumatic fusions, most of the cases developed in the lower thoracic and/or the upper lumbar spine, no findings localized to the cervical spine were found. Ankyloses developed between the vertebral bodies in 11 cases, the zygapophyseal joints were involved in 6 individuals, but in three instances the small facet joints are missing as a consequence of a *post mortem* loss (Fig. 4.13.).

Figure 4. 14. Partial fusion of the 9th and 10th thoracic vertebrae as a result of the compression fracture of the 9th thoracic segment (individual Szeged – Vár 262, Maturus, female).

More than two vertebrae are ankylosed in one individual, 4 segments are fused in the specimen Magyarhomorog – Kónyadomb 37 (Senium, female). The upper thoracic spine is involved, bilateral fusions of the zygapophyseal joints among the 2nd and 5th thoracic segments are recognizable. The fusion lines are irregular, these areas are slightly bumpy. Te disc spaces are not affected. Signs of osteoporosis are found in the spine, both the fused 3rd and the 12th

thoracic vertebrae present biconcave vertebral plates; slight wedge-shapes are also found (Fig. 4.15).

In the skeletal remains of the individual Bácsalmás – Homokbánya 331 the 5th sacral and the 1st coccygeal vertebrae are ankylosed. The fusion developed as a consequence of the ossification of the anterior sacrococcygeal ligaments, thus the sacralization may be excluded as an aetiological factor. The skeleton presents several pathological alterations (see Chapter 4.1.4. Ankyloses of the lower extremities), these extensive multiple lesions suggest that some traumatic event may have played an important role in the ossification of the sacrococcygeal ligament.

4.15. Compression fracture following osteoporosis is resulted in multiple ankyloses of the zygapophyseal joints among the 2nd and 5th thoracic vertebrae (a,b). Biconcave vertebral plates and slight wedge-shaped vertebral bodies are recognizable both in the 3rd and the 12th thoracic segments (c,d). (specimen MHK-37, Senium, female).

4.1.1.4. Infectious diseases

Skeletal remains of 16 individuals present bony ankyloses in the spine that may be associated with some infection. Amongst the infectious cases vertebral fusions caused by non-specific infections were found in four probable cases, while the healing process after a tuberculous infection may be responsible for the development of the fusions in 12 individuals (Fig.4.16.).

The non-specific infections resulted in vertebral fusions appeared only in adult females, in two older specimens (OF-16979, SZV-561) the determination of the sex was not possible. The

lower thoracic and the lumbar spine were involved in all of the cases, and with the exception of the SZV-516 specimen, vertebral blocks incorporated two segments.

Concerning the involved elements, we can see that the partial or complete fusion of the vertebral bodies is present in all cases, while the zygapophyseal joint ankyloses affected two specimens. Additional pathological alterations are also seen in all of the cases. Cloacal openings are recognizable on the anterolateral sides of the vertebral bodies, slight or moderate size cavities behind them are also recognizable. In these cavities significant amount of pus may have been collected, they characterized with smooth walls. The collection of pus resulted in vertebral body destruction, as a consequence of this process the vertebral bodies are slightly collapsed in two cases.

specimen		localization					skeletal alterations										aetiology
		spinal segments	disc	facet joint right	facet joint left	other joint fusion	vertebral collapse	kyphosis	cloaca	carious vertebral lesions	HV	ECL	periostitis rib	periostitis long bone	CO CC	cold abscess	
1	KAT - 49	LV2 - LV3	1	1	1	-	+	-	+	-	-	+	-	-	-	-	non-specific infection (?)
2	BA - 352	TV9 - TV10	1	0	0	-	+	+	+	-	-	-	-	-	-	-	non-specific infection
3	OF-16979	TV10 - TV11	1	1	1	-	-	-	+	-	-	-	-	-	-	-	non-specific infection
4	SZV - 561	LV3 - LV5	2	2	2	-	-	-	+	-	-	-	-	-	-	-	non-specific infection (?)
5	BCS - 65	TV8 - TV11 LV1 - LV3	N 2	3 2	3 2	-	N +	+ +	N -	-	-	-	-	+	-	-	TB
6	BCS - 90	LV5 - S1	1	1	1	-	+	-	-	-	-	-	-	-	-	+	TB
7	SUS - 19	CV7 - TV8 TV3 - TV4 - right rib	8 -	6 -	6 -	- 2	+	+	-	+	-	-	-	-	-	-	TB
8	SZK - 343	TV5 - TV6 TV5 - TV6 - left rib	1 -	1 -	1 -	- 2	+	+	-	+	-	-	-	-	-	-	TB
9	HVN - 10 (j)	TV12 - LV1	1	1	1	-	+	+	-	-	-	-	-	-	-	-	TB
10	BA - 208	LV5 - S1	1	1	1	-	+	-	-	-	-	-	+	+	-	+	TB
11	BMP-827	TV8 - TV9	1	1	1	-	+	+	-	+	-	-	-	-	-	-	TB
12	BMP - 1409	TV1 - TV3 TV4 - TV5 TV6 - TV8	2 1 2	2 1 2	2 1 2	-	+	+	-	-	-	N	-	-	-	-	TB
13	BMP - 1974	TV8 - TV9	N	1	1	-	+	+	-	+	-	-	+	-	-	-	TB
14	BMP - 2342B	TV12 - LV1	1	1	1	-	+	+	-	-	-	-	-	-	-	-	TB
15	NYL - 82	TV10 - LV5	7	7	7	-	+	+	-	+	-	-	-	-	-	-	TB
16	SZV - 483	TV8 - LV2	6	6	6	-	+	+	-	+	-	-	-	-	-	-	TB

Figure 4.16. Localization and additional characteristics of the vertebral fusions caused by infection (HV: hypervascularization, ECL: endocranial lesions, CO: cribra orbitalia, CC: cribra crania, +: present, -: not present, N: missing, not examinable).

No other skeletal changes are seen in these skeletons, only the slight distortion of the small facet joints and small osteophytes on the margins of the vertebral bodies may refer to some changed positional/kinetic situation. However we cannot exclude that these degenerative alterations are associated with the ageing, and they developed before the infection. We present here three specimens.

Specimen 1: Kunszállás – Fülöpjakab – Alkotmány TSZ – 49 (Adultus, female)

The specimen KAT - 49 presents osseous signs of some infectious processes. The second and third lumbar vertebrae are fused; the zygapophyseal joints are completely, while the vertebral bodies are partly ankylosed. The margins of the bodies are remained intact, but the height of the third vertebra is decreased. The center area of this segment is conically emerges above the margins, the fusion of the center part is recognizable (Fig. 4.17. a,c). Small cloacal opening is found on the anterior side of the second lumbar vertebra's body; new bony appositions (periosteal reactions) are also seen on this surface. In our opinion some non-specific infection as an underlying disease is possibly suggested by the presence of other osseous alterations as well.

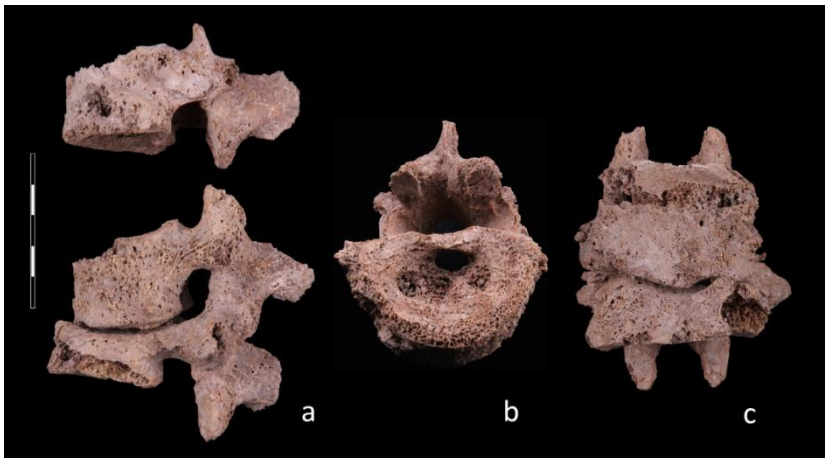


Figure 4.17. Vertebral fusion of the 2nd and 3rd lumbar vertebrae (specimen Kunszállás – Fülöpjakab – Alkotmány TSZ -49, Adultus, female).

The first lumbar vertebral body presents biconcavity; but signs of osteoporosis are not recognizable in the vertebrae. The depressed areas are characterized with smaller, wavy surfaced depressions, and they are in connection with smooth walled tunnels (cloacae). These cloacae correspond with the vertebral foramen and with the left side of the vertebral bodies (Fig. 4.17. a, b). On the basis of the skeletal changes, some non-specific infection seems to be one of the possible candidates in the background. However, the healing processes following tuberculous infection may be various (Harisinghani *et al.*, 2000), thus tuberculous infection cannot be exclude in this specimen.

Specimen 2: Óföldeák – 16979 (stray find, Senium, undetermined sex)

The lower thoracic spine is involved in the complete fusion in the specimen OF – 16979 (stray find, Senium, undetermined sex), both the bodies and the zygapophyseal joints of the 10th and the 11th thoracic vertebrae are fused. The vertebral bodies' fusion line is irregular, slight bumpy area is seen along it (Fig. 4.18. b), ankyloses of the facet joints present smooth appearance. Three cloacal openings are recognizable on the vertebral bodies. The first one is on the right side of the 10th vertebra, the second drainage tunnel is facing the vertebral foramen. The third, teardrop shaped cloacal opening is found on the left side of the lower vertebral body (Fig. 4.18. a). All of them are characterized with smooth margins, slight periosteal remodeling is recognizable around them.

The CT-analysis revealed the interior structure of the ankylosed vertebrae. Saggital images (Fig. 4.18. c,d) confirm the presence of irregular shaped cavities of slightly sclerotic margins are found both in the upper and the lower segments. The coronal images (Fig. 4.18, e-g) show that these cavities are not separated, but they are in connection with each other, and they form an extensive cavity in the fused segments, which lesion is localized more posterior in the vertebral bodies. On the basis of the macromorphological and the CT-analysis, some non-specific infection seems to be the most probable aetiological factor; the vertebral osteomyelitis resulted in ankylosis during the healing process.

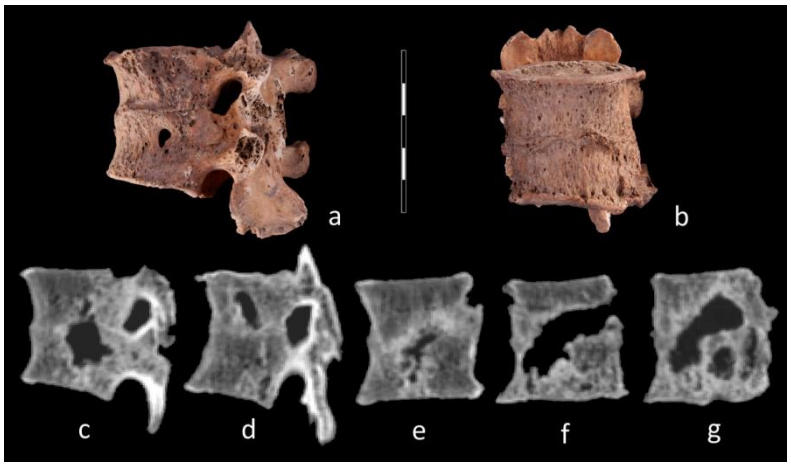


Figure 4.18. Complete fusion of the 10th and 11th thoracic vertebrae, both the macromorphological (a,b) and the CT-picture (c-g) reveal the presence of some non-specific infectious process.

Concerning the other skeletal alterations, only such lesions were found, which are not associated directly with the vertebral infection in all probability: small osteophytes in the thoracic and lumbar vertebrae, ossification of the right side sacroiliac ligament and slight distortion of the right hip joint are seen.

Specimen 3: Szeged – Vár – 561 (Maturus, female)

Three lumbar vertebrae are ankylosed in the skeletal remains of the individual SZV – 561 (Maturus, female) (Fig. 4.19). Although the *post mortem* devastation impeded the complete reconstruction of the lower lumbar spine, the ankyloses associated with smooth walled cavities inside the bodies are clearly recognisable. These cavities are in connection with two round shaped openings in the third and at least two teardrop shaped cloacae on the anterior surface of the fourth vertebral bodies, but we cannot rule out the presence of other drainage tunnels.

The vertebral bodies' lateral surface is rough, remodelled periosteal area is found here. The zygapophyseal joints are completely ankylosed, no kyphotic angulation in the posterior elements are seen. On the basis of the osseous signs, pyogenic non-specific infection seems to be a possible aetiological factor in these two specimens. However, tuberculous infection can mimic or hide other diseases, so we cannot rule out the tuberculosis either in this case.

Figure 4.19. Complete fusion of three lower lumbar vertebrae in the specimen Szeged – Vár – 561 (Maturus, female).

During our analysis specimens associated with healed skeletal tuberculosis resulted in ankyloses were found in 12 individuals (Fig. 4.20.). The alterations developed twice frequently in females than in males (eight and four cases, respectively). Concerning the age distribution of

sexes, the Adultus and Maturus age category is the most represented, vertebral fusions associated with tuberculosis were found only in two individuals belonging to the Senium category. If we separate the two sexes, it is clearly seen that the peek is found in the Adultus age category in females, while the cases belonging to a male individual are more represented in the older age categories.

	male	female	undetermined	total
Adultus	0	5	0	5
Adultus-Maturus	0	0	0	0
Maturus	3	2	0	5
Maturus-Senium	0	0	0	0
Senium	1	1	0	2
adult	0	0	0	0
total	4	8	0	12

Figure 4.20. Distribution of the axial TB-associated ankyloses according to sex and age.

Concerning the localization of the ankyloses, we can say, that the thoracic and lumbar vertebrae are involved in the majority of the cases. Although the small sample size impedes the precise statistical analysis, the lower thoracic and upper lumbar segments were affected the most frequently in our analytical sample. Both the disc joints and the facet joints were involved in all of our cases; zygapophyseal joint fusions present a balanced development according to laterality.

With the exception of those cases, when the fusions involved the fifth lumbar and the first sacral vertebrae, collapses of the vertebral bodies are seen. The collapses affect the anterior parts of the bodies and they resulted in moderate or serious kyphosis (Pott's gibbus). Beside intervertebral joint ankyloses, the fusion of the costosternal articulations are seen in two cases, right side appearance is found in the specimen SUS - 343, while the costosternal fusion developed on the left side in the individual SZK – 343 (Fig. 4.16).

The number of the involved vertebrae is diverse, while two segments are affected in 7 cases, at least 7 vertebrae are fused in the rest of the cases. The extensive alterations resulted in a single vertebral block in three cases (SUS – 19, NYL – 82, SZV – 483), but in another two instances two (BCS – 65) or three (BMP – 1409) separated vertebral blocks are recognizable (Fig. 4.21.).

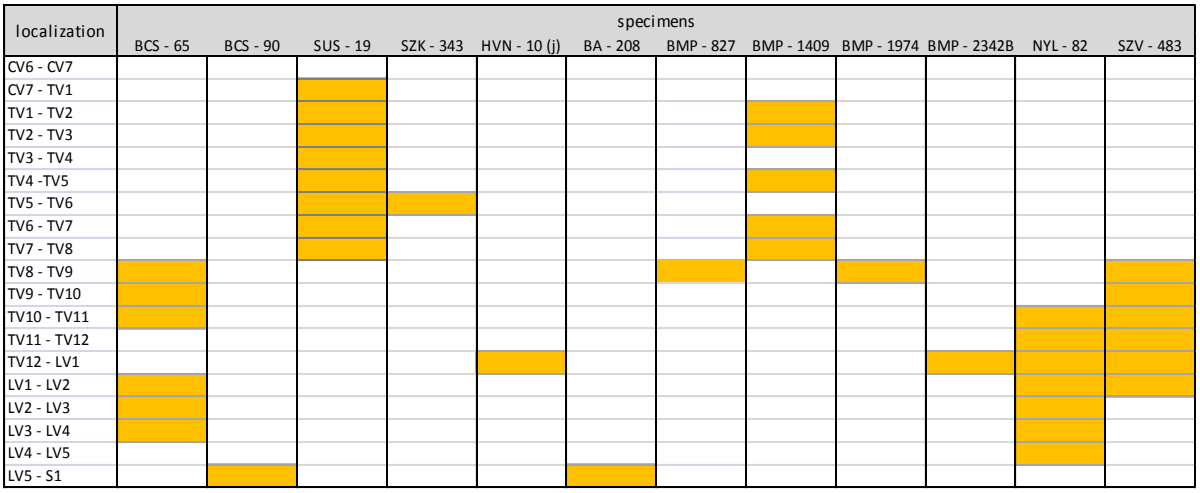


Figure 4.21. Localization of the TB - associated vertebral fusions.

Additional skeletal alterations are seen only a few cases, rib or long bone periostitis was found in 3 cases, while increased blood vessel impressions of the vertebral bodies (hypervascularization) or endocranial lesions were not seen in the skeletal remains of our specimens. Hip involvement is seen in one individual (Bélmegyer – Csömöki-domb 90), as a result of severe destruction of both the left hip bone and proximal femur is suggestive of tuberculous coxitis (Pálfi et *al.*, 1992). The diagnosis based on morphological signs is confirmed by molecular biological results, the identification of the DNA-fragments of the Mycobaterium tuberculosis complex was successful (Haas *et al.*, 1999; Haas *et al.*, 2000a).

Here we present four spinal tuberculosis cases with extensive osseous lesions.

Specimen 1: Bélmegyer – Csömöki-domb 65 (Adultus, female)

Two vertebral blocks are present in the spine of the individual Bélmegyer – Csömöki-domb 65 (Adultus, female). The first group of the ankyloses developed in the lumbar spine, the vertebral block contains the first three lumbar segments (Fig. 4.22. a-c). The vertebral bodies are almost completely destructed. V-shaped appearance of the first and the second lumbar vertebral bodies is seen, the fusion of the bodies resulted in angular kyphosis, the pathognomic sign (Pott ’s disease) of the skeletal tuberculosis is clearly visible. The body of the third segment present an even more destructed form, it almost completely disappeared, only small areas from the superior margins of the posterior and lateral parts are recognizable, sharp edged particles are seen. The destruction of the third vertebral body reveals the lower surface of the

second segment's body, the partly destructed area is characterized with small roundish cavities on this surface. The less destroyed part of the body is found along the mediansaggital axis of the body, this emerging area divides the body into two more depressed lateral parts. Beside the destructive changes, newly formed paravertebral mass is seen on the left side of the vertebral block. Although the upper vertebral plate of the first lumbar segment is intact, the disease does not localize solely in the lumbar vertebrae. Another involvement area is also present in the thoracic spine; the second vertebral block includes four vertebrae from the 8^{th} to 11^{th} thoracic segments (Fig. 4.22. d). Complete ankylosis is seen among the posterior elements, slight posterior curvature is recognizable in the sample.

Figure 4.22. TB-associated thoracic and lumbar vertebral fusions are presentin the specimen Bélmegyer – Csömöki-domb – 65 (Adultus, female).

Although, as a result of the *post mortem* loss the vertebral bodies were not available for the analysis, the present curvature and the direction of the vertebral pedicles allow drawing certain conclusions. Based on the mentioned phenomena, we can hypothesize at least partial collapse and a probable fusion of the vertebral bodies. Additional osseous changes are not present in the skeletal remains, but on the basis of the macromorphological traces, chronic tuberculosis seems to be the most probable aetiological factor. The individual survived the disease, and the healing process led to the development of the vertebral blocks.

Results of previously taken X-ray analyses supported the macromorphological picture: all of the joints of the involved areas are completely disappeared; the original joint gaps are not recognizable on the roentgenograms (Pálfi, 1991). The presence of a chronic disease and the elongated healing process are also confirmed by the results of histological analyses carried out

on the sample originating from the paravertebral mass of the lumbar spine. The light microscopic picture reveals normal mature bony structure; the long-term osteoblast activity may be in associated with a long-term reparative process.

The tuberculosis as an underlying disease is also supported by the results of previous microbiological analyses, mycobacterial DNA fragments of the *Mycobacterium tuberculosis* complex were found in the samples originating from the specimen Bélmegyer – Csömöki-domb 65 (Haas *et al.*, 1999; Haas *et al.*, 2000a).

Specimen 2: Sükösd – Ságod 19 (Adultus, female)

Severe multiple destructive lesions are recognizable in the skeletal remains of a young adult female individual originating from the cemetery of Sükösd – Ságod. The first focus of the disease is the spine. The segments from the 7^{th} cervical to the 8^{th} thoracic vertebra are fused; all of the disc joints and the small facets are involved. The bodies of the 2^{nd}-7^{th} thoracic vertebrae are extremely collapsed, the collapse is more developed in the anterior parts of the bodies. As a consequence of the fusion of the V–shaped segments, severe angular kyphosis (Pott's gibbus) is present. Beside the vertebral ankyloses costovertebral fusions are also recognizable in the spine, the ribs and the 3^{rd}-4^{th} vertebrae are fused bilaterally (Fig. 4.23. a,b). As a consequence of the collapse and of the ankyloses of the spinal segments, the occlusion of the intervertebral foramen at the level of the 3^{rd}-4^{th} thoracic vertebrae is found.

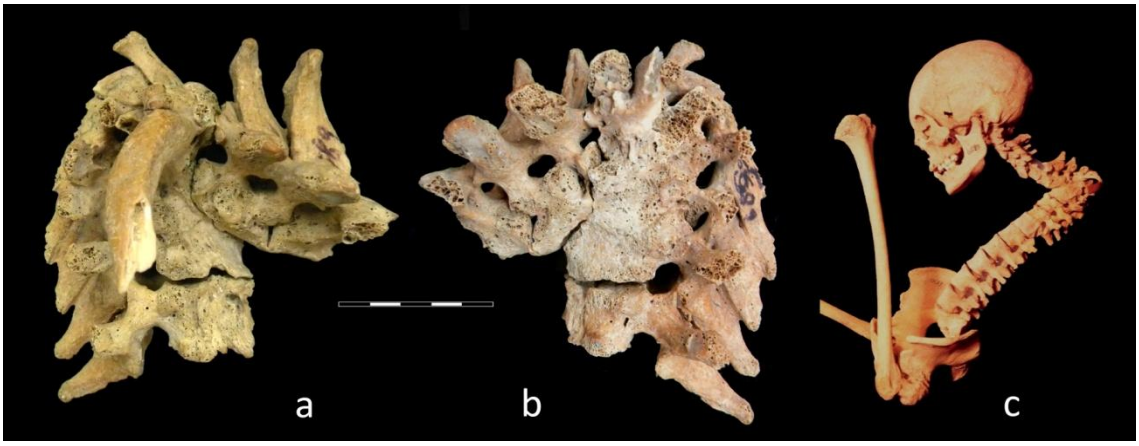


Figure 4.23. The collapse and fusion of 7^{th} cervical and the first eight thoracic vertebrae resulted in severe Pott's gibbus (a,b). Reconstruction of the skeleton of the specimen Bélmegyer – Csömöki – domb 19 (Adultus, female)(c).

Previous X-ray and computed tomography analyses were carried out by Marcsik and her colleagues. The saggital roentgenograms revealed both the collapse of the vertebral bodies and the complete fusion of the zygapophyseal joints. CT images proved that the width of the spinal canal did not decreased in a significance degree; the original diameter is recognizable even at the level of the angular kyphosis. On the other hand, we can state, that the intervertebral foramina width is decreased, or they are completely closured at the level of the 3rd-5th thoracic vertebrae (Marcsik *et al.,* 1999).

The second focus of the disease is the sacrum; beside multiple carious lesions on the upper sacral plate lytic alterations on the ventral side of the sacrum are also seen. The right hip joint seems to be the third localization of the disease in the skeleton, osteolytic and proliferative pathological alterations are suggesting a primary infectious process, later degenerative alterations developed.

The left hip joint presents a serious dislocation; the distorted femoral head, the newly formed joint surface on the lesser trochanter and the new joint surface on the iliac wing above the original acetabulum suggest a secondarily developed articulation. As a consequence of the infectious and degenerative processes, the femur is fixed in a flexed position; the atrophy of the bones of the lower limbs suggest that the individual did not walked after the development of the joint fixation (Fig. 4.23. c). On the basis of the macromorphological and medical imaging findings, the tuberculosis is the most probable candidate in the background of the alterations.

Although the spinal canal did not decreased in its width, the long-term pressure on the spinal cord and the narrowing/closure of the intervertebral foramina might provoke some neurological problems, in all probability. Due to the skeletal alterations, it is possible to state that the young woman had not been able to walk; she was paralyzed in a severely hunched position.

The presence of tuberculosis was also confirmed by previous microbiological analyses; a positive identification of mycobacterial DNA-fragments from the *Mycobacterium tuberculosis* complex was possible in the sample of Sükösd – Ságod 19 (Haas *et al.*, 1999; Haas *et al.*, 2000a).

Specimen 3: Bácsalmás – Homokbánya 208 (Senium, male)

The lumbosacral junction is involved in the ankylosis in the skeletal remains of a male individual belonging to the Senium age category (Fig. 4.24). The two segments are completely fused; both the vertebral bodies and the posterior elements are affected. The vertebral bodies are ankylosed by newly formed bony bridges on both sides of the anterior part; cloaca-like openings are present among these osseous connections.

Bony fusion also developed between the 5th lumbar vertebra's right transverse process and the right wing of the sacrum. Extensive bony mass is recognizable on the left side of the lumbar spine between the 3rd and the 5th vertebrae. These bony projections did not fuse the involved segments; however, their presence might impede the movement of the lumbar spine. Strong osteophytes are seen on the right side of the affected lumbar vertebral bodies, slight distortion of the facet joint surfaces are also found. The presence of the paravertebral mass together with the lytic lesions developed on the ventral surface of the sacrum and the rough visceral surface of three ribs suggest that skeletal tuberculosis is one of the most probable candidates in the background of the bony changes.

Figure 4.24. TB-associated lumbosacral vertebral fusion, paravertebral mass formation and traces of cold abscess on the ventral side of the sacrum of the specimen Bácsalmás - Homokbánya – 208 (Senium, male).

Additional skeletal alterations are also recognizable in the specimen BA-208, but the presence of the fractures of the tibiae and the fibulae may not be in association with the spinal tuberculosis, in all probability.

Specimen 4: Szeged – Vár – 483 (Adultus, female)

Classical changes of the skeletal tuberculosis is found in the specimen SZV – 483 Adultus, female). The fusion of seven segments (TV8 – LV3) is present, vertebral bodies and the posterior elements are also ankylosed. The five caudal segments has collapsed, and as a result of the development of the wedged vertebral bodies severe angular kyphosis (Pott's gibbus) with angulation of about 90 degrees developed (Fig. 4.25. a,b). The original shapes and borders of the bodies are hardly recognizable; the surface of the bodies is rough (Ősz *et al.,* 2005, 2009).

The borders of the vertebral bodies cannot be well differentiated, and the bony structures are abnormal at the maximum of the kyphotic deformity. Asymmetric paravertebral mass is seen at the level of the lower segments, it developed in a more severe form on the left side. The costovertebral joints are not involved in the fusion. Narrowing of the intervertebral foramina is found on both sides of the spine.

CT-images revealed the characteristics of the vertebral bodies' internal structure and the spinal canal. This latter one present a moderate narrowing at the level of the kyphosis (Fig. 4.26, left), the phenomenon – together with the presence of the decreased size intervertebral foramina – may have played an important role in the development of some neurological complication. However, we did not find any skeletal changes which can be in association with neurological problems.

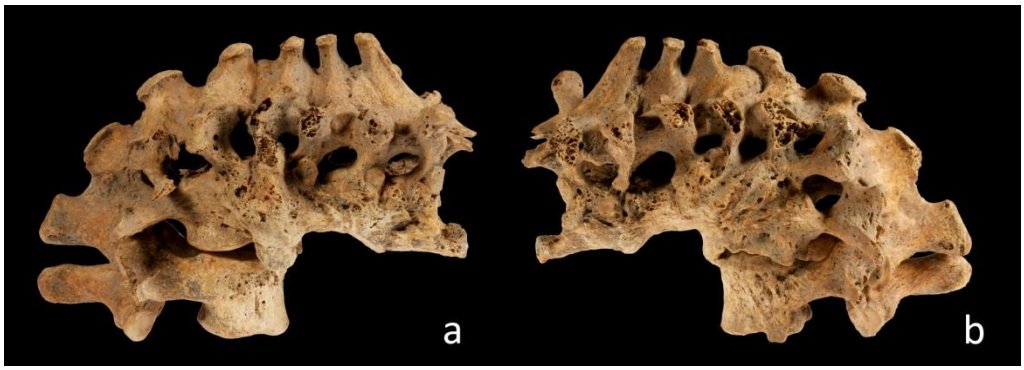
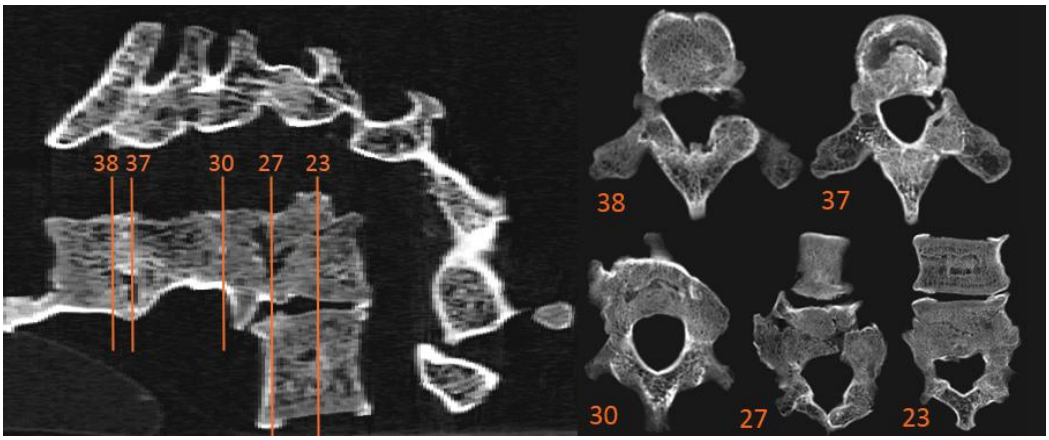


Figure 4.25. Complete fusion and extreme kyphosis of the thoracolumbar segments (specimen Szeged Vár – 483, Adultus, female).

Axial and coronal images present strong destruction of the involved vertebral bodies; two different stages are seen in these images. The less severe alteration is the fusion of two segments without a significant destruction (Fig. 4.26. right, slices 38 and 37), where the

vertebral ankylosis is accompanied by slight devastation of the adjacent endplates and by irregular, sclerotic fusion line. The more developed destruction is localized to the lower vertebrae, where the original shape of the anterior parts is not recognizable, only wedged vertebral bodies separated by narrow cavities are present (Fig. 4.26. right, slices 30, 27, 23).



4.26. CT-images of the Pott's gibbus in the specimen Szeged Vár – 483 (Adultus, female).

4.1.1.5. Metabolic diseases

Only a few metabolic diseases can cause osseous fusions, among them the classical form of diffuse idiopathic skeletal hyperostosis (DISH) is one of the most characteristic and most easily recognizable diseases in the skeleton. It was first described by Forestier and Rotes-Querol in 1950 (Forestier and Rotes-Querol, 1950), and it is characterized with ligament ossifications and strengthening of entheses (Resnick and Niwayama, 1976).

Various appearance of the (DISH) was found among the metabolic diseases in the examined osteoarcheological series. Here we note, that another metabolic disease, osteoporosis may also have resulted in osseous fusion as initial process, these vertebral compression fractures possibly associated with osteoporosis are presented among the traumatic alterations in Chapter 4.1.1.3.

Concerning the DISH cases, we analyzed them in three subcategories; the classification of the cases is based on the appearance of the anterior longitudinal ligament ossification, the sacroiliac joint fusion caused by the sacroiliac ligament ossification, the involvement of the intervertebral disc spaces and zygapophyseal joints (Waldron, 2009). The subcategories are:

a) DISH cases: at least four adjacent vertebral bodies are completely fused by the calcification/ossification of the anterior longitudinal ligament; the intervertebral disc spaces and zygapophyseal joint gaps are close to the original situation, narrowing of these spaces were not visible; absence of sacroiliac joint changes;
b) early-stage DISH cases: the complete fusion caused by the anterior longitudinal ligament ossification is present in less than four contiguous vertebrae; the narrowing of the intervertebral disc spaces and the zygapophyseal joint gaps are not visible; absence of sacroiliac joint changes;
c) probable DISH cases: these cases are not determined by Waldron (2009), the subcategory made create the possibility of the examination of the sacroiliac fusion caused by the ossification of the sacroiliac ligament(s). The other criterion is the anterior longitudinal ligament ossification with no fusion.

Concerning the sex distribution we can say that only males or individuals with undetermined sex were found in the categories. Only adult individuals are present, only two Adultus skeletons are involved beside the dominance of the individuals belonging to the Maturus and Senium age categories.

During our analyses, we examine the development and the appearance of the anterior longitudinal ligament ossification first, later we present the appearance of the additional skeletal alterations that may be associated with the disease. At the end of the chapter the characteristics of the probable DISH cases is shown.

Ossification of the anterior longitudinal ligaments

DISH cases

We found seven cases presenting the right side ossification of the anterior longitudinal ligament resulted in vertebral fusion at least four adjacent vertebrae (Fig. 4.27). All of our cases

present mid-lower-thoracic fusions, all specimens except the skeletal remains of the individual MHK-217 show only thoracic involvement. The most frequently affected vertebrae are the 5th to 12th segments (Fig. 4.28. a,b); no significance difference can be seen among them. The cervical spine does not present complete ligament ossification, while the lumbar spine is involved only in one case (specimen MHK-217). Concerning the laterality of the complete ossification, the upper thoracic spine presented unilateral right side ossification, but more complex appearance is recognizable in the lower thoracic segments. In four instances bilateral flowing ossification is found, in three of them (specimens MHK – 217, OF – 16996 and OPM – R6) complete fusion is recognizable.

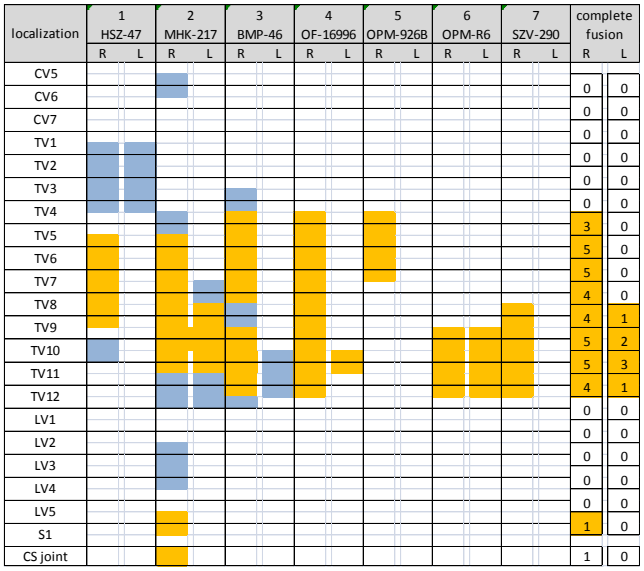


Figure 4.27. Distribution of the classical DISH cases according to the degree and the localization of the anterior longitudinal ligament(s) and the sacroiliac ligament(s) (R: right side, L: left side, yellow: ligament ossification with complete fusion is present, blue: ligament ossification with no fusion).

Bilateral anterior longitudinal ligament ossification resulted in no fusion is found in the upper thoracic spine, in the case of the specimen HSZ -47 the 1st-4th thoracic segments were involved.

In the specimen MHK-217 the bilateral ligament ossification at the level of the 9th and 10th thoracic vertebrae presents a special appearance, the right and left side ligaments forms a bony belt around the segments, this phenomenon is similar to syndesmophyte ossification.

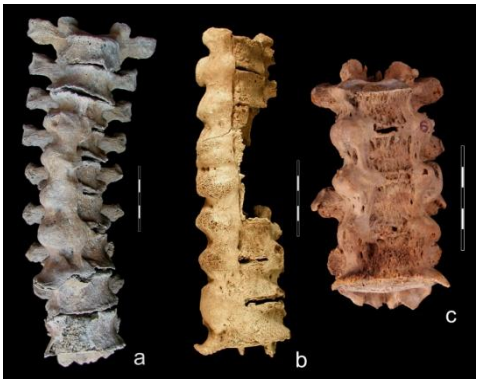


Figure 4.28. The ossification of the anterior longitudinal ligament is pathognomic to diffuse idiopathic skeletal hyperostosis (a: specimen HSZ-47, b: specimen OF-16996, c: specimen OPM–R6, bilateral appearance).

Incomplete ligament ossification is found only in three cases (specimens HSZ-47, MHK-217 and BMP-46). Concerning the number of the affected vertebrae (including both the complete and the incomplete ossification) is between 4 and 13 (mean 7.14).

Early-stage DISH cases

Concerning the early-stage DISH, more complex cases were found (Fig. 4.29.); it's a consequence of the definition for early-stage DISH. Although the diagnostic criteria of the early-stage DISH do not permit the development of the fusion of four contiguous vertebrae, our cases present vertebral blocks including maximum three segments. However, the development of two or more separated blocks is allowed, this phenomenon together with the development of incomplete ligament ossification present compound ossified spinal ligament appearance.

Four specimens presenting one vertebral block are recognizable in our analytical material, in two of them (individuals OPM-631 and OPM-R58) not only the right side ligament became ossified, but bilateral appearance is recognizable, in the fourth case only left side candle wax-like bony bridge formed. In the majority of the cases (n=8) two vertebral blocks developed.

The most represented vertebral segments - similarly to the distribution found in DISH cases - are the mid-thoracic (6^{th} and 7^{th}) vertebrae. However, in contrast with the previous subcategory, as a consequence of the development of vertebral blocks in distant vertebral regions, a more 'diffuse' picture is seen. The complexity of the cases is also supported by the presence of the incomplete ligament ossification, the number of the involved vertebrae,

including the complete and incomplete ossification varies between two and sixteen (mean = 7.85).

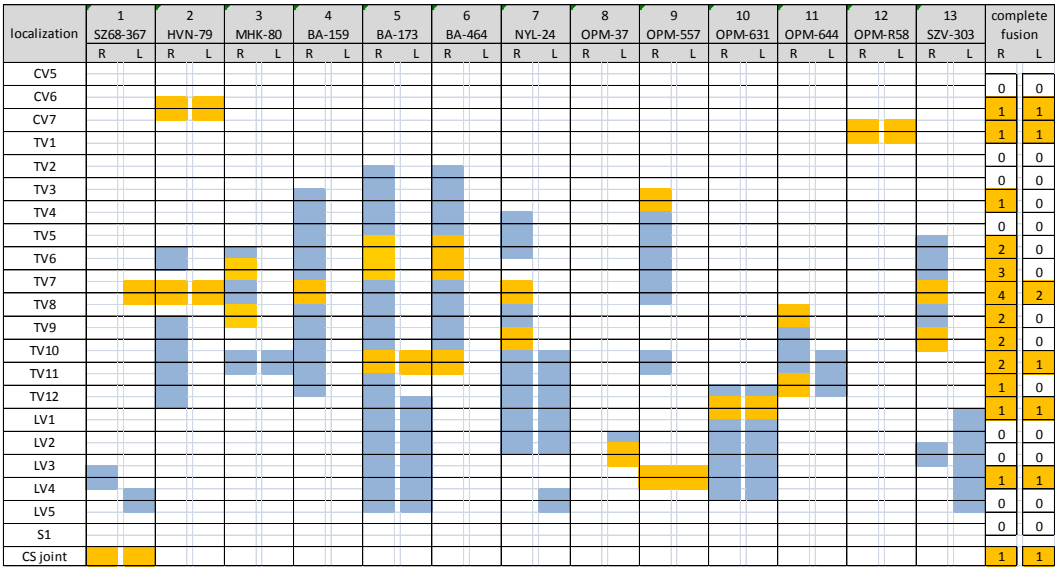


Figure 4.29. Distribution of the early-stage DISH cases according to the degree and the localization of the anterior longitudinal ligament(s) (R: right side, L: left side, orange: ligament ossification with complete fusion is present, blue: ligament ossification with no fusion).

In the specimen BA-173 the anterior ligament ossification between the 3rd and 4th lumbar vertebrae presents a special appearance, the right and left side ligaments forms a bony belt around the segments, this phenomenon is similar to syndesmophyte ossification. However, the poor the state of preservation impedes the complete analysis; therefore we cannot exclude the presence of real syndesmophyte ossification in this case. If it developed, multiple diseases may be responsible for the development of the skeletal alterations.

Additional skeletal alterations

Additional skeletal lesions found in the two subcategories are summed up in the next tables (Fig. 4.30 and Fig. 4.31.).

The lack of the disc space involvement is one of the four diagnostic criteria for DISH, except of the specimen MHK-217 all of the examinable disc spaces corresponds with this requirement. In the specimen MHK-217 the original disc space is disappeared, but the CT-

analyses revealed (Fig. 4.36.) that the disappearance is caused by new calcified deposits on the disc surfaces, and the original intervertebral gap height is recognizable.

characteristics DISH	1 HSZ-47	2 MHK-217	3 BMP-46	4 OF-16996	5 OPM-926B	6 OPM-R6	7 SZV-290	N	%
	Senium, M	Maturus, M	Senium, M	Adultus, M	Adultus, M	adult, U	Ad-Mat, M		
right side OALL	+	+	+	+	+	+	+	7/7	100
- complete (no. of vertebrae)	5	7+2	9	9	4	4	5		
- not complete (no. of disc spaces)	0	4	1	0	0	0	0		
- number of affected vertebrae	5	13	10	9	4	4	5		
left side OALL	+	+	+	+	-	+	-	5/7	71.4
- complete (no. of vertebrae)	0	4	0	2	0	4	0		
- not complete (no. of disc spaces)	3	2	2	0	0	0	0		
- number of affected vertebrae	4	6	3	2	0	4	0		
narrowed intervertebral disc space	-	-	-	-	-	-	-	0/0	0
narrowed zygapophyseal joint space	-	+	+	+	-	-	-	3/7	42.9
ossification									
- OPLL	-	-	-	-	-	-	-	0/0	0
- OLF	+	+	+	+	+	+	+	7/7	100
- OSSL	-	+	+	-	-	N	-	2/6	33.3
- OISL	-	-	-	-	-	N	-	0/5	0
- OCCL	-	-	-	+	-	N	-	1/6	16.7
- OILL	-	-	-	N	-	N	-	0/4	0
- OACSL	-	+	-	-	+	N	-	2/6	33.3
calcification on vertebral disc surface	-	+	+	+	-	+	+	4/7	57.1
enthesopathy									
- upper limbs and girdles	+	+	+	N	-	N	+	4/5	80
- lower limbs and girdles	+	+	+	N	+	N	+	5/5	100
sacroileitis	-	+	-	N	-	-	-	1/6	16.7
OSIL									
- OSIL with no fusion	-	-	-	N	-	N	-	0/5	0
- sacroiliac fusion	-	+	-	N	-	N	-	1/5	20

Figure 4.30. Distribution of the DISH cases according to the additional skeletal lesions (OALL: ossification of the anterior longitudinal ligament, OPLL: ossification of the posterior longitudinal ligament, OLF: ossification of the ligamentum flavum, OSSL: ossification of the supraspinous ligament, OISL: ossification of the interspinous ligament, OCCL: ossification of the costal capsular ligament, OILL: ossification of the iliolumbar ligament, OACSL: ossification of the anterior costosternal ligament, OSIL: ossification of the sacroiliac ligament, N: missing, not examinable).

The lack of the zygapophyseal joint space involvement is seen in all of the early-DISH cases, but in three instances (3/7, 42.9%) at least one fused small facet joint was found in the skeletal remains of the individuals diagnosed with DISH (Fig. 4.30).

Additional calcification in the intervertebral disc spaces was found in both the DISH and early-DISH cases. It developed more frequently in the first subgroup; traces of the alteration were recognizable in 57.1% and 23.1% in the two categories.

Spinal and extraspinal ossifications were also seen in the specimens of both categories. Among the spinal alterations, the *ligamentum flavum* (Fig. 4.32. b), the posterior longitudinal ligament (Fig. 4.32.c), the supraspinous ligament (Fig. 4.32.a), the interspinous ligament, costal capsular ligament, the iliolumbar ligament ossifiactions were recognizable. Concerning the extraspinal sites, ossifications of the anterior costosternal ligaments and the sacroiliac ligament(s) (Fig. 4.32. d) were seen. At least one of these alterations developed in all of the DISH cases, while we found four cases in the second subgroup, when ligament ossification was

not seen. The ossifications appear as a single phenomenon in three and two cases in the two subgroups, but in the significance amount of the cases at least two sites were involved in the ossification (57.1 and 46.2%, respectively).

characteristics early stage DISH	1 SZ68 - 367	1 HVN-79	2 MHK-80	3 BA-159	4 BA-173	5 BA-464	6 NYL-24	7 OPM-37	8 OPM-557	9 OPM-631	10 OPM-644	11 OPM-R58	12 SZV-303	N	%
	Maturus, M	Maturus, M	Maturus, M	Senium, M	Maturus, M	Senium, M	Maturus, M	adult, U	Senium, M	adult, M	Senium, M	adult, U	Maturus, M		
right side OALL	+	+	+	+	+	+	+	-	+	+	+	+	+	12/13	92.3
- complete (no. of vertebrae)	0	2+2	2+2	2	3+2	3+2	2+2	0	2+2+2	2	2+2	2	2+2		
- not complete (no. of disc spaces)	1	1	3	8	6	6	8	0	5	5	2	0	4		
- number of affected vertebrae	2	5	6	10	11	10	11	0	12	5	5	2	8		
left side OALL	+	+	+	+	+	-	+	+	+	+	+	+	+	12/13	92.3
- complete (no. of vertebrae)	0	2+2	0	2	2	0	0	2	2+2	2	0	2	0		
- not complete (no. of disc spaces)	1	0	1	8	5	0	6	1	0	5	2	0	5		
- number of affected vertebrae	2	4	2	10	8	0	7	3	4	5	3	2	5		
narrowed intervertebral disc space	-	-	-	-	-	-	-	-	-	-	-	-	-	0/13	0
narrowed zygapophyseal joint space	-	-	-	-	-	-	-	-	-	-	-	-	-	0/13	0
ossification															
- OPLL	-	+	-	-	-	-	-	-	-	-	-	-	-	1/13	7.7
- OLF	-	+	-	+	-	+	-	+	-	-	+	-	-	5/13	38.5
- OSSL	-	+	-	+	+	+	+	+	-	+	-	-	-	7/13	53.8
- OISL	-	-	-	-	-	-	-	-	-	-	-	-	-	0/13	0
- OCCL	+	-	-	+	-	-	-	-	-	-	-	-	-	1/13	7.7
- OILL	-	-	-	+	-	+	-	-	-	-	-	-	-	3/13	23.1
- OACSL	-	-	-	-	+	+	-	-	-	-	+	-	-	3/13	23.1
calcification on vertebral disc surface	-	-	+	-	+	-	-	-	-	-	+	-	-	3/13	23.1
enthesopathy															
- upper limbs and girdles	-	+	-	-	+	-	-	-	-	-	-	-	+	3/13	23.1
- lower limbs and girdles	+	+	-	+	-	-	-	-	-	-	+	-	+	5/13	38.5
sacroileitis	-	-	-	-	+		-	-	-		-	-	-	1/13	7.7
OSIL															
- OSIL with no fusion	-	-	-	-	-	+	-	-	-	-	-	-	-	1/13	7.7
- sacroiliac fusion	+	-	-	-	-	-	-	-	-	-	-	-	-	1/13	7.7

Figure 4.31. Distribution of the early-stage DISH cases according to the accompanied skeletal lesions (OALL: ossification of the anterior longitudinal ligament, OPLL: ossification of the posterior longitudinal ligament, OLF: ossification of the ligamentum flavum, OSSL: ossification of the supraspinous ligament, OISL: ossification of the interspinous ligament, OCCL: ossification of the costal capsular ligament, OILL: ossification of the iliolumbar ligament, OACSL: ossification of the anterior costosternal ligament, OSIL: ossification of the sacroiliac ligament).

Two ligament types were involved the most frequently (Fig. 4.30, Fig. 4.31). The ossification of the *ligamentum flavum* developed in all of the available specimens in the first subcategory, while it can be seen in the 38.5 % of the specimens among the early-DISH cases. Another typical involvement area is found among the apical parts of the spinous processes. These supraspinous ligament ossifications are recognizable with higher prevalence in the early-DISH category (53.8%), however less developed appearance is seen in these cases.

Enthesopathies are seen in all cases belonging to the DISH category, lower limbs and girdles were involved in 100% of the specimens, while the upper extremities were affected in 80% of the individuals. The development of the enthesopathies in the early-DISH cases does not present as high prevalence as it is seen in the first group, the upper extremities were involved in 23.1% of the individuals; the lower limbs and girdles were affected in 38.5% (Fig. 4.31.).

Sacroiliac involvement is found only four cases in the two subcategories. Multiple lytic lesions developed unilaterally in two specimens, while the ossification of the sacroiliac ligament resulted in sacroiliac fusion is seen in one DISH (specimen MHK-217) and another one early-DISH case (specimen SZ68-368).

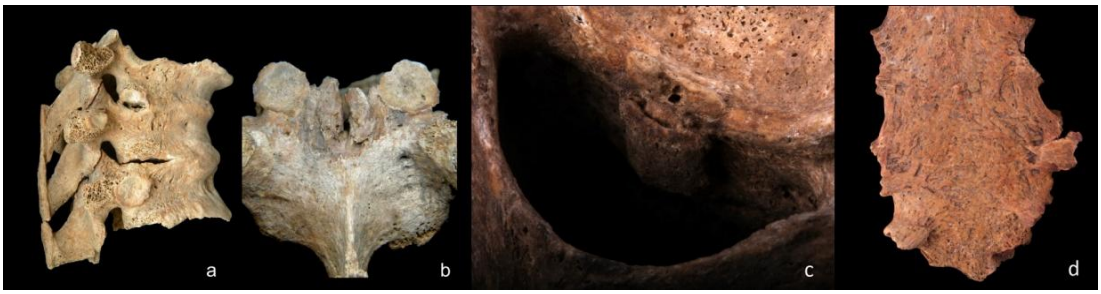


Figure 4.32. Spinal and extraspinal ossifications may be associated both DISH and early-stage DISH cases (a: ossification of the supraspinous ligament, specimen BMP-46; b: bony elements between the two upper facet joints may be caused by the ossification of the ligamentum flavum (specimen BMP-46), c: ossification of the posterior longitudinal ligament (specimen HVN-47); d: ossification of the anterior costosternal ligaments (specimen BA-464).

Probable DISH cases

The third subgroup contains seven cases, when at least one complete sacroiliac fusion caused by the sacroiliac ligament ossification (Fig. 4.33.). In two individuals bilateral appearance is found, while unilateral development is recognizable in five cases. Among the unilateral sacroiliac cases strong dominance of the right side is seen, the left side involvement is recognizable only in one skeleton.

Multiple lytic lesions in the sacroiliac joint are not found among the cases. In those cases (n=5), when the fusion is associated with incomplete anterior longitudinal ligament ossifications, our diagnosis may be more positive, while in the rest of the individuals DISH as an aetiological background may be more hypothetical.

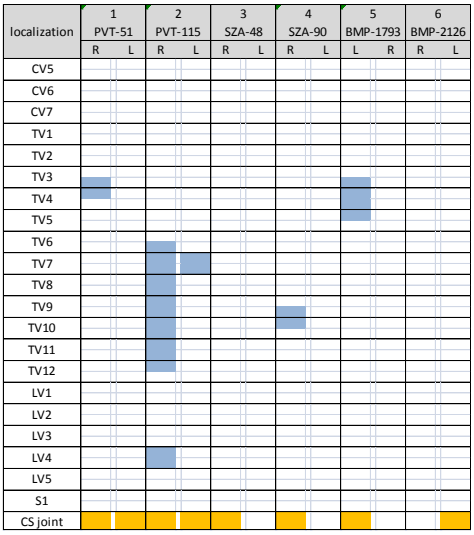


Figure 4.33. Probable DISH cases with sacroiliac ligament ossification.

Histological analyses were carried out in two samples originating from the specimen Ópusztaszer – Monostor 644 (Senium, male). Samples taken from the right side ligament ossification revealed that the osseous bridges have normal mature bony structure; the accumulation of calcium is also recognizable (Fig. 4.34.). The microscopic picture from the section of patellar spur reveals normal bony structure as well, in some parts, as sign of chondrogen ossification, cartilaginous lacunae are also visible. Histological analyses confirm the presence of a long-term calcification and ossification process, these data fit to diffuse idiopathic skeletal hyperostosis, where a slowly developing hyperostotic process is present (Paja *et al.,* 2010b).

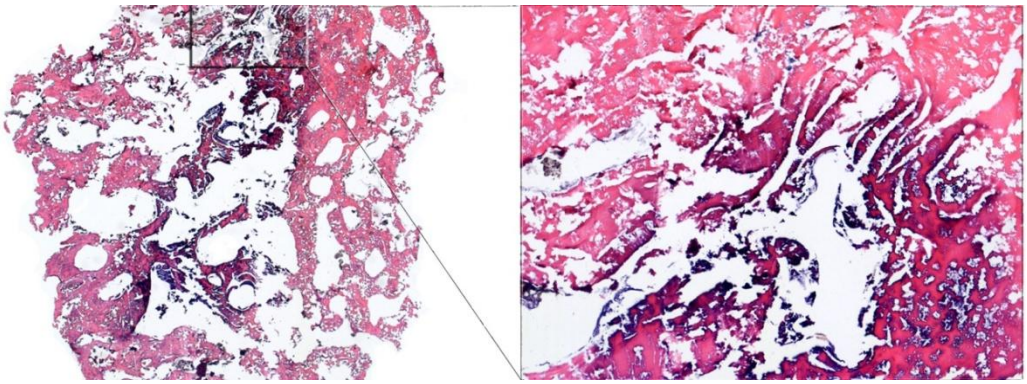


Figure 4. 34. The histological picture of the sample originating from the ossified anterior longitudinal ligament presents normal mature bone with increased accumulation (darker purple areas) of calcium (specimen OPM-466, H&E stain, left: OM 2-5x, right: OM 10x).

Medical imaging techniques (X-ray and CT) were utilized for supporting our previous diagnoses. The saggital roentgenograms confirmed that neither intervertebral disc spaces, nor small facet joint gaps remained intact (Fig. 4.35.). CT-analyses were carried out to reveal the interior structure of the involved spinal segments. In the specimen Óföldeák – 16996 (stray find, Adultus, male), both the intervertebral disc height and the zygapophyseal joint gaps remained intact (Fig. 4.36. a, b, d), although newly developed deposits (chondrocalcinosis) is seen in one of the vertebral plates (Fig. 4.36. d). The anterior side ligament ossification shows the 'coating phenomenon'. While the outer part of the ligament appears as a dense layer, the inner part of the ligament is less radiodense, the shape of the vertebral body did not become squared (Fig. 4.36. b,c). Slight ossification in the area of the posterior arch is also visible (Fig. 4.36.c), the new bony projection intrudes to the vertebral canal, and the development of it may be associated with the ossification of the *ligamentum flavum*. (Paja *et al*., 2010b).

Figure 4.35. The saggital roentgenogram confirmed the presence of the intact intervertebral disc and small facet joint spaces, the body heights did not decreased (specimen Szeged – Vár 291, Maturus, male).

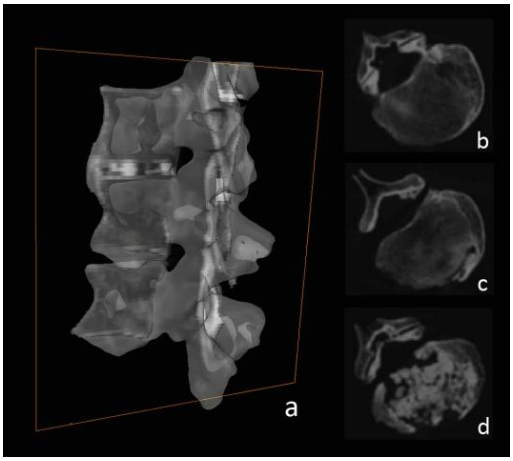


Figure 4.36. The 3D reconstruction (a) and the axial slices (b-d) reveal the characteristics of DISH: preserved disc spaces (a), intact zygapophyseal joint gaps a,b), 'coating' phenomenon (c) and chondrocalcinosis (d) is recognizable in the CT images (specimen Óföldeák - 16996, Maturus, male).

In the specimen Magyarhomorog – Kónyadomb – 217 (Maturus, male) an extensive ossification process is recognizable (Fig. 4.37). The complete ossification of the right side anterior longitudinal ligament connects the vertebrae between the 5th and 11th thoracic

segments, while the same type involvement of the left side is seen between the 8th and the 11th thoracic vertebrae. As a result of the bilateral appearance, the bony projections between the 9th and the 11th vertebrae form complete osseous belts at the level of the intervertebral gaps; their characteristics are similar to the syndesmophyte ossification. Incomplete anterior longitudinal ligament ossification is also was found, they are visible in two cervical vertebrae, in the upper and lower thoracic and also in three lumbar segments. The last lumbar and the first sacral vertebrae are also fused by ligament ossification, but in this case, on the basis of the slight decrease of the right side of the fifth lumbar segment's body accompanied with a round shape opening on the anterior surface of the body we cannot rule out the presence of some infectious process. Although most of the small facet joints are intact, the zygapophyseal joints between the 9th and the 10th thoracic vertebrae are fused bilaterally. Right side sacroiliac fusion is also present in the skeleton; it is caused by sacroiliac ligament ossification (Fig. 4.37. c). Bumpy are at the superior part of the joint is recognizable; some post mortem destruction revealed that the right auricular surfaces are intact; no pathological alterations are seen on them (Fig. 4.37. d). In contrast, some multiple lytic lesions are present in the left sacroiliac joint. Enthesopathies of both the upper and lower limbs and girdles are present. The slight ossification of the *ligamentum flavum* and the supraspinous ligaments is present.

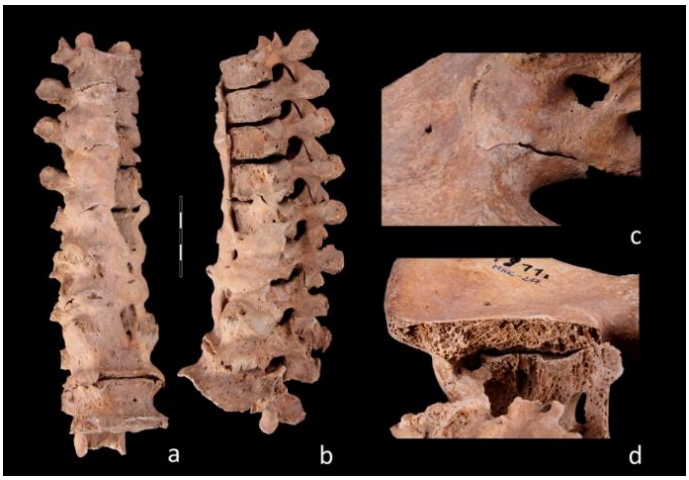


Figure 4.37. The ossification of the anterior longitudinal ligaments (a,b) accompanied with periarticular sacroiliac fusion(c,d) is in association with diffuse idiopathic skeletal hyperostosis (specimen MHK-217, Maturus, male).

The coronal (Fig. 4.38. a) and saggital (Fig. 4.38. b) CT-images reveals that in two segments, although the disc space height did not decrease, but the intervertebral spaces are disappeared as a consequence of chondrocalcinosis (Fig. 4.38. c - axial slice 246).

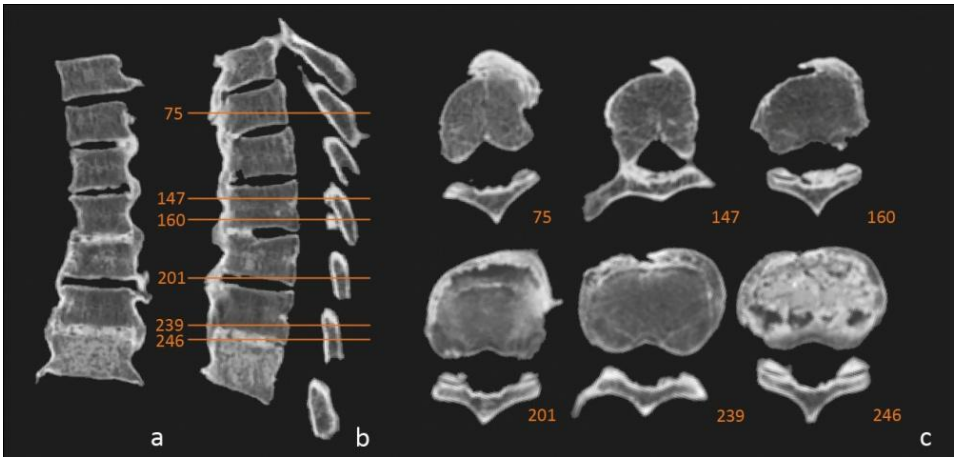


Figure 4.38. The radiological characteristics of the coronal (a), saggital (b) and axial (c) CT-images confirm the diagnosis of DISH in the specimen MH-217 (Maturus, male).

Concerning other pathological lesions, the 'coating phenomenon' is clearly seen in the axial sciles, it is recognizable even in those slices (Fig. 4.38. c - slices 201 and 239), when the bilateral ossification resulted in syndesmophyte-like appearance macroscopically. Both the saggital and axial images proved the presence of extra radiodense projections on the anterior side of the posterior arches; these are associated with the ossification of the *ligamentum flavum*.

4.1.1.6. Rheumatic diseases

Numerous inflammatory conditions are belonging to the rheumatic diseases, one ofthe most characteristics group of them the seronegative spondylarthropathies. The category incorporate several inflammatory diseases (e.g. ankylosing spondylitis, Reiter's disease, psoriatic arthritis), common characteristics of them the lack of the rheumatoid factor, and strong association with HLA-B27 antigen is recognizable (Resnick and Kransdorf, 2005; Sieper et al., 2002).

4.1.1.6.1. Seronegative spondylarthropathies

Concerning the complex group of the seronegative spondylarthropathies, ankylosing spondylitis (AS) and probable AS were diagnosed in the skeletal remains of nine individuals (Fig. 4.39.), in another two individuals the presence of the SNSA as an underlying process is only hypothetical. The poor state of preservation and the lack of some diagnostically important skeletal parts made the differential our diagnosis uncertain in two individuals (SZK-80, BA-80A), in these cases our diagnosis is probable AS. No females were found among the nine cases and elderly individuals belonging to the Maturus and Senium age categories were involved.

In all of our cases, except the specimen Székkutas-Kápolnadűlő 80, the lumbar spine is ankylosed; in three of them the lumbosacral junction is also involved.

Concerning the affected vertebral elements, both the vertebral bodies and the posterior parts were fused in the AS cases, syndesmophyte fusion is not seen only in the case of the specimen HVK-20, where the vertebral bodies are not available for the analyses. The syndesmophyte fusions developed bilaterally, symmetrical appearance is recognizable. The most affected sites are the lower lumbar segments; the 4-5th lumbar junctions are involved in all of the cases. In three specimens the fusion caused by the bridging process of the syndesmophytes continues upwards, in the extremely extensive case of Pitvaros – Víztározó 215 the ankyloses reached the cervical spine. Skip lesions are not recognizable. Concerning the zygapophyseal joint involvement, we can say that they developed in parallel with the vertebral body fusions and they appear bilaterally in almost all of the specimens. In the specimen Bátmonostor – Pusztafalu 1735 only unilateral zygapophyseal joint fusion is found, the lack of the left side ankylosis may be in association with the earlier stage of the disease. The fusion areas are bumpy, newly built irregular bony structure is found here. As a result of severe ankyloses in the lumbar spine, the physiological lordosis is not recognizable.

Costovertebral ankyloses were found only in one case (PVT-215), both the heads and the tubercles were fused to the adjacent vertebral elements; these fusions were accompanied with costovertebral and intercostal ligament ossifications.

While sacroiliac fusion is seen only in one case (PVT-215), multiple lytic lesions of the auricular surfaces (sacroiliitis) are recognizable in three cases (n=3/4, 75%), both unilateral and bilateral forms are recognizable. In the rest of the AS specimens the sacroiliac joint surfaces were not examinable as a consequence of the sacroiliac fusion or the presence of partial or complete *post mortem* loss.

Additional skeletal alterations are also present in the ankylosing spondylitis specimens. Enthesopathies are recognizable in four cases (57%), while the presence of some ligament ossification is seen in six specimens (85.7%). The most involved ligaments are the ligamentum flavum (4 cases), but the supraspinous ligament, the iliolumbar ligament; the interspinous ligament and the costal capsular ligaments are also affected at least one case among the individuals.

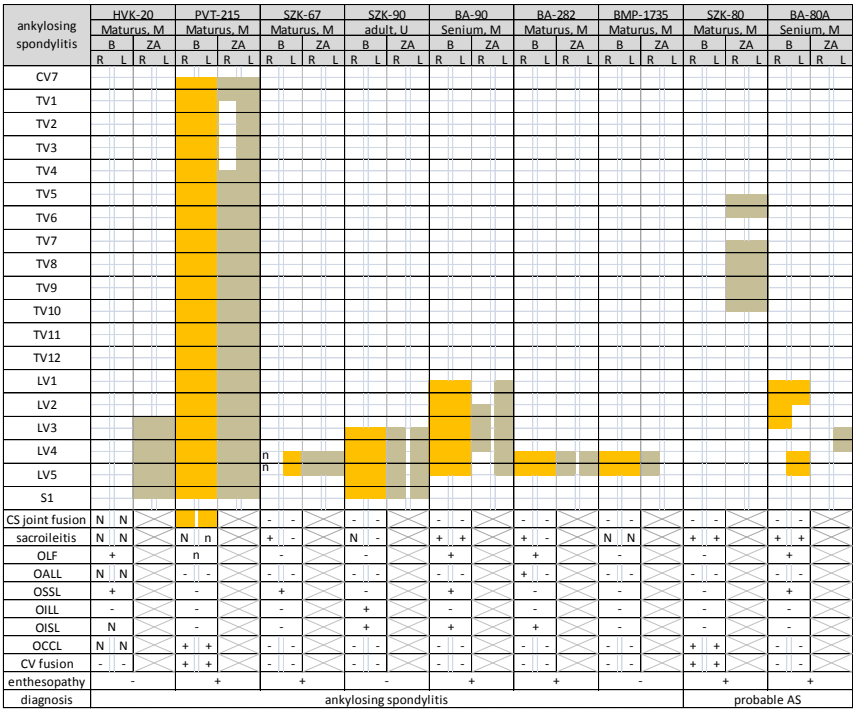


Figure 4.39. Characteristics of the AS and probable AS cases (B: vertebral body; ZA: zygapophyseal joint, R: right side, L: left side; OLF: ossification of the ligamentum flavum; OALL: ossification of the anterior longitudinal ligament; OSSL: ossification of the supraspinous ligament; OILL: ossification of the iliolumbar ligament; OISL: ossification of the interspinous ligament; OCCL: ossification of the costal capsular ligament; CV fusion: costovertebral fusion). Note: the precise localization of the involved vertebrae in the specimen SZK-80 is unkown, the approximate coloration is present that the fusions developed in the mid-thoracic spine.

In two specimens the diagnosis of the ankylosing spondylitis is very probable as the poor state of preservation impeded the more precise analysis. Additional morphological traces that make our diagnoses uncertain are the skip lesions, the presence of this characteristics accompanied by the lytic lesions of bones of the legs may refer to the development of some other seronegative spondylarthropathy (e.g. psoriasis) in these individuals.

Here we present four cases diagnosed with seronegative spondylarthropathy.

Specimen 1: Hódmezővásárhely – Kopáncs III. homokbánya 20 (Maturus, male)

The fusion of the arches of the sacrum and the lower three lumbar vertebrae can be observed in the fragmentary material of the grave 20 (the bone bodies are missing). Although vertebral bodies are not present, but the ligamentum flavum and supraspinous ligament ossifications connect and fix the 3rd-5th vertebrae and the sacrum (Fig. 4.40.). The both side zygapophyseal joints are affected as well; bumpy new bony formation is present in the fusion area.

Concerning other pathological alterations, lytic lesion at the right ischiac tuberosity, and slight distortion of the two acetabular articular surfaces is recognisable. As a consequence of the lack of the predilectional sites the status of the sacroiliac joints and the majority of the extra-spinal articulations and entheses are not examinable.

Axial computed tomography images point out that not only the periarticular zygapophyseal areas are involved in the ankyloses, but bony connections are built between the adjacent upper and lower facets' surfaces (Fig. 4.41.) (Paja *et al.,* 2010a, Paja, 2012).

Figure 4.40. The complete fusion of the posterior elements of the vertebral segments (LV3-sacrum) is associated with ankylosing spondylitis (specimen HVK-20, Maturus, male).

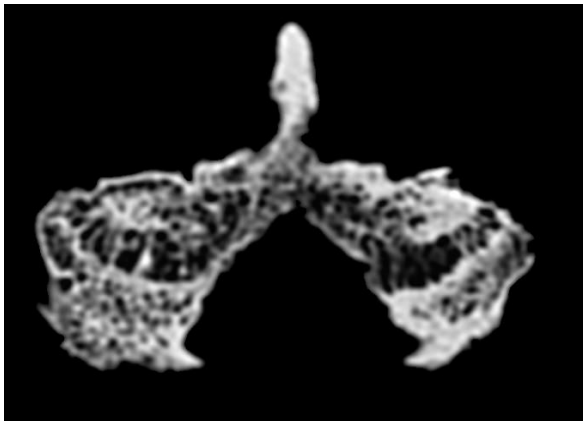


Figure 4.41. The zygapophyseal joints are fused completely, the joint gap is disappeared as a result of newly developed bony elements (specimen HVK-20, Maturus, male).

Specimen 2: Pitvaros – Víztározó 215 (Maturus, male)

The well-preserved skeletal remains of a matured male individual present extensive lesions of ankylosing spondylitis, one hundred joints became ankylosed as a result of the disease. Bilateral ankylosing vertebral syndesmophytosis can be seen from the 6th cervical to the 1st sacral segments, typical bamboo-spine appearance is recognizable (Fig. 4.42. a-c). Facet joints are also involved. The articulations completely disappeared on the left side, while the joints remained intact among the 1st and 4th thoracic vertebrae on the right side. Post mortem fracture of the lumbar spine revealed the interior structure of one of the zygapophyseal joints, and it is clearly seen that the joint gap is disappeared, the sclerotic joint surfaces are ankylosed in a complete way (Fig. 4. 42. e).The fusions of the thoracic spine is associated with bilateral costovertebral ankyloses, both the joints between the rib heads and the vertebral bodies and joints between the costal tubercles and the lateral processes of the vertebrae are involved. The phenomenon affected more costovertebral joints on the left side, while seven ribs were ankylosed on the right side, the number of the fused rib-vertebra connections reached the nine on the left side. The coexistence of the more extensive costovertebral fusion and the lack of the right zygapophyseal joint ankyloses resulted in a slight right side scoliosis of the upper thoracic spine (Fig. 4.42. b).

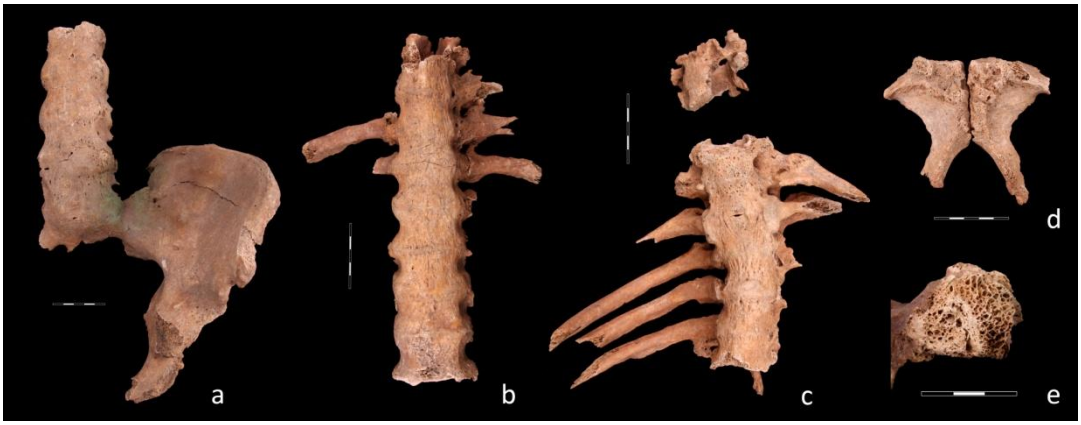


Figure 4.42. Classical skeletal lesions developed in the specimen Pitvaros – Víztározó 215 (Maturus, male).Extensive syndesmophytosis of the spine resulted in 'bamboo spine' appearance (a-c). Bilateral sacroiliac (b,c), zygapohyseal (e), costovertebral fusions (b,c) and erosive lesions of the pubic symphysis (d) are in association with ankylosing spondylitis.

Bilateral sacroiliac fusions are also recognizable in the skeleton. The original joint gaps are not seen, the smooth surfaced fusion area exclude the presence of the sacroiliac ligament ossification.

Concerning the additional skeletal changes, both erosive and bone forming enthesopathies are present in the extraspinal skeleton. The irregular erosive lesions on the anterior side of the pubic symphysis may be in association with the seronegative spondylarthropathy, but these changes may also refer to tuberculosis (Fig. 4.42. d).

Previously made roentgenograms attested the presence of the syndesmophytosis resulted in vertebral fusions and the development of the complete costovertebral ankyloses. These alterations were confirmed by CT-images as well. In the frontal CT picture syndesmophytosis, osteoporosis of the vertebral bodies and central erosions of the discs can be seen. (Pálfi *et al.,* 1996b; Pálfi *et al.,* 1999). Computed tomography analyses confirmed the phenomena found in X-ray. Axial CT-slices present the complete costovertebral fusions, these were associated with ligament ossification, both the radiate ligaments at the rib heads and the anterior costotransverse ligaments are involved. The zygapopgyseal joint fusions are clearly seen in the saggital CT-images, while slight central lytic lesions in the vertebral plates and slight osteoporosis are recognizable beside the syndesmophytosis in the coronal pictures (Pálfi *et al.,* 1996b; Pálfi *et al.,* 1999).

Small calcified/ossified pleura (or lung) fragments were found during the basic anthropological examination. As fibrous lung or pleural processes may appear in ankylosing spondylitis (e.g. Ducolone et al., 1984; Kinnear and Shneerson, 1985; Ho *et al.*, 2009), the presence of these fragments might have been in association AS. However, fragments like these may also be associated with tuberculosis, therefore DNA-analysis was done. As a result of the tests, DNA-fragments of the *Mycobacterium tuberculosis-complex* was identified, thus the coexistence of tuberculosis and ankylosing spondylitis is proved (Haas *et al*. 1999, Haas *et al.*, 2000a; Pálfi *et al.*, 1999).

Specimen 3: Bácsalmás – Homokbánya 90 (Senium, male)

The entire lumbar spine is ankylosed in the specimen BA-90 (Fig. 4.43.), syndesmophytosis is seen around the intervertebral spaces. The development of the bony bridges is more expressed on the lateral sides of the vertebral bodies, while the anterior parts present less developed and perforated connections. The disc spaces seem to be intact in their heights, no narrowings are seen. The posterior parts of the vertebrae present fusions as well, all the zygapophyseal joints on the left side and the right side small facet gaps between the 2nd and the 4th segments are completely disappeared. Ligament ossifications are seen in the lumbar spine, slight supraspinous and more expressed interspinous ligament involvement are found in these segments.

Concerning other skeletal alterations, moderate bilateral sacroiliitis characterized with multiple subchondral lesions is found. Strengthened entheses of the calcanei and of the ischial tuberosities are recognizable, these alterations exhibit both erosive and proliferative bony changes. The presence of the joint surface distortions is suggesting osteoarthritis, these alterations are recognizable in several sites; e.g. acromioclavicular and glenohumeral joints, small facet surfaces of the lower cervical and thoracic spine, lower costovertebral joints are involved.

The analysis of previously made X-ray films (Pálfi *et al.*, 1996a; Horváth *et al.,* 1997) confirmed that the ossified and ankylosed syndesmophytes resulted in typical ‘bamboo spine’ appearance, the original disc space height among these segments is does not decreased. On the basis of the macromorphological and radiographic characteristics, the ankylosing spondylitis

seems to be the most probable aetiological factor in the background of the extensive skeletal changes.

Figure 4.43. The entire lumbar spine is involved in the ankylosing spondylitis, both the intervertebral disc spaces and the posterior zygapophyseal joints are fused (specimen BA-90, Senium, male).

Specimen 4: Székkutas – Kápolnadűlő – 80 (Adultus, male)

Although the poor state of preservation together with the incompleteness resulted in difficulties for reconstructing the skeleton, but special ankylosing processes are recognizable in the skeletal remains. Fusions developed in two sites, two and another four thoracic vertebrae present ankyloses (Fig. 4.44. a). As a consequence of the vertebral bodies' *post mortem* loss, only the fusions involving the posterior elements of the segments are examinable. No kyphosis is seen. Bilateral costovertebral fusions are also present in the lower four vertebrae, the ankyloses involved both the joints between the rib heads and the vertebral bodies and between the costal tubercles and the lateral processes of the vertebrae (Fig. 4.44. a). As a result of the ossification of the anterior costosternal ligaments, additional fusion is recognizable among the left side ribs (Fig. 4.44. b). The remains of the lumbar spine do not present ankyloses, but large osteophytes are found in the vertebral bodies. Additional changes are also present in the skeleton. The sacroiliac joints show slight lytic lesions (sacroiliitis), but the bony elements are not fused. The right side carpometacarpal joints show moderate proliferative alterations.

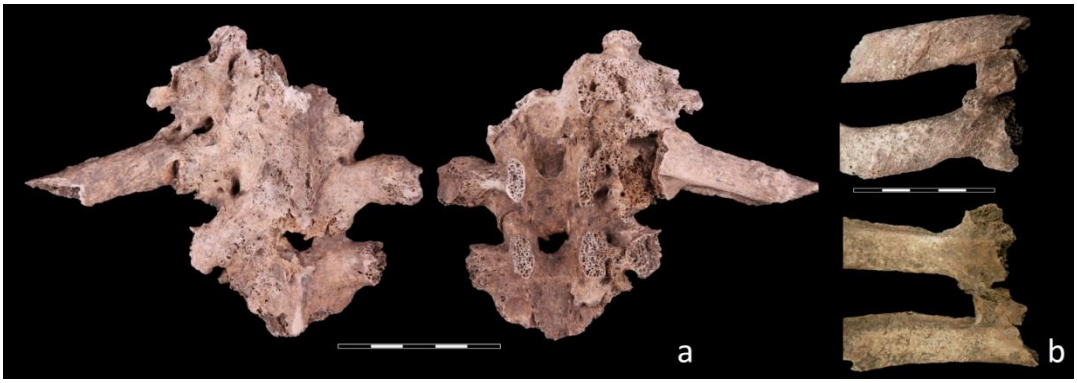


Figure 4.44.Bilteral ankyloses of the zygapophyseal joints and the costovertebral joint of the mid-thoracic spine are present in the skeletal remains of the individual Székkutas – Kápolnadűlő 80 (Adultus, male).

The previously made X-ray confirmed the fusion of the costovertebral joints; costovertebral ligament ossification is also seen in the roentgenograms (Pálfi, 1990).

On the basis of the macroscopic and radiologic examinations, the changes may be in association with some seronegative spondylarthropathy. Although the incompleteness and the fragmentary state of the skeleton impede to give a precise diagnosis, we cannot rule out the presence of the ankylosing spondylitis. However, other spondylarthropathies may also be responsible for the bony alterations.

Another two individuals present skeletal changes of which may be associated with seronegative spondylarthropathies, but partly the fragmentary state of the skeletons, partly the presence of multiple pathological conditions hinder the precise differential diagnosis.

Specimen 1: Orosháza – Béke TSZ – 76 (Maturus, male)

Complete right side sacroiliac ankylosis is present in the skeletal remains of the male individual belonging to the Maturus age category. The joint gap is not recognizable, smooth fusion area is present. No ligament ossification is found around the sacroiliac joints, concerning the other skeletal changes, moderate spondylosis deformans in the cervical and lumbar spine and strengthened entheses of the calcanei and the humeri are present. As the classical AS-associated signs are not present in the sekeleton, our diagnosis is uncertain. On the basis of the complete sacroiliac fusion, the presence of some seronegative spondylarthropathy is not excluded, but other aetiological factor may also be responsible for the development of the fusion.

Specimen 2: Ópusztaszer – Monostor 865 (Senium, female)

Bilateral sacroiliac fusions are developed with no ligament ossification in the skeletal remains of the individual OPM-865. *Post mortem* fractures revealed that strong multiple lytic lesions are present on the left auricular surface of the iliac bone, the right side involvement is not recognizable. The spine is also affected is the fusions, three vertebral blocks formed. The first one involves the right anterior and central parts of the bodies of the 10^{th} and 11^{th} thoracic vertebrae, the zygaophyseal joints are intact. The second block includes the two first lumbar segments, complete fusion between the posterior parts of the vertebral bodies is found. The small facet joints are not fused, the anterior parts of the bodies are missing. The third vertebral block is localized in the 4-5^{th} lumbar vertebrae, beside the posterior parts of the bodies the inferior margins of the zygapophyseal joints are fused, irregular bumpy area is seen here. The intervertebral disc space seems to be intact; no significant decrease of the space height is visible in the spinal fusions. Classical syndesmophytosis is not found, however the anterior parts of the vertebral bodies are lost *post mortem*.

Other skeletal changes are also present, moderate osteoporosis resulted in slight biconcavity of the 12^{th} thoracic vertebral bodies. Concerning the degenerative processes, distorted small facet joints are recognizable in the thoracic and lumbar spine.

On the basis of the macromorphological traces, two different diseases may have played an important role in the development of the spinal and sacroiliac ankyloses. The increased age associated with the presence of osteoarthritis in the small facet joints and osteoporosis may suggest that multiple ankyloses developed as a result of some degenerative process. On the other hand, bilateral sacroiliac fusions rarely develop in degenerative osteoarthritis; the presence of sacroiliitis together with the intact disc spaces may refer to the presence of some seronegative spondylarthropathy.

4.1.2. Trunk (rib cage)

Concerning the joints of the rib cage, the three parts of the sternum and rib-rib connections were involved in ankyloses. Fusions of the costosternal joints were not found during our analysis.

Among the sternal ankyloses both manubriomesosternal and xiphisternal joint fusions are recognizable. The fusion area is smooth in all of the cases; we did not find traces of other pathological processes. They developed as a single phenomenon in the majority of our cases (Fig. 4.45, a, c, d), but the coexistence of the two ankyloses is also found Fig. 4.45. b). Two types of the manubriomesosternal fusions are seen in the first group, in the first appearance type the fusion developed alone. In the second type the fusion is associated with another alteration; the lack of the fusion between the segments of the sternal body is also recognizable. This latter manifestation is interpretable as misplaced manubriomesosternal joint, when the new articulation is seen between the 1st and 2nd mesosternal segments. Concerning the aetiological background, developmental defects and ageing may be responsible for the fusions, in all probability, but the differentiation between them is not possible.

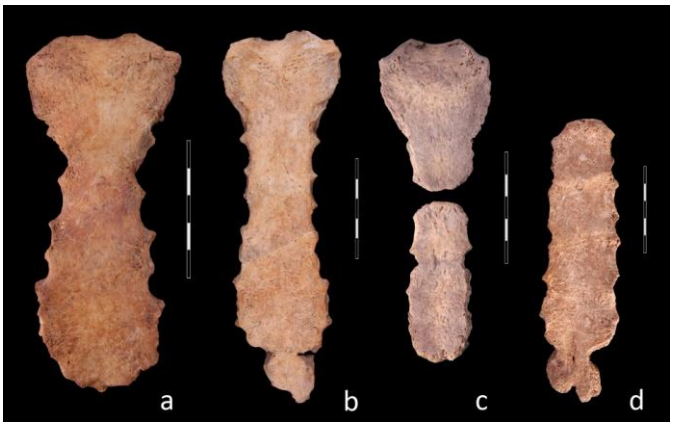


Figure 4.45. The manubriomesosternal and xiphisternal joint fusions (a: specimen BA-175, Maturus, F; b: specimen BMP-2477, Senium, M; c: specimen SZA-17, Adultus, F; d: specimenHVN-20, Senium, M) may be in association with developmental defects and/or ageing.

Fusions of the two upper parts were recognizable in 28 cases, the majority of the cases belonging to the Maturus age category (Fig. 4.46.). The representation of the Adultus and Senium age category seems to be very similar, but as the number of the skeletons belonging to the Senium age category is much lower; the manubriomesosternal fusions seem to be appeared more frequently in Senium age categories.

The ankyloses of the sternal body and the xiphoid process is the biggest group among the sternal fusions, it is seen in 41 skeletons (Fig. 4.46.). Similarly to the previous group, the Maturus age category gives the highest number of cases, it is followed by the Senium and Adultus categories. Ankyloses appeared in two sterna joints are present in the skeletal remains of ten individuals. We found double fusions only in the Maturus and Senium categories (five and three cases, respectively), in two individuals the determination of the age at death was not possible.

Concerning the distribution of the sex, an interesting profile is seen. While the distribution of the sex seems to be balanced in the first and third categories, very strong male predominance is found in the second group (Fig. 4.46.). Xiphisternal fusions are recognizable in 30 males and in only nine females, this imbalanced distribution may be in association with the different preservation conditions.

	sternal body - sternal manubrium	sternal body - xiphoid process	sternal manubrium - sternal body - xiphoid process
Adultus	7	7	0
Adultus - Maturus	2	0	0
Maturus	11	17	5
Maturus - Senium	1	2	0
Senium	6	12	3
adult	1	3	2
male	15	30	5
female	13	9	3
undetermined sex	0	2	2
total	28	41	10

4.46. Distribution of the sternal fusions according to the sex, the age at death and the involved joints.

The fusions of the ribs is a particular category, because no classical joint ankyloses were found among them. Bony bridges in the areas of the heads, the tubercles and mid-shaft are seen, but none of them resulted in classical osseous ankyloses. We can interpret these fusions as partial functional ankyloses, the fixed ribs may have been responsible for the rib-cage's smaller capacity of movement, in all probability. We found ten rib fusions, except of the specimen Bácsalmás – Homokbánya 85, the fusions involved two bones (Figure 4.47.).

specimen		age, sex	number, laterality	involved area	diagnosis
1	OPM - 939	Maturus, F	2 right ribs	necks	developmental defect
2	PVT - 114	Infantia I, U	2 right ribs	mid-shafts	developmental defect
3	SZA - 39	Adultus, F	2 left ribs	tubercles	developmental defect
4	SZA - 110	Infantia I-II, U	2 right ribs	tubercles	developmental defect
5	SUH - 31	Maturus, F	2 right ribs (1st-2nd)	mid-shafts	developmental defect
6	BMP - 1845	Maturus, U	2 right ribs	mid-shafts	developmental defect
7	OPM - 343	Infantia I, U	2 left ribs	heads	developmental defect
8	OPM - 392	Infantia II, U	2 ribs	heads	developmental defect
9	BA - 85	Maturus, M	3 right ribs (7th-9th)	necks	tuberculosis
10	OHB - 63	Maturus, M	2 right ribs	mid-shafts	unknown

Figure 4.47. Distribution of the rib fusions according to the age at death, sex, the involved bones and the probable diagnosis.

On the basis of macromorphological examinations, developmental defect seems to be the most probable aetiological factor in nine individuals. Smooth fusion area with hardly visible fusion lines is present in these samples (Fig. 4.48.), no traces of other pathological conditions are visible.

Figure 4.48. Developmental defect resulted in rib fusion in the specimen Szatymaz – Vasútállomás 110 (infant, undetermined sex).

The alterations developed in two males and three females, the determination of sex was not possible in one Maturus individuals. Infants were also involved in the defect in four instances. Concerning the laterality - although the analytical sample is small – strong imbalance is found; the alterations appear on the right side in six cases, while the left side was involved in two individuals.

Three right side ribs are fused in the specimen Bácsalmás – Homokbánya 85 (Maturus, male); rough surfaced bony connection developed among the 7^{th} and 9^{th} ribs (Fig. 4.49.).

Figure 4.49. Rough surfaced osseous belt developed among the right 7-9th ribs. The alterations are associated with skeletal tuberculosis (specimen Bácsalmás – Homokbánya 85; Maturus, male).

Beside the fusions superficial periosteal bone formation on the visceral side of ribs is also found. The opposite side ribs present periosteal reactions as well; slight, partly remodeled, partly woven bone formations refer to the presence of rib periostitis (Molnár and Pálfi, 2004.). Calcified pleural fragments are also found, and as a result of microbiological examinations, mycobacterial DNA-fragments of the *Mycobacterium tuberculosis* complex were isolated (Haas *et al.,* 2000a).

On the basis of the macromorphological and microbiological analyses, an association among the findings may be suggested, and the features are strongly suggestive of a tuberculous infection, the infection may have spread from the lung to the neighboring tissues.

In the last case the aetiology of the rib fusion is unknown, but both developmental and infectious disease may be responsible for the development of the very thin membrane-like connection between the two right side ribs. The smooth fusion area with no visible signs of the original borders is suggestive of the developmental/segmentational failure. However, the hip bones present very strong pathological lesions. The pubic symphysis is closured; the anterior surface in this area shows irregular bony structure. The posterior surface is smooth; no fusion line is recognizable here. Another pathological condition is found in the left hip bone; the acetabulum became shallow and distorted, the original shape of the anatomical area is almost completely disappeared. Irregular new bony formation developed in and around the acetabulum, an oval cloaca-like opening on the medial surface of the iliac wing is recognizable. Pitting and increased vessel impressions on the frontal's endocranial surface are seen. On the basis of the alterations the presence of some infectious process is strongly suggested, we

cannot rule out the tuberculosis as an underlying disease (Marcsik *et al.*, 2006). Summarizing our data, although some developmental defect seems to be the most probable aetiological factor in the background of the rib fusion, but a long-lasting chronic infection followed by remodeling may also result similar alterations.

4.1.3. Upper extremities and girdles

In the examined material ankyloses localized to the upper limbs and girdles were found in nine individuals, bony fusions involve 72 joints. Concerning the localization of these osseous ankyloses, one case of elbow fusion was found and the distal radioulnar articulation is also fixed in one case. Amongst the upper extremity ankyloses, most of the cases involved the carpals, in these 4 cases carpal fusions were associated with ankyloses at least two of the carpometacarpal joints. Carpometacarpal articulations became fused as a single phenomenon in one case, while the metacarpophalangeal and proximal interphalangeal joints were ankylosed in two individuals. The alterations are present only in adults; concerning the sex distribution no difference in males and females was found (Fig. 4.50.).

Ankyloses of the upper extremities (especially the fusions localized to the big joints) are quite rare, thus we describe all of these cases. We followed the anatomical order within the chapter.

Specimen 1: Biharkeresztes – Ártánd – Kisfarkasdomb -35 (Adultus, female)

In the skeletal remains of the Adultus female individual of BAK-35 humeroulnar joint fusion is seen. The ankylosis involved a small area, bony bridge developed between the ulna's olecranon and the medial part of the olecranon fossa (Fig. 4.51. a). No signs of previous fracture or infection are present in any of the bones. Although the aetiology is unknown in this case, the development of the ankylosis may be associated with the stiffness of soft tissue elements and/or pain of the elbow joint.

no. of ind.	no. of cases	specimen	age at death	sex	ankylosis			
					localization	laterality	type	aetiology
1	1	BAK-35	Adultus	F	humeroulnar	left	osseous - functional	unknown (posttraumatic?)
2	2	BMP-1451	Senium	F	distal radioulnar	left	osseous - functional	posttraumatic origin (fracture)
3	3	BA-132	Senium	F	radioscaphoid	right	osseous - functional	non-specific septic arthritis (?)
	4				radiolunate	right	osseous - functional	
	5				ulnolunate	right	osseous - functional	
	6-15				all carpal joints	right	osseous - functional	
	16				2nd CMC	right	osseous - functional	
	17				3rd CMC	right	osseous - functional	
	18				4th CMC	right	osseous - functional	
	19				1st IMC	right	osseous - functional	
	20				2nd IMC	right	osseous - functional	
4	21	BMP-129	Maturus	F	radioscaphoid	left	osseous - functional	non-specific septic arthritis (?)
	22				radiolunate	left	osseous - functional	
	23				ulnolunate	left	osseous - functional	
	24-33				all carpal joints	left	osseous - functional	
	34				2nd CMC	left	osseous - functional	
	35				3rd CMC	left	osseous - functional	
	36				1st IMC	left	osseous - functional	
5	37-46	BMP-2344A	Adultus	M	all carpal joints	right	osseous - functional	non-specific septic arthritis (?)
	47				2nd CMC	right	osseous - functional	
	48				3rd CMC	right	osseous - functional	
	49				4th CMC	right	osseous - functional	
	50				5th CMC	right	osseous - functional	
	51				1st IMC	right	osseous - functional	
	52				2nd IMC	right	osseous - functional	
	53				3rd IMC	right	osseous - functional	
6	54-63	BMP-BXVI-149	Adultus	U	all carpal joints	left	osseous - functional	non-specific septic arthritis (?)
	64				1st CMC	left	osseous - functional	
	65				2nd CMC	left	osseous - functional	
	66				3rd CMC	left	osseous - functional	
	67				4th CMC	left	osseous - functional	
7	68	OPM-872	Maturus	M	2nd CMC	right	osseous - functional	non-specific septic arthritis (?)
	69				3rd CMC	right	osseous - functional	
8	70	SZV-516	Maturus	M	3rd MCP	right	osseous - functional	non-specific septic arthritis /degenerative origin (?)
	71				3rd PIP	right	osseous - functional	/rheumatic arthritis (?)
9	72	SZV-156	Mat-Sen	M	PIP	-	osseous - functional	posttraumatic ((sub)luxation) / degenerative origin

Figure 4.50. Characteristics of ankyloses of the upper extremities according to basic anthropological data, localization and probable aetiology.

Specimen 2: Bátmonostor – Pusztafalu -1451 (Senium, female)

The distal radioulnar joint is ankylosed in the Senium female individual of BMP-1451. The fusion developed as a result of two different processes. The first fusion appeared in the joint itself, while in the second case the ossification of the dorsal radioulnar ligament is seen. The distal ulna is distorted; the presence of this phenomenon is associated with a healed ulnar fracture. On the basis of the characteristics found in the forearm the ankylosis developed after a traumatic event.

Specimen 3: Bácsalmás – Homokbánya – 132 (Senium, female)

In the case of the specimen BA-132 bony ends fused in 18 cases (Fig. 4.51. b-d). As a result of the multiple ankyloses, the entire wrist and all of the mediocarpal joints became fixed, three carpometacarpal articulations (2^{nd}-4^{th} CMC joints) and two intermetacarpal joints are also

involved. While the original shape of the bones and the joint gaps are partly recognizable on the dorsal side (Fig. 4.51. b), the ossificated volar radiocarpal and intercarpal ligaments cover the bones of the carpus (Fig. 4.51. c). The surface of the bones is strongly porotic, this porosity involves both the carpals and the proximal ends of the ankylosed metacarpals. Signs of fracture are not recognizable. Newly built porous bone is found on those distal radial and proximal navicular joint surfaces which are not ankylosed; these alterations may be associated with some infectious process.

Figure 4.51. Left humeroulnar joint fusion in the individual BAK-35 (a), joints of the wrist, the mediocarpus and the carpometacarpal articulations are involved in the specimen BA-132 (b-d) and in the specimen BMP-129 (e,f).

Concerning the aetiology of the multiple ankyloses between the bones of the hand, the most probable aetiological factor seems to be some infectious arthritis resulted in complete fusions, but we cannot rule out the presence of some previous traumatic event.

Specimen 4: Bátmonostor – Pusztafalu - 129 (Maturus, female)

The specimen BMP-129 belongs to a Maturus female individual, and the osseous signs are very similar to the previous sample. All the joints of the carpus are involved, smooth bony surfaces interrupted with some irregular shape cavities on both the volar and the dorsal sides are recognizable (Fig. 4.51. e,f). The symptoms are in association with ligament ossification, anterior and posterior ligaments of the wrist and the carpus are involved. Second and third carpometacarpal and the first intermetacarpal joints are also fused, these ankyloses fixed the metacarpals in extended position. Post mortal fractures of this area exposed the interior structure of the distal line carpals, and the present less dense trabecular system may be in association with the lack of the use of the joints. However we can state that the rest of the

articulations were used after the development of the ankylosis. Strong distortion characterized with flattening and newly formed rims of the joint surfaces of the distal radioulnar and the not ankylosed carpometacarpal joints are present.

Figure 4.52.Multiple bony ankyloses of the right hand (specimen BMP-2344A)

Specimen 5: Bátmonostor – Pusztafalu - 2344A (Adultus, male)

Complete carpal and carpometacarpal ankyloses are present in the specimen BMP-2344A, the original joint gaps are not recognizable. Roughness on both the dorsal and volar sides is found, beside rough bony surfaces, porosity of the carpals and the proximal ends of the metacarpals are recognizable. Cloacal openings are not seen (Fig. 4.52. a,b). Beside these fusions the distortion of the radioscaphoid, radiolunate and ulnolunate joint surfaces is present; roughness, microporosity and small irregular shaped lytic lesions are seen on these surfaces. The anteroposterior roentgenogram reveals that the original shape of the bones are not recognizable and the joint gaps disappeared; irregular system of radiodense and radiolucent areas can be seen instead of the anatomically normal situation (Fig. 4.52. c). The fact that beside wrist and hand involvement no other osseous lesions are found in the skeletal remains of the adult male individual may suggest that some local event may be in association with the development of the fusions. On the basis of the X-ray image we can say that the emergence of the ankyloses may take a long time, as a consequence of the healing process the original composition of the hand is disappeared. Taking the above mentioned signs into consideration, non-specific septic arthritis seems to be the possible aetiological factor in the development of the ankyloses.

Specimen 6: Bátmonostor – Pusztafalu - BXVI-149 (adult, undetermined sex)

In the specimen BMP- BXVI-149 (stray find) ankyloses developed among the all carpals and in four carpometacarpal joint (Fig. 4.53. a-c). Although the third and fourth metacarpals are lost post mortally, but the area of the ankyloses are seen. The position of the second metacarpal has changed; it is rotated to the lateral direction along its longitudinal axis. Joint spaces are partly recognizable; in some cases newly formed cancellous trabecular system is visible between the affected carpals. No signs of a previous fracture can be seen in the specimen, the porosity together with some small lytic areas on the carpals' surfaces may refer to the presence of some infection. The X-ray image confirmed our previously described macroscopic alterations. The intercarpal and carpometacarpal joints are recognizable as thickened, more radiodense lines, the intercarpal joint gaps appear as less radiodense areas, and they are filled with less dense bony lamellar system (Fig. 4.53. d).

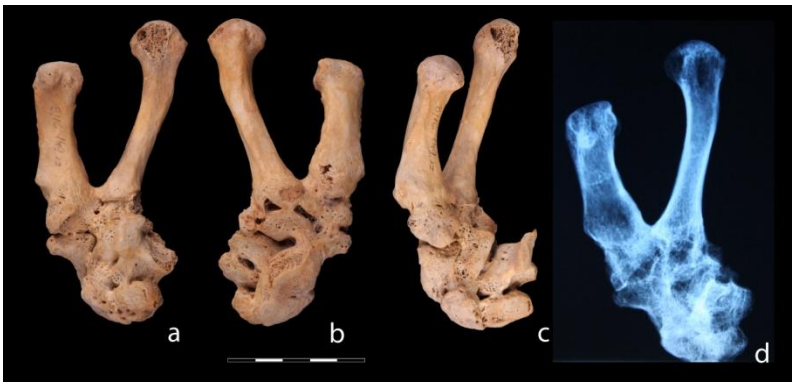


Figure 4.53. Bony ankyloses of the carpals and metacarpals (specimen BMP-XVI-149).

In our opinion some infection may be responsible for the arthritis, where ankyloses developed as the final stage of the healing process. However, we can say that on the basis of the changed position of the second metacarpal may suggest some traumatic event (e.g. (sub)luxation) as an underlying pathological process, and we cannot rule out the presence of some seronegative arthropathies.

Specimen 7: Ópusztaszer – Monostor – 872 (Maturus, male)

The second and the third carpometacarpal joints are ankylosed in the skeletal remains of the Maturus male individual (Fig. 4.54. a). The original joint gaps are not recognizable; the fusion area does not present any morphological change. The proximal metacarpals and the

involved short bones (trapezoid, capitate) show porosity, these alterations together with the presence of irregular shape small lytic lesions on all sides of these bones suggest that some infection may play an important role in the development of the joints. Although as a result of the present ankyloses the capacity of the movement of the affected hand decreased, but the individual was able to use this hand. It is may confirmed by the presence of osteoarthritis in the carpal and metacarpal bones of the same hand.

Figure 4.54. Osseous ankyloses of the carpometacarpo (a: specimen OPM-872), the metacarpophalangeal (b: specimen SZV-516) and the proximal interphalangeal (b: specimen SZV-516, c: specimen SZV-156) joints

Specimen 8: Szeged – Vár – 516 (Maturus, male)

The right third metacarpal and the proximal and middle phalanges of the hand are affected in the fusions found in the Maturus male individual (specimen Szeged – Vár - 16). The ankylosis resulted in a slight curvature of the middle finger; the bones are fixed in a slight flexion position (Fig. 4.54. b). The longitudinal axis has changed as well, very slight *varus* deformity of the phalanges is found. The area of the metacarpophalangeal ankylosis is swollen a bit, smooth surface is present here. In the proximal interphalangeal fusion two different phenomena are recognizable. The palmar side thickening is a result of the ossification/calcification of the palmar interphalangeal ligament, while the presence of irregular shaped bony ends are visible on the dorsal and lateral sides may be suggestive of both degenerative and rheumatoid arthritis. Surfaces of the three bones present both undulating appearance and slight pitting; these periosteal changes may be associated with some infectious process. Other skeletal elements present signs of osteoarthritis as well, distorted joint surfaces of clavicles, bones of the right arm and leg may be support the presence of the degenerative

processes in the individual. On the basis of the osseous changes, we can say that the precise underlying disease is not found. The infectious origin seems to be the most probable aetiology of the ankyloses, but we cannot exclude that degenerative or rheumatic diseases were present before the infectious process.

Specimen 9: Szeged – Vár – 156 (Mat-Sen, male)

The specimen SZV-156 (Mat-Sen. male) presents an ankylosis of one of the proximal interphalangeal joints of the hand, the bones are fixed in a severe flexion (about 85 degrees) (Fig. 4.54. c). The joint is partly recognizable, large irregular surfaced thickening at the fusion area is found. Slight (sub)luxation of the middle phalanx is seen, this process may be responsible for the development of the ankylosis, but we cannot rule out the role of degenerative alterations, these changes may developed after the traumatic process. The traumatic origin may be confirmed by the fact that the skeletal remains of the individual present some clearly traumatic lesions (e.g. healed, slightly dislocated fracture of the left distal ulna).

4.1.4. Lower extremities and girdles

In the material of our analysis, ankyloses localized to the lower limbs and girdles were found in 23 individuals. Bony fusions involve 33 joints; in four instances not the articulations are affected. In the latter four cases only functional ankylosis is recognizable, bony bridges can be seen close to the distal tibiofibular joint as a result of the healing process following a fracture. Concerning the localization of the osseous ankyloses, one case of hip and one case of pubic symphysis fusion were found in our material, one or more bony elements of the knee joint was involved in 6 individuals. We found ankyloses localized in the proximal or distal tibiofibular articulations in four instances, while the bones of the ankle and the foot were affected in four

individuals. Concerning the sex distribution, strong male predominance is seen at these cases, ankyloses developed in the lower limbs and girdles only in three women (Figure 4.55.).

Ankyloses of the lower extremities (especially the fusions localized to the big joints) are quite rare, thus we describe all of these cases, we followed the anatomical approach within this chapter.

no. of ind.	no. of cases	specimen	age at death	sex	ankylosis			
					localization	laterality	type	aetiology
1	1	OHB - 63	Maturus	male	pubic symphyses	-	osseous - functional	TB (probable)
2	2	BMP-1920	Maturus	male	hip	right	osseous - functional	non-specific septic arthritis
3	3	MHK-80	Maturus	male	femorotibial	left	osseous - functional	non-specific septic arthritis (healed fracture)
4	4	BMP-16	Maturus	female	femorotibial	right	osseous - functional	non-specific septic arthritis
5	5	BCS-215	Maturus	male	femorotibial	right	osseous - functional	TB arthritis (probable)
	6				femoropatellar	right	osseous - functional	TB arthritis (probable)
6	7	BMP-390	Senium	male	femorotibial	left	osseous - functional	non-specific septic arthritis (healed fracture ?)
7	8	BMP-465	Maturus	male	femorotibial	left	osseous - functional	TB arthritis
	9				tibiofibular	left	osseous - functional	TB-arthitis
8	10	BMP-993	Senium	male	femorotibial	right	osseous - functional	TB-arthitis
	11				femoropatellar	right	osseous - functional	TB-arthitis
9	12	BA-331	Maturus	male	proximal tibiofibular	right	osseous - functional	non-specific septic arthritis (healed fracture)
10	13	BMP-2527A	Adultus	male	proximal tibiofibular	left	osseous - functional	non-specific septic arthritis (healed fracture)
11	14	OPM-174	Maturus	male	proximal tibiofibular	left	osseous - functional	degenerative (probable)
12	15	BCS-12	Adultus	male	distal tibiofibular	left	osseous - functional	posttraumatic (healed fracture)
13	16	BMP-2462	Maturus	male	distal tibiofibular	right	osseous - functional	unknown (probable posttraumatic)
14	17	SZV-291	Maturus	male	tibiotalar	right	osseous - functional	non-specific septic arthritis
15	18	BA-153	Senium	female	tibiotalar	right	osseous - functional	non-specific septic arthritis
	19				distal tibiofibular	right	osseous - functional	non-specific septic arthritis
16	20	OPM-774	Senium	female	subtalar	right	osseous - functional	degenerative (probable)
17	21	SUH-237	Maturus	male	calcaneocuboid	right	osseous - functional	leprosy
	22				1st cuneonavicular	right	osseous - functional	leprosy
	23				2nd cuneonavicular	right	osseous - functional	leprosy
	24				3rd cuneonavicular	right	osseous - functional	leprosy
	25				medial intercuneiform	right	osseous - functional	leprosy
	26				lateral intercuneiform	right	osseous - functional	leprosy
18	27	BMP-2369	Maturus	male	1st proximal MTP	right	osseous - functional	non-specific septic arthtitis
19	28	OPM-22	Maturus	male	PIP (foot)	unknown	osseous - functional	non-specific septic arthritis (postraumatic?)
	29				DIP (foot)	unknown	osseous - functional	non-specific septic arthritis (postraumatic?)
20	30	SZ68-78	Maturus	male	distal tibiofibular	right	functional	posttraumatic (healed fracture)
21	31	BMP-120	Ad-Mat	male	distal tibiofibular	left	functional	posttraumatic (healed fracture)
22	32	BMP-1381	adult	undetermined	distal tibiofibular	left	functional	postraumatic (healed fracture)
23	33	BMP-2136B	Maturus	male	distal tibiofibular	right	functional	posttraumatic (healed fracture)

Figure 4.55. Ankyloses of the lower extremities according to basic anthropological data, localization and probable aetiology.

Specimen 1: Orosháza – Béke TSZ – 63 (Maturus, male)

The complete fusion of the pubic symphysis is seen in the skeletal remains of the male individual. The fusion area presents strong irregular structure on the anterior side, proliferative and erosive lesions are also recognizable (Fig. 4.56. a). The posterior side of the pubic symphysis is smooth, the original fusion gap is not seen. Although the ankylosis of the pubic symphysis may be in association with several diseases, but the presence of the severe destruction in the left hip bone may suggest the tuberculous aetiology. As Marcsik and her colleagues reported earlier (Marcsik et al., 2006), the acetabulum became shallowed and distorted, extensive new irregular bony formation developed in and around the acetabulum

(Fig. 4.56. b,c). Additional alterations may also in association with TB, multiple lytic lesions on the endocranial surface of the frontal bone and labyrinth-like vessel impressions in the parietal bones are seen. Bilateral periosteal reactions in the tibiae are found.

The opposite side hip bone exhibit the overuse of the joint, the moderate distortion of the lunar surface refer to the presence of the osteoarthritis. The changed range and mobility of motion may be supported by the development of enthesopathies in several attachment areas. The right 1st and second ribs are fused (Fig. 4.56. d), but it is caused by some developmental defect, in all probability. However, we cannot exclude the association between the fusion and tuberculosis with certainty.

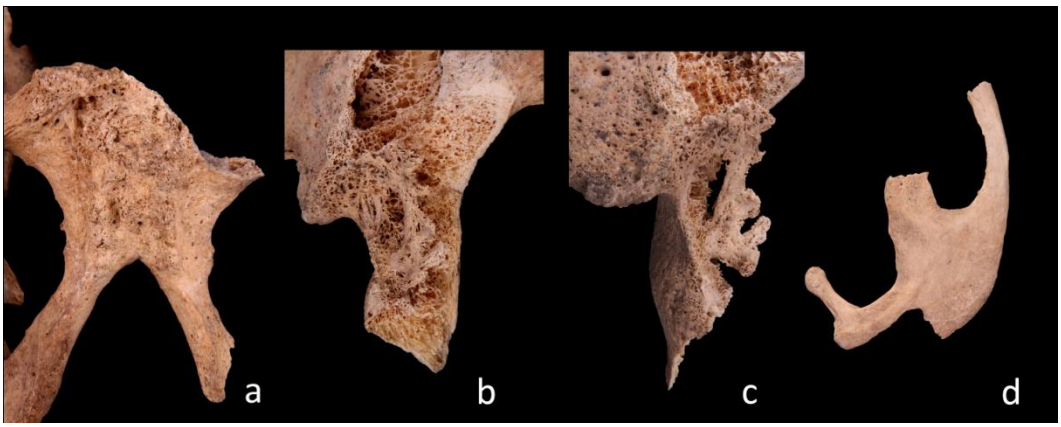


Figure 4.56. The fusion of the pubic symphysis (a) may be in association of the presence of the tuberculous coxitis (b,c). The fusion of the 1st and 2nd right side ribs may have a developmental background (d) (specimen OHB – 63, Mat, male).

Specimen 2: Bátmonostor – Pusztafalu – 1920 (Maturus, male)

The right hip of the elderly male individual is fixed in a flexion of about 90 degrees. The original shape of the femoral neck is not recognizable, newly built extensive thickening covers both the neck of the femur and the acetabular region. Signs of fracture are not visible, only *post-mortem* fracture is found in the proximal femoral diaphysis (Fig. 4.57. a-b). While the surface of the femoral shaft presents no pathological lesions, the neck and the innominate bone is rough, both pitting and spiculous new bone formations are present.

Cloacal openings on the hip bone are also seen, small teardrop-shape and roundish openings are recognizable on both the lateral and medial side, their diameter is less than 0.5 cm (Fig. 4.57. c). On the medial side smooth surfaced shallow depressions with ‘flowing’

appearance are seen. Concerning other pathological lesions in the skeletal remains, cloaca on the left side hip bone and severe osteoarthritis with overhanging bony lips of the same side femoral head is found.

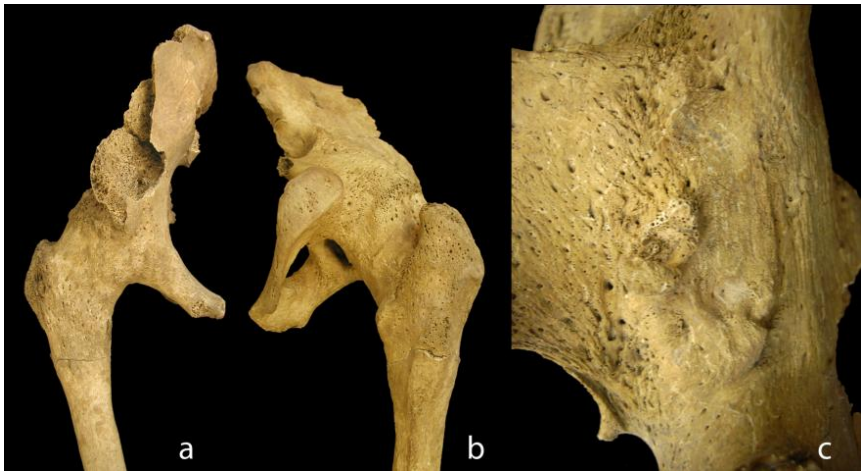


Figure 4.57. Right side hip ankylosis of an elderly male individual (BMP-1920).

X-ray and CT scan were carried out to get precise interior structure of the involved joint. Roentgenogram, as a result of superimposition, only revealed the presence of destructive areas at the acetabular region. CT scans (Fig. 4.58. left) helped to investigate the interior structure in a more precise way, these images revealed extensive lytic areas both in the femur and the hip bone. In the sagittal images (Fig. 4.58. left) three phenomena is found. Radiolucent, roundish-oval area with slight sclerotic margin appears at the level of the greater trochanter. Extensive cavity is recognizable inside the femoral head, which area is partly divided by bony walls. In the medial part of the cavity more radiodense residuum is visible. The third finding is the loss of the original spongious bone in the iliac body; small lytic lesions are present inside these less radiodense areas. Axial images clarify the precise extension of these lesions. In the axial slice 584 a cavity is seen, which involves both the spongious and compact bone. The roundish-oval lesion surrounded by sclerotic margin in the greater trochanter (axial slice 621) raises the possibility of some local infection. The femoral head's irregular-shape destruction seems to be a single cavity (axial slices 677, 690, 719), which is partly divided into three or more smaller cavities. The radiodense residue in the axial slice 677 seems to be sequestrum. We can see a radiodense transverse line crossing the femoral head (axial slice 719), along the line some ossification/calcification process is recognizable. The original shape of the head is also seen, but

the joint gap is not recognizable anymore as a result of the development of new bony elements between the two joint surfaces.

Our diagnosis is based on the presence of local periostitis, cloacal openings and sequestra. This triad is generally in association with some infectious disease, in most of the cases some non-specific infection caused by a bacteria (e.g. *Staphylococcus, Streptococcus*) is responsible for the extensive destruction. In our case, a possible fracture of the femoral head may play an important role in the development of the infection. As the end stage, as a result of the healing process ankylosis formed that involved capsular elements too.

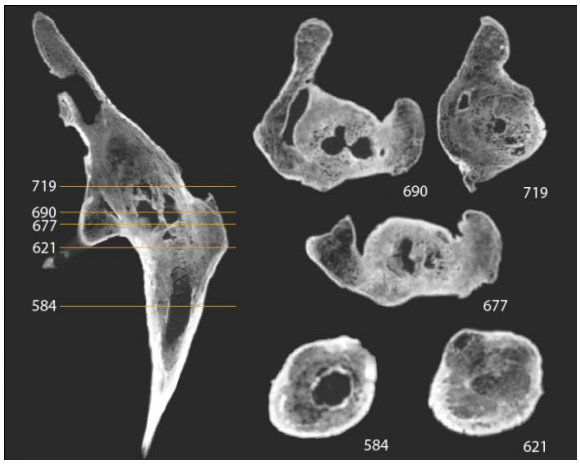


Figure 4.58. CT images of the specimen Bátmonostor – Pusztafalu – 1920 (Maturus, male).

Concerning our analytical material, six knee ankyloses were found. In three instances both femorotibial and femoropatellar joints are involved, single femorotibial fusion is recognizable in the skeletal remains of two individuals, while in one case tibiofibular ankylosis is also formed beside the femorotibial fusion.

Specimen 3: Magyarhomorog – Kónyadomb – 80 (Maturus, male)

The left lower limb is ankylosed in the Maturus male individual. The fusion is recognizable at the femorotibial joint; neither femoropatellar nor tibiofibular joints are involved (Fig. 4.59. a). Medial and lateral condyles are completely fused, but we have to note that *post mortem* destruction caused by taphonomic effects impedes the complete analysis. The original cortical structure on the anterior side is not visible as a result of the mentioned taphonomic process, while extra bony bridges formed between the two bones on the posterior

side. The fusion line at the level of the original joint gap is not recognizable. Extensive new bone formation of cancellous structure (more than 1.5 cm in its height) developed on the antero-lateral side of the lateral femoral condyle. Signs of periostitis are seen both in the femur and the tibia; porous new bone appositions are present along the entire length of the long bones, the diaphyses of them are swollen. Strong callus formation in the left femoral diaphysis is in association with a fracture. The lesion healed with dislocation, as a result of the dislocation the left limb is shortened with about 5 centimeters. Round-shape drainage cloacae are seen at the level of the fracture on both the anterior and posterior sides of the femur. The presence of them may be associated with osteomyelitis caused by some infection; the pathogens may have reached the bone from the environment as a result of an opened fracture. The individual seems to be used both the left and right legs after the development of the ankylosis. Strong distortion and lipping of the acetabuli, the femoral head and bones of the right knee refer to the overuse of the extremities.

Figure 4.59. Femorotibial ankylosis and dislocated healed fracture of the specimen Magyarhomorog – Kónyadomb – 80 (Maturus, male).

Roentgenograms (Fig. 4.59. b-c) confirmed the dislocation of the femoral shaft and the periostitis, but concerning the interior structure of the knee joint, as a consequence of the *post mortem* destruction, no additional information is available by them.

Concerning the aetiology, posttraumatic pyogen infection seems to be the most probable underlying cause in the case of MHK-80, the presence of the dislocated fracture; the

cloacal openings and the extensive periosteal reaction suggest that some non-specific bacterial infection is responsible for the pathological alterations. The pathogens may have reached the body by direct implantation following the fracture, later the pathogens may have infected the knee joint through the bloodstream or direct spread from the fracture area. Posttraumatic infection as a background may be confirmed by the fact that some other healed fractures in the skeleton are seen, callus formations in eight rib fragments and in the left fibula's midshaft are visible.

We have to note that pathognomic signs of diffuse idiopathic skeletal hyperostosis in the lower thoracic spine is also found in the skeletal remains of this individual (see Chapter 4.1.1.5.), but in our opinion, the two different diseases are not linked to each other, in all probability.

Specimen 4: Bátmonostor – Pusztafalu – 16 (Maturus, female)

In the female individual belonging to the Maturus age category the right knee is involved, both the femorotibial and the femoropatellar joints are fused. The femur and the tibia ankylosed in hyperextension of about 25 degrees. The tibia is rotated to the lateral direction; the knee is fixed in moderate valgus position. The femorotibial joint presents complete ankylosis, while the original joint gap is not recognizable, the intercondylar fossa is remained intact on the posterior side of the knee joint (Fig. 4.60. a-b).

Figure 4.60. Knee ankylosis of the individual BMP-16.

Cloaca-like opening is seen on the anterior side, the round-shape hole (about 0.7 mm in its diameter) is found at the level of the original joint gap. The knee cap is fused to the femur,

but the position has changed, it dislocated to the upper border of the patellar surface (Fig. 4.60. a). Remodeled bony surfaces in the right tibial and fibular diaphyses refer to some periosteal reaction; as a result of the process thickening of the tibia can be found. Concerning other lesion in the skeleton, signs of degenerative osteoarthritis (distortion, new rim formations at the margins of the articular surfaces) are recognizable in the opposite side lower limbs' joints.

CT images reveal the interior lesions of the partly destroyed knee joint. As in the saggital reconstruction is seen, radiolucent areas both in the tibial meta- and epiphyses (Fig. 4.61. left). The elongated metaphyseal lesion is not a single cavity; the coronal image (Fig. 4.61. right) confirms that more than one smaller cavities are present. Similar radiolucent area is recognizable in the femoral distal metaphysics, but we cannot rule out the presence of some taphonomical event in this case. In the axial slice 552 subperiostal lesion is seen, the development of it may be in association with the tibial periositis. Slice 555 presents not only the tibial metaphyseal cavity, but a small radiodense area inside an oval cavity of sclerotic margin may refer some dead bone (sequestrum). This phenomenon is also found in the femoral metaphysis (slice 580), but in this latter case we cannot exclude the presence of a piece of soil. The anterior side cloaca-like area is clearly visible in the CT-images as well (slice 566), but it's located at the level of the original joint gap, thus we cannot state whether this opening is a cloaca or only the remnant of the joint gap.

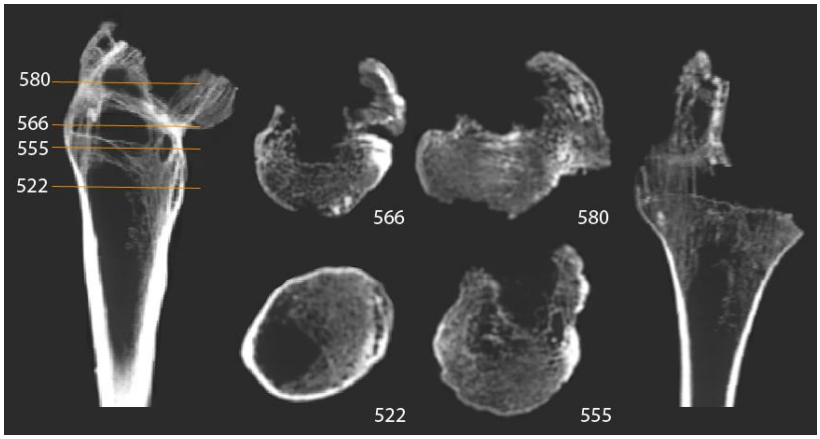


Figure 4.61. CT-images of the knee ankylosis of the specimen BMP-16 (Maturus, female).

On the basis of the macroscopic and CT analyses, some infection seems to be the most probable aetiological factor in the development of the knee ankylosis. The simultaneous

presence of metaphyseal and epiphyseal lesions and the less extensive periostitis may refer to tuberculous arthritis, but we cannot rule out some non-specific infection as an underlying reason.

Specimen 5: Bélmegyer – Csömöki-domb – 215 (Maturus, male)

Complete ankylosis of the right knee (both the femorotibial and the femoropatellar articulations are involved) developed in the elderly male individual. The involved long bones are in extended position of 165-170 degrees. Bony bridges connect the femoral and tibial condyles; a tunnel is seen between them (Fig. 4.62. a, c). The patella dislocated upwards, its base is attached to the femur's patellar surface (Fig. 4.62. b). No signs of fracture or cloacal openings can be seen, but the diaphyseal surfaces of the involved long bones are undulating; slight-moderate, but extensive periostitis is recognizable in the entire length of the shafts. The severe distortion of the same side femoral head indicates that the limb was used throughout the individual's life. (Pálfi and Csernus, 1990)

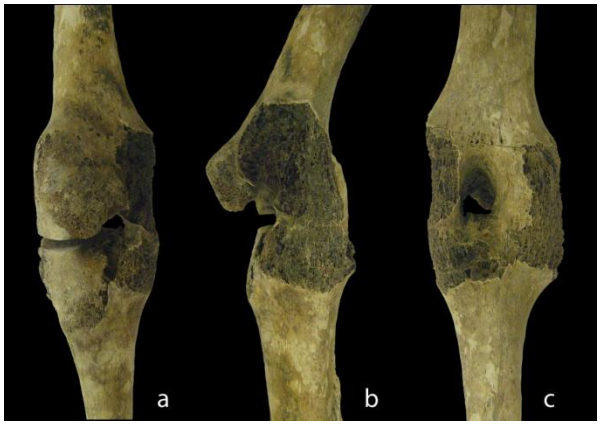


Figure 4.62. Knee ankylosis of the specimen Bélmegyer – Csömöki – domb – 215 (Maturus, male).

CT-images provide useful information about the internal structure of the affected bones. Bony lamellar system of the distal femur and the proximal tibia seems to be relatively strong in the saggital images (Fig. 4.63. left), and the lamellae cross the partly visible joint surfaces. This characteristics suggests that the individual survived for a long period after the disease, and the leg was used after the development of the ankylosis. The saggital CT image presents elongated radiolucent areas of the shin bone; these cavities infiltrate both the metaphysis and the epiphysis, and have slight sclerotic margins.

Axial slices confirm the presence of irregular shaped cavities; cloacal opening is not visible in any of these images (Fig. 4.63. right). On the basis of the macroscopic and medical imaging characteristics, tuberculous osteomyelitis and arthritis seem to be the potential aetiological factors in the background of the knee ankylosis. However, the presence of some non-specific infection as an underlying disease cannot be excluded either.

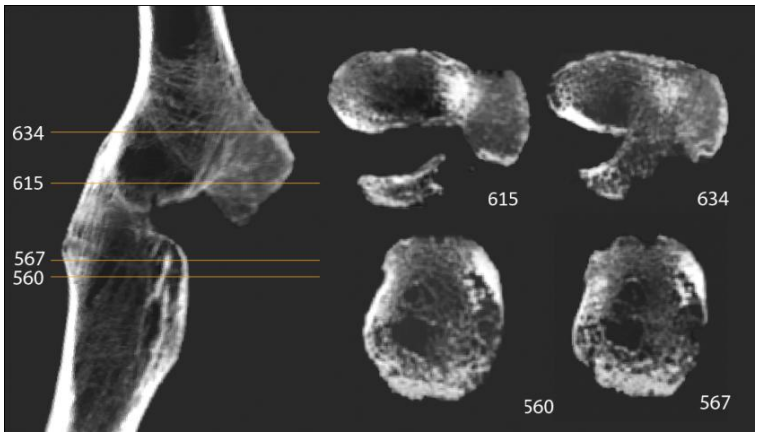


Figure 4.63. CT-images of the knee ankylosis of the specimen Bélmegyer – Csömöki – domb – 215 (Maturus, male).

Specimen 6: Bátmonostor – Pusztafalu – 390 (Senium, male)

The Senium male individual presents ankylosis of the left knee; the joint is fixed in extension position (Fig. 4.64. a-c). The femorotibial articulation is partly recognizable; while the complete fusion is found at the medial condyles, incomplete ankylosis is present at the lateral condyles. A drainage cloaca with around 0.8 mm in its diameter is seen in the intercondylar fossa (Fig. 4.64. a). Slight periosteal apposition is found on both the femoral and the tibial shafts, undulating surfaces are seen. The tibia is dislocated into the posterior direction (Fig. 4.63. b); the tibial plateau seems to be flattened.

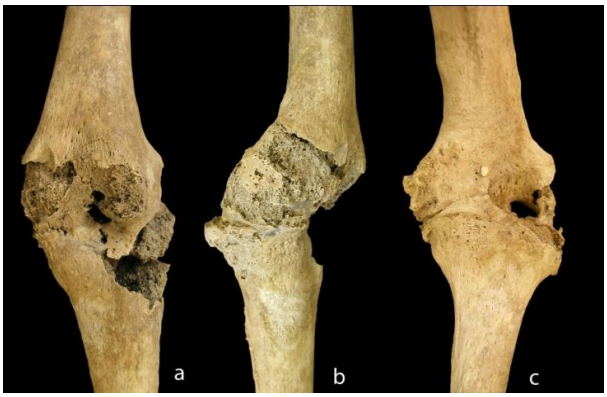


Figure 4.64. Knee ankylosis of the specimen Bátmonostor – Pusztafalu - 390.

CT-images (Fig. 4.65.) revealed the interior structure of the fused bones. In the coronal image (Fig. 4.65. left) sclerotic margin of the ankylosed bones are recognizable, the fusion line does not present carious characteristics. Both sagittal images (Fig. 4.65. right) and axial slices provide information about the development of an oval shaped cavity (Fig. 4.65. right, slice 135). This area is characterized with radiolucency and slightly sclerotic margins. A more radiodense area in the centre of the lesion may suggest the development of dead bone (sequestrum).

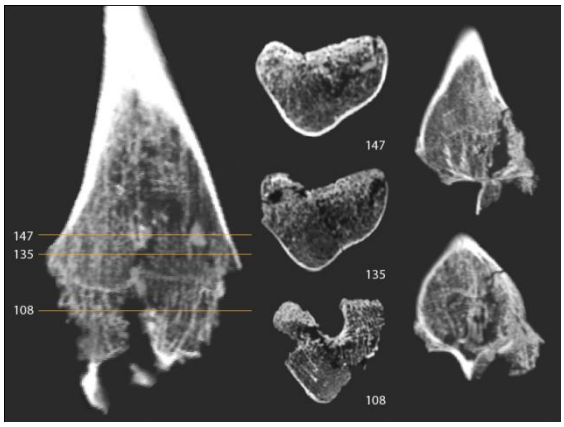


Figure 4.65. CT images of the knee ankylosis of the specimen Bátmonostor – Pusztafalu - -390.

Concerning the underlying disease we hypothesize that some fracture affected the tibial epiphysis or the metaphysis which may have resulted in the flattening of the tibial plates. The co-existence of the cloaca-like opening, the irregular shaped cavity in the femoral metaphysis and the periosteal changes suggests that some infection also appeared and the fracture later healed with ankylosis.

Specimen 7: Bátmonostor – Pusztafalu - -465 (Maturus, male)

The ankylosis involves the long bones of the left lower limb (Fig. 4.66. a-d). The knee joint is fixed in a lateral rotation and angulation of about 35 degrees (Fig. 4.66. b) that does not correspond to normal physiological flexion. The fusion of the medial condyles is complete, whereas the lateral condyle is attached to the tibial lateral plate by a bony bridge (Fig. 4.66. a). The femoropatellar and proximal tibiofibular articulations are also fused. These areas have been affected by post-mortem taphonomic processes, and as such cannot be examined. At the level of the original joint gap, an irregular osseous belt emerges whose surface is characterized with new, rough-surfaced bony elements (Fig. 4.66. a-b, d).

Spicules of new periosteal bone formations can be recognized on the medial side of the proximal metaphysis adjacent to the tibial tuberosity (Fig. 4.66. d). The fibula also shows signs of irregular periosteal bone apposition at the proximal end and along the diaphysis (Fig. 4.66. b-c). On the anterior aspect of the tibial diaphysis and at the medial side of femoral shaft, a circumscribed swelling up to 15 mm in height can be seen, where the distinction between the original cortical and the newly formed bone can easily be recognized. The *linea aspera* and *linea musculi solei* appear pronounced and are easily recognizable.

In the sagittal CT-images, it is possible to recognize the original joint surface, although carious borders are visible as opposed to a smooth line aspect. The denser appearance of the joint surfaces refers to some calcification/ossification processes (Fig. 4.66. e-f). Oval and irregularly-shaped lytic lesions can be seen in the axial and sagittal images involving both the metaphysis and epiphysis of the affected long bones (Fig. 4.66. f-g). Axial CT images confirmed the presence of new periosteal appositions on the tibial and femoral diaphyses (Fig. 4.66. g-h). The ossification does not appear to have incorporated with the original cortical layer. The medullar cavities are not involved; neither tibial nor femoral medullar cavities show any changes in their diameter (Fig. 4.66.). The apparent strengthened entheses recognizable along the *linea aspera* and *linea musculi solei*, as well as maintenance of the cortical thickness suggest continued use of the affected limb after healing of the infectious process.

Figure 4.66. Complete fusion of the left femorotibial and tibiofibular joint in the individual Bátmonostor – Pusztafalu - -465 (Maturus, male).

The 3D reconstruction of the fused joint confirms the pattern visible in 2D images. Furthermore, the more precise 3D morphology of the circumscribed lytic lesions observed in the sagittal images is clearly demonstrated (Fig. 4.67. a). These lesions correspond to an intra-medullar volume occupying the trabecular space of the distal-femoral and proximal-tibial metaphysis, elongated in shape with finger-like projections. These "mirror-image" lesions extend to the fused articular line.

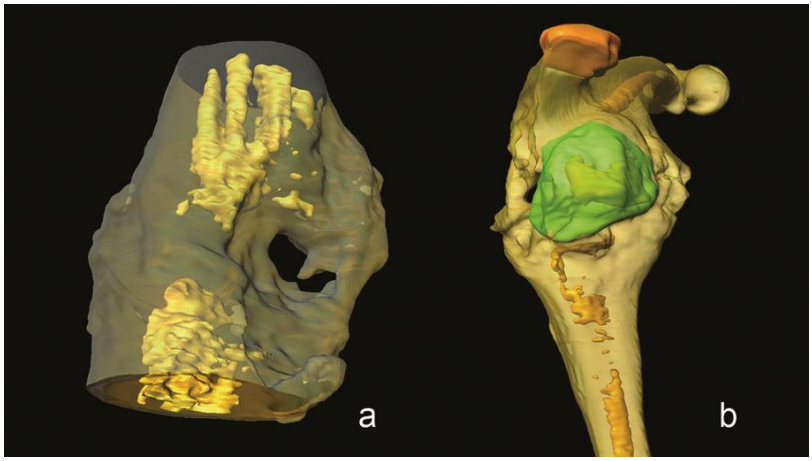


Figure 4.67. 3D reconstructions of the knee ankylosis (a: specimen BMP-465, b: specimen BMP-993).

On the basis of the macromorphological and medical imaging techniques, tuberculosis seems to be the most probable aetiological factor in the development of the ankylosis.

Specimen 8: Bátmonostor – Pusztafalu – 993 (Senium, male)

In the skeletal remains of the second individual, the right knee joint is completely ankylosed and destroyed. The femur and the tibia are fused, and flexed 85 degrees. The patella is dislocated to the upper border of the lateral femoral condyle and fused to its lateral surface (Fig. 4.68. a-b). Osseous fusion occurred between the posterior aspects of the tibial and femoral condyles. The medial condyles are fused along their entire width; the lateral condyles are joined by a narrow bony connection. As a consequence of *post-mortem* taphonomic processes, the internal structure of the lateral condyle of the femur is exposed, and three small (6-7 mm in diameter) lytic lesions are recognizable in the trabecular bone (Fig. 4.68. a).

A bony projection that is 55 mm in length and 35 mm in width projects anteriorly from the ankylotic joint (Fig. 4.68. a-b). The surface of this wedged outgrowth is rough and covered

with dense trabeculae. Typical cortical structure is not found in this area. Above the medial femoral condyle a new smooth-surfaced bone formation is found near the medial epicondyle (Fig. 4.68. b). Slight periosteal reactions are also visible. While lamellar and spongy new bone formations cover the femoral shaft, the anterior side of the tibial diaphysis shows only slight spongy new bone appositions. The position of the bones suggests that the tibia slipped in the posterior direction. We found in the skeleton other pathological alterations as well, like the distortion of femoral heads, slight bilateral enthesopathy of the Achilles-tendon insertions, slight exostoses at the anterior side of the lumbar vertebral bodies, bilateral *cribra orbitalia* (porotic stage) and deep granular endocranial depressions on the frontal bone.

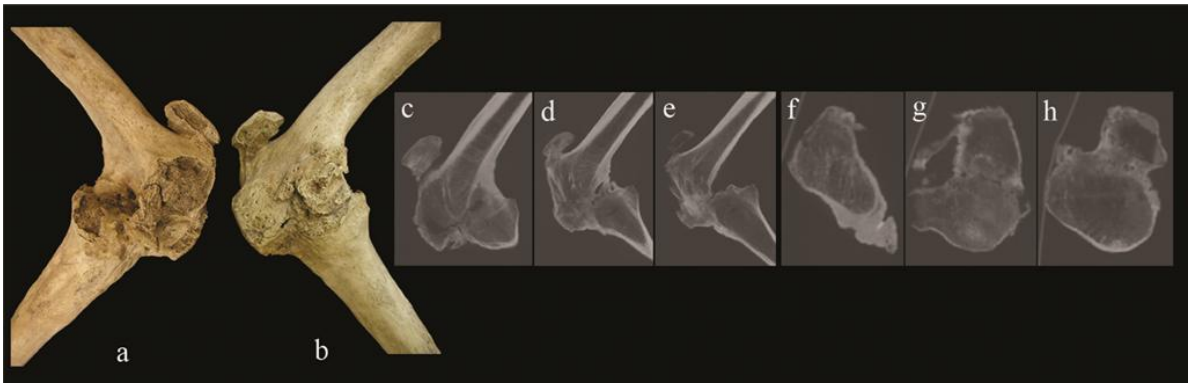


Figure 4.67. Macroscopic and CT-images of the right knee ankylosis in the specimen Bátmonostor – Pusztafalu - -993.

A small teardrop-shaped cavity inside the new bone formation on the posterior aspect was visualized using CT (Fig. 4.68. c-d). In the proximal tibia, radiolucent areas refer to the devastation of the original bony mass. These irregularly shaped areas break through the level of the epiphyseal line and involve both the metaphysis and the epiphysis. The lamellar system of the distal femoral metaphysis remained fairly stable, but the direction of the trabeculae has changed, such that they are almost perpendicular to the longitudinal axis of the bone. This orientation continues within the irregularly structured wedge-shaped new bone formation (Fig. 4.68. c-e). Axial CT images confirmed that beside macroscopically visible cavities, additional lytic lesions or areas of reduced density are also present in the internal aspect of both femoral condyles (Fig. 4.68. f- h). The structure of the new lamellar deposit near the medial epicondyle is homogenous, similar to compact bone's structure, and no trabecular elements can be seen (Fig. 4.68. f).

In the 3D reconstruction (Fig. 4.67. b) it is clearly visible that the patella glided upwards and fused anterior to the distal femoral metaphysis. Its base is attached to the femur by a sessile ossification that potentially represents the proximal part of the patellar ligament that became involved in the overall healing process within the joint. The reconstruction confirms the volume of the anterior bony mass located at the original place of the patella, which is most probably corresponding to the ossification of ligamentous and bursal remnants due to use of a prosthesis. The presence of a cavity inside this bony mass can be linked either with a circumscribed infection or with taphonomic process. Another lytic lesion was found parallel to the level of epiphyseal line in the tibial metaphysis. The lateral bony bridge corresponds to the calcification of the fibular collateral ligament.

On the basis of the macromorphological and medical imaging techniques, similarly to the previous specimen, TB seems to be the most probable aetiological factor of the ankylosis.

Specimen 9: Bácsalmás – Homokbánya - 331 (Maturus, male)

The right proximal tibiofibular joint is ankylosed in the elderly male individual from the medieval cemetery of Bácsalmás – Homokbánya. The fusion line is irregular, the surrounding area of the articulation is puffed, and new bone formation is recognizable. The fibula's proximal end is slightly curved. The tibial condyles are extremely distorted, both eburnation on the lateral plate and big osteophytes in and around the tibial condyles are present. The lateral condyle's plateau is not horizontal, its lateral part is depressed, and a skew joint surface formed (Fig. 4.69. a-c). The tibial deformity may be a consequence of an oblique fracture of the proximal tibia's lateral condyle.

The event may also involved the proximal fibula, but the degenerative joint disease developed after the fracture may also take part in the development of the fusion. The traumatic event resulted in a severe *genu valgum* deformity (Fig. 4.69. c).

Some other joints are also extremely distorted, small and big articulations of the upper and lower extremities present signs of degenerative osteoarthritis. Spinal pathologic alterations are also recognizable; spondylosis deformans and spondylarthritis are found in almost every vertebra. The traumatic origin of the fusion is confirmed by the presence of other pathological

lesions; the fusion of two ribs may be in association with trauma. The fusion of two cervical vertebrae may be explained by some degenerative process; both vertebral bodies and zygapophyseal joints are involved in this vertebral ankylosis.

Figure 4.69. Proximal tibifimoral ankylosis of the specimen Bácsalmás – Homokbánya -331 (Maturus, male). Severe *genu valgum* deformity formed as a result of an oblique tibial fracture.

Specimen 10: Bátmonostor – Pusztafalu - 2527A (Adultus, male)

The left proximal tibiofibular joint is present an ankylosis in the skeletal remains of the Adultus male individual BMP-2527A. The fibula's proximal end deformed in a serious way; the original joint surface is not recognizable as a result of the newly built bony bridge between the two articular surfaces. Spiculous and porous periosteal new bony formations developed at the proximal end, both the epiphysis and the metaphysis are affected (Fig. 4.70. a). Small opening can be seen the on the fibular head, the area is slightly swollen. No signs of fracture or infection are found on the tibia, but an extensive swelling on the right shinbone's midshaft is visible. The medial side of the affected bone is swollen and its surface is characterized with porous, irregular new bone. Small cloaca-like opening is found in the center of the area. Concerning other pathological alterations, thickening of the left ulna's mid-epiphysis is found, the fracture healed without dislocation.

The specimen's X-ray films reveal the presence of some infectious process of both the left fibula and the right tibia (Fig. 4.70. b,c). The fibula's head is swollen; the more radiodense appearance may refer to the presence of healed fracture associated with osteomyelitis. The

radiolucent area of the left tibia is seems to be not pathological; the majority of the tibial condyles are missing as a result of a *post mortem* devastation. The left tibia's proximal metaphysis is characterized with irregular cavities, their margins are sclerotic. These lesions can be associated with the development of osteomyelitis (Fig. 4.70. c).

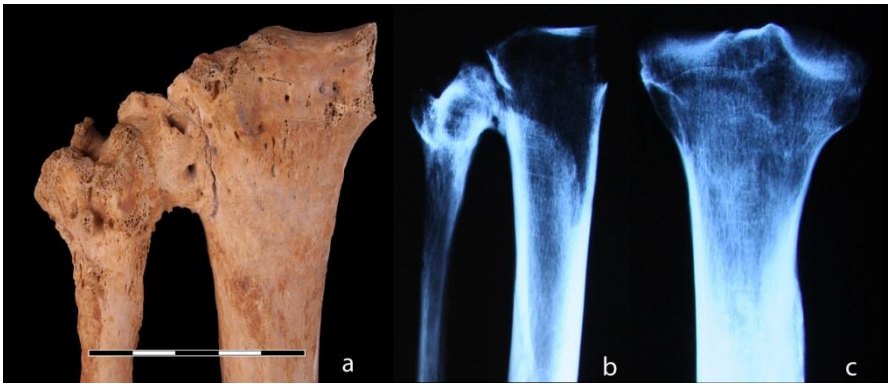


Figure 4.70. Bony fusion of the left proximal tibiofibular joint (a). X-rays (b,c) reveal infectious processes inside both the left fibular head and the right tibial proximal metaphysis in the specimen Bátmonostor – Pusztafalu - 2527A (Adultus, male).

On the basis of the macroscopic and radiographic findings, the ankylosis developed as a consequence of a fibular fracture, which healed with no dislocation. Following the fracture some infection appeared, it involved not only the right fibula, but the opposite side tibia also presents the signs of osteomyelitis.

Specimen 11: Ópusztaszer – Monostor – 174 (Maturus, male)

The left proximal tibiofibular joint is affected in the ankylosis of the specimen 174. The elderly male individual's left lower limb presents severe degenerative osteoarthritis. The medial tibial condyle is in a lower position than the lateral one; this possibly congenital condition may play an important role in the development of degenerative alterations in the proximal tibiofibular joint. Signs of fracture or infection are not recognizable in the skeleton. The tibiofibular fusion may be a result of some degenerative process, the irregular fusion line and the puffy area may suggest the development of this disease.

Specimen 12: Bémegyer – Csömöki – domb – 12 (Adultus, male)

Bony ankylosis developed at the level of the left distal tibiofibular joint. The fusion involved the posterior part of the joint; at the anterior part the original joint surfaces are recognizable (Fig. 4.70. a). The posterior slightly emerged area is smooth surfaced; no signs of previous fracture or infection are visible (Fig. 4.71. b).

Figure 4.71. Partial ankylosis of the distal tibiofibular joint of the specimen Bélmegyer – Csömöki – domb – 12 (Adultus, male).

Our diagnosis is based on the presence of multiple healed fractures in the skeleton. These are found in the proximal shaft of the left fibula and in the mid-shaft of the other side fibula and tibia. We have to note, that although infection was not found on the affected distal tibiofibular area, but both roughness and porous lamellar periosteal appositions on the ventral surface of the ribs and striations on the opposite side tibia are present. The fusion seems to be developed as a consequence of the ossification of posterior inferior tibiofibular ligament; some physical stress factor (trauma, changed motoric functions) may play an important role in the ossification/calcification process.

Specimen 13: Bátmonostor – Pusztafalu – 2462 (Maturus, male)

Complete distal tibiofibular fusion is involved in the skeletal remains of a Maturus male individual. The distal fibula is swollen; some pitting on the lateral surface is seen. Tibial surfaces are not affected, nor signs of previous fracture, neither signs of infection are seen. Elongated openings are found on the anterior side of the fusion, these are the remainder of the space between the two bones and do not function as cloacal openings. The area of the ankylosis is smooth surfaced on the anterior side, while slight roughness is seen on the posterior side. The

fibula's *post mortem* cross fracture revealed the interior structure of the distal fibula. Beside the original structure of the lateral part, normal spongious bone characterized with denser trabecular system is developed at the side facing to the tibiofibular joint; these two different areas are separated by the original compact bone. Concerning other pathological alterations, moderate strengthening of Achilles tendons in both calcanei is recognizable. On the basis of the osseous signs, fibular fracture seems to be the most probable reason as an underlying disease, the healing resulted in ankylosis.

Bony ankyloses of the tibiotalar joints were found in two cases, they present very similar bony alterations. Both of the samples were scanned, diagnoses were based on typical radiological and macromorphological characteristics.

Specimen 14: Szeged – Vár – 291 (Maturus, male)

The right tibia and the talus are fused in the skeletal remains of an elderly male individual. The fusion line is not visible, smooth aspect is seen. The tibial shaft is swollen; its surface presents irregular, partly spiculous, partly undulating areas. Oval shaped, slightly protruding areas characterized with porous new bone formation may be associated with a skin ulcer. Two cloacal openings can be seen on the anterior side of the distal tibial shaft, one of them is oval, while the upper one is elongated in its shape. At the line of the two cloacae slight linear depression may be the sign of a healed oblique fracture of the distal tibia (Fig. 4.72. a-b). Periosteal reaction is not recognizable in the talus; only early stage osteoarthritis is seen on the subtalar surface.

Concerning the antero-posterior roentgenogram and the CT-scans, clearly recognizable elongated cavity is found in the internal part of the tibia. The margin of it is sclerotic, and the connection between the cavity and the lower position cloacal opening is easily examinable in the axial CT slices (Fig. 4.72. c-d). On the basis of the osseous signs posttraumatic infectious arthritis seem to be the most probable aetiology in this case; the infection resulted in osteomyelitis, later it spread from the marrow cavity into the joint. The traumatic origin may also confirmed by the presence of a non-dislocated healed fracture in the mid fibula.

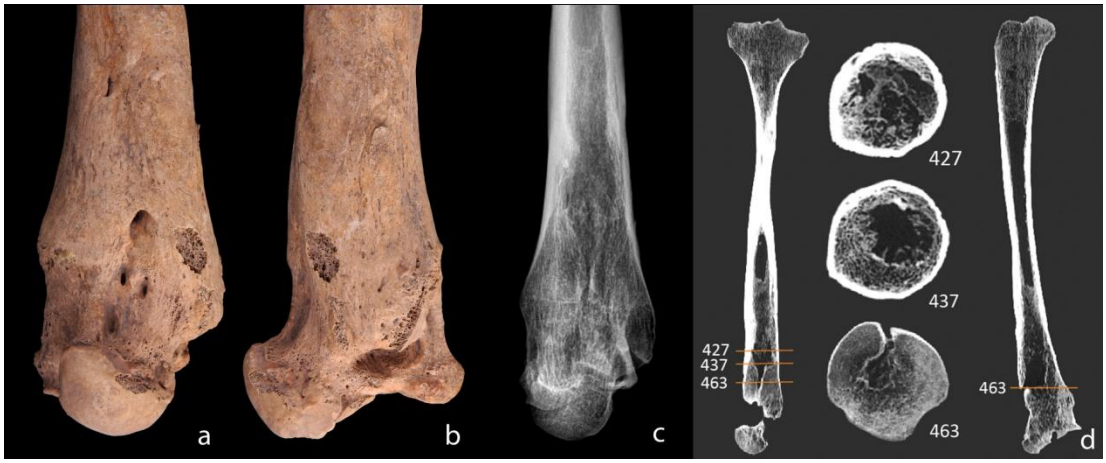


Figure 4.72. Tibiotalar fusion in the skeletal remains of Szeged – Vár – 291 (Maturus, male).

Specimen 15: Bácsalmás – Homokbánya – 153 (Senium, male)

Tibiofibular and tibiotalar ankyloses developed in the specimen Bácsalmás – Homokbánya -153, as a result of the first fusion the talus is fixed in plantar flexion (≈ 15-20 degrees). The nature of the bony lesions is very similar to the characteristics of SZV-291.

Swollen diaphysis, cloacal openings and irregular, remodeled surface are visible in the tibia and fibula (Fig. 4.73. a-c), similar alterations are seen in CT scans too (Fig. 4.73. d). Although TB-associated signs are present in the skeleton, but as the cemetery of Bácsalmás – Homokbánya is very rich in TB cases (Maczel, 2003), we cannot exclude the tuberculosis as aetiological factor in this case.

Figure 4.73. Right tibiotalar and distal tibiofibular ankyloses in the individual Bácsalmás – Homokbánya -153 (Senium, male).

Specimen 16: Ópusztaszer – Monostor – 774 (Senium, female)

The right talus and calcaneus are fused in the specimen OPM-774. The unilateral ankylosis involved the anterior, the middle and the medial part of the posterior surfaces, while the joint gap at the lateral half of the posterior articular surface is recognizable (Fig. 4.74.). The fusion line is irregular and bumpy area is found around it. No signs of infection or fracture are seen, but the distortion of all talar joint surfaces is present. These alterations are typical osseous signs of the degenerative osteoarthritis, and these lesions together with the enthesopathy of the Achilles-tendon suggest special physio-mechanical situation caused by the restricted movement of the subtalar joint. Degenerative origin is suggested by other skeletal changes as well. Fusion of four vertebral bodies is seen; these alterations (although the intervertebral discs are not the representative of the same type joints) suggest that degenerative stress involved lots of part of the body.

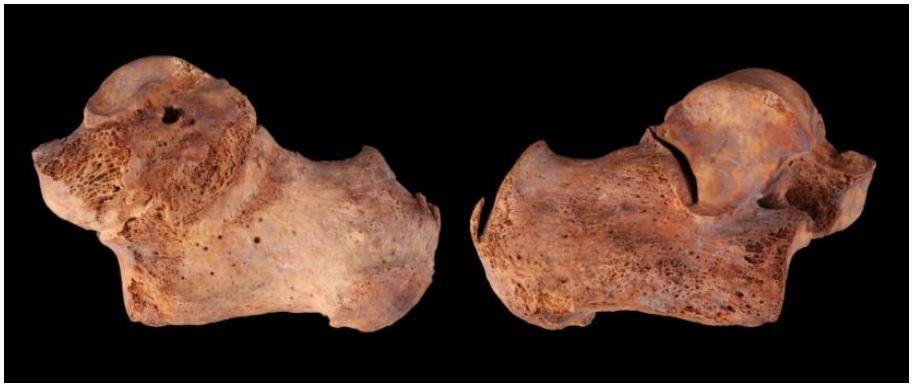


Figure 4.74. Partial fusion of the subtalar fusion of the specimen Ópusztaszer – Monostor – 774.

Specimen 17: Sárrétudvari – Hízóföld – 237 (Maturus, male)

In the skeletal remains of a matured male individual (specimen SUH - 237) multiple ankyloses involving the right foot were found (Pálfi, 1991). In the calcaneocuboid joint complete fusion is seen, the joint is not recognizable (Fig. 4.75. a, b). Around the fusion area slight proliferative periosteal reaction is seen, but no other osseous lesions are found.

The second-fourth fusions are seen among the navicular and the three cuneiforms, where the joint is not recognizable. The shape of the navicular is strongly distorted, its base became porous and flattened, and the length of it is extremely shortened. The latter two

ankyloses formed among the three cuneiforms; while at the posterior parts complete fusions developed, the anterior parts of the cuneiforms are not involved (Fig. 4.75. c).

Figure 4.75. Multiple ankyloses of the right foot of the individual Sárrétudvari – Hízóföld – 237 (Maturus, male).

Cloacal opening are not seen in these bones, but moderate periosteal reaction is recognizable on the bone surfaces. The majority of the not affected articulations of the foot is strongly distorted, very strong flattening and lipping are found in the talo-navicular, tarso-metatarso joints, erosive lesions are present in the left calcaneotalar joint. The hip joints are also distorted; strengthened entheses are also seen in the hips. Concerning other pathological lesions, slight periosteal reaction in the right tibia, moderate widening of the pyriform aperture, erosive periosteal reactions localized to the maxilla, slight, smooth surfaced depressions on the anterior surfaces of the both side maxilla and new bony deposits in the sinuses are found. Although 'pencil' phenomenon is not recognizable, these changes raised the possibility of leprosy (Pálfi, 1991, Marcsik *et al.*, 2009). This hypothesis was confirmed by microbiological analyses, the identification of DNA-fragments of *Mycobacterium leprae* was possible from the examined bone samples (Haas et al, 2000b). On the basis of the microbiological result and the osseous alterations, leprosy seems to be the most probable aetiology in the case of SUH - 237. Although leprosy does not cause bony fusions, but as a consequence of the peripheral nerve devastation traumatic events are more frequent in these individuals. These traumatic processes may lead to the development of bony ankyloses.

Specimen 18: Bátmonostor – Pusztafalu – 2369 (Maturus, male)

In the Maturus male individual ankylosis of the right first metatarsophalangeal joint is seen, the fusion resulted in a slight *varus* deformity (Fig. 4.76. a). The fusion involved partly the

articulation; the joint gap is recognizable on both the dorsal and volar sides. While on the dorsal side only an irregular line is visible at the level of the joint gap, newly formed bony projection of irregular structure is also found on the volar side of the fused articulation (Fig. 4.76. a-b). Signs of previous fracture or infection are not present in this specimen. Other pathological alterations are not seen in the skeletal remains of the individual. Concerning the diagnosis, rheumatoid arthritis and degenerative osteoarthritis are also possible diseases as underlying diseases, but the lack of symmetrical lesions and the presence of significant size newly formed bony projection on the volar side suggest that some degenerative and/or infectious process may be the most probable aetiological factor in the case of specimen Bátmonostor – Pusztafalu - 2369.

Figure 4.76. Metatarsophalangeal (specimen BMP-2369, a-b) and PIP and DIP joint (OPM-22, c) ankyloses of the foot.

Specimen 19: Ópusztaszer– Monostor – 22 (Maturus, male)

Two ankyloses of the foot is seen in the Maturus male individual of OPM-22 (Fig. 4.76. c). The joint gap at the proximal interphalangeal joint fusion is partly recognizable; roughness and porosity of the bony surfaces are found. While the PIP joint is fixed in extension, the fusion of the distal interphalangeal joint resulted in flexion of 90 degrees. Great bony mass is visible laterally along the PIP and DIP joints. The participation of the collateral ligaments in the development of this bony mass is possible, although it cannot be said with certainty. Concerning the aetiology of the fusion, some traumatic process (e.g. (sub)luxation)) may have played an important role in the development of the ankylosis, the presence of roughness and pitting around the joints may suggest some infectious event as well.

Only functional fusions are developed in the last four cases (Szarvas – site 68-78, Bátmonostor – Pusztafalu - 120, Bátmonostor – Pusztafalu - 1381, Bátmonostor – Pusztafalu - 2136). All of these ankyloses developed in the distal tibiofibular joints as a result of tibial fractures, in the specimens BMP-1381 and BMP-2136B healed fibular fracture is also found. All the tibial fractures healed with moderate-severe dislocation, in the cases of BMP-120 and BMP-2136B the presence of osteomyelitis cannot be excluded. This infection is suggested by the presence of swollen tibial metaphyses, porous periosteal appositions on the long bones; small cloaca-like openings are also present on the tibiae.

4.2. Aetiological approach of ankyloses

4.2.1. Developmental alterations

Vertebral fusions and ankyloses between the bones of the rib cage were recognizable among developmental alterations in our series, neither the upper, nor the lower limbs and girdles presented fused bones with developmental background.

Synostosis vertebralis was found in skeletal remains of 28 individuals, except of one case, the fusions formed single vertebral blocks. The differentiation between the developmental fusions and vertebral ankyloses with other pathological conditions is relatively simple. The fusion areas are smooth, the fusion lines are partly or completely disappeared, and in the first type thin junction line is visible with no irregular surface.

In those cases, where the determination of sex was possible, we found the same amount of findings in males and females (11-11 cases), the distribution according to sex seems to be balanced. Not only adult individuals were involved, we also found synostoses in the skeletal remains of both infants and juveniles.

In the majority of the individuals vertebral fusions involved two vertebrae, but in three cases the synostoses include at least three segments. Concerning the localization of the

ankyloses, the mid-lower cervical and the upper thoracic vertebrae are involved the most frequently. We did not find remarkable difference according to the joints, the involvement of the vertebral discs and the zygapophyseal joints present balanced appearance. No significance difference between the two sides was found, left and right side small facet joints are involved in almost the same amount (Fig. 4.76.).

characteristics	synostosis vertebralis	sacralisation
appearance	thin fusion lines	thin fusion lines
	no irregular bony surface	no irregular bony surface
distribution of age at death	all age categories	only adults
distribution of sex	balanced	strong male predominance
distribution of involved joints	balanced	-
typical localization	in all spinal segments	LV5-S1 >> S5-CcV1
	mid-lower cervical spine upper thoracic spine	
laterality	balanced	-
coexistence with other developmental alterations	not uncommon	not uncommon

Fig. 4.76. Characteristics of the spinal ankyloses of developmental origin.

More complex cases were also found among vertebral developmental fusions. In the specimen Bátmonostor – Pusztafalu – 1305A the serious maldevelopment of the 4th thoracic vertebra is associated with multiple fusion., The right parts of the 4th vertebra is completely disappeared, only the left hemivertebral element is present (Fig. 4.4.). Another specimen (Bátmonostor – Pusztafalu – 2504) demonstrates two vertebral blocks in the thoracic spine including two and three vertebrae. In this case additional pathological alterations are also seen, the presence of serious scoliosis resulted in degenerative lesions and fusions (Fig. 4.5) are found. A probable case of Klippel-Feil syndrome is also recognizable in our investigation series; the fusion of the 4-5th cervical vertebrae associated with other skeletal deformities may refer to the syndrome (Fig. 4.3.).

Concerning the second subcategory of the developmental axial alterations numerous cases of sacralization were found during our analyses; the lumbosacral and sacrococcygeal junctions are involved in 83 and 59 cases, respectively. Concerning the sex distribution of the sacralization, medical and palaeoanthropological sources present different results, but in the majority of the analyses no significant differences between the sexes can be seen, the

prevalence is balanced (Bron, 2007; Barnes, 1994). In contrast with these data, we found very strong male predominance both in the lumbosacral and sacrococcygeal sacralization cases (Fig. 4.6). The imbalance may be explained by distorting effects. One of these may be the fact that the determination of the sex was not possible in several cases.

The congenital fusions developed not alone in lots of cases, the coexistence with other developmental alterations is recognizable in 64 specimens. In these cases two to five easily detectable developmental defects are present in the same skeleton. The most frequently associated diseases involved the lower spinal vertebrae, genetically predisposed *spondylolysis*, *spina bifida* of the lower lumbar vertebrae and partial or complete bifid sacrum were found among these alterations.

Focusing on the joints of the rib cage, neighbouring ribs and the three parts of the sternum were involved among the developmental ankyloses. The fusion area is smooth in all specimens; traces of other pathological processes are not associated in these fusions. Among the latter localization, both manubriomesosternal and xiphisternal joint fusions are recognizable. They developed as a single phenomenon in the majority of our cases, but the coexistence of the two ankyloses is also found. Two types of the manubriomesosternal fusions are recognizable, they developed alone, in the second type we can interpret the phenomenon as a shifted mesomanubriosternal joint (Fig. 4.45. c). We found more xiphisternal joint fusions, it is probable explained by the fact that the ageing as an aetiological factor is also emerged in these cases, but the differentiation between the causes is not possible. Concerning the sex distribution of the rib cage fusions, the ankyloses localized to the sternum are seen only in adult individuals with the dominance of older age categories, rib fusions are also recognizable in subadults.

4.2.2. Degenerative alterations

Vertebral ankyloses and probable fusion cases of degenerative aetiology localized to the upper and lower extremities are found among the osseous ankyloses associated with degenerative reasons.

The majority of the degenerative ankyloses is localized to the spine (35 individuals), the cervical segments followed by the thoracolumbar junction are the most involved areas. No significant difference among the involved joints is seen; approximately the same number of the intervertebral discs and zygapophyseal joints were affected. Concerning the laterality, we found no difference, left and right side small facet joints were involved in the same number. Strong male predominance is found, the ankyloses developed almost twice in males than in females (21 and 12 cases, respectively). An increasing tendency with ageing is recognizable in this fusion type; however the changes developed at younger age in women (Fig. 4.7.).

characteristics	ankyloses with degenerative etiology
appearance	wavy fusion lines
	bumpy, irregular bony surface
	two vertebrae are involved in most of the cases
distribution of age at death	increasing tendency with ageing
distribution of sex	strong male predominance
distribution of the involved bones	vertebrae >> extremities
typical localization	in all spinal segments
	cervical spine, thoracolumbar junction
	bodies ≈ zygapophyseal joints
laterality	more unilateral, balanced
coexistence with other alterations	degenerative alterations (osteoarthritis, spondylosis deformans)

Fig. 4.77. Characteristics of the ankyloses associated with degenerative aetiology.

The recognition of the degenerative fusions presents no difficulties. Irregular or wavy fusion lines characterized with irregular bone surface is found in these samples. The presence of other pathological conditions (e.g. spondylosis deformans or degenerative osteoarthritis) helped our diagnosis as well, the correlation among the fusions and these diseases are clearly seen. The ankyloses resulted single osseous blocks including two vertebrae in most of the cases, while in some individuals the vertebral blocks contain three segments or development of two blocks is recognizable. The degenerative spinal fusions' characteristics found in our osteoarchaeological series is seen in the Figure 4.77.

Beside the vertebral fusions, only three probable extraaxial ankyloses of degenerative origin were found; we cannot rule out the role of degenerative processes in a proximal interphalangeal joint fusion (specimen Szeged – Vár 516, Figure 4.54. c), in a proximal

tibiofibular ankylosis (specimen Ópusztaszer – Monostor 174) and in a subtalar coalition (specimen Ópusztaszer - Monostor 774).

4.2.3. Traumatic alterations

Ankyloses associated with traumatic events are recognizable in the spine and in the upper and lower limbs and girdles.

Compression fracture is the most probable aetiological factor as an underlying disease in the most of the cases of the spinal fusions (11 individuals), while in one specimen (Bácsalmás- Homokbánya – 331) the fusion of the 5th sacral and 1st coccygeal segments caused by anterior sacrococcygeal ligament ossification may be explained by other traumatic event. Ankyloses associated with compression fracture are characterized with decreased vertebral body height, the phenomenon is seen in both the anterior and posterior parts of the bodies. Concerning the involved joints, the intervertebral discs are the most typical articulations (10 cases). The zygapophyseal joint may also be affected, right side involvement is seen in 6 specimens (66,6 %), while the left side small facet joints are affected in four individuals (50 %). We found one specimen, when bilateral zygapophyseal joint fusions are seen without vertebral body ankyloses (specimen Magyarhomorog – Kónyadomb – 37), in this case multiple small facet involvement is recognizable (Fig. 4.13.). The lower thoracic and upper lumbar spine is the most represented, no ankyloses in the cervival spine is seen. Only adults were involved, the older age categories (Maturus, Senium) seems to be the most represented. (Fig. 4.12). Although the number of cases does not allow to draw proper conclusions, but the distribution of the sex seems to be imbalanced; seven males and four females present spinal ankyloses of traumatic origin.

Concerning the appearance, we can say that except of one case the fusions resulted in vertebral blocks containing two vertebrae. Two manifestation types are found in those cases, where the vertebral bodies are involved in the fusion. In the first category the intervertebral disc spaces are not recognizable, while in the second form a bony bridge is seen as a result of osteophyte fusion. Additional pathological alterations are also found, the half of the cases,

where the vertebral bodies were available for the examinations, signs of spinal osteoporosis are recognizable; light, and porous vertebrae and/or concavity of the vertebral plates are present.

Probable traumatic ankyloses localized to the upper extremities were found in two cases. In the first case distal radioulnar fusion, while in the second specimen phalangeal-interphalangeal fusion may be in association with some traumatic event (Fig. 4.50.).

The lower limbs and girdles present 11 individuals with posttraumatic ankyloses (Fig. 4.55.). Fusions of the femorotibial joint, the distal tibiofibular joint and the articulations of the foot are found, the alterations are associated with slight traces of some infection in five individuals. Only males are involved, and the majority of the cases is belonging to older age categories.

Special manifestation is recognizable among the posttraumatic fusions in four cases, where the areas close to the distal tibiofibular joints were involved. We can interpret these cases as functional ankyloses: the fusions did not affect the joint itself, but the osseous bridges between the bony ends may have impeded the movement of the articulation, in all probability.

4.2.4. Infectious diseases

Ankyloses associated with infectious processes are recognizable in the spine and in both the upper and lower extremities; skeletal remains of 32 individuals present single or multiple fusions.

Among the spinal ankyloses, our diagnosis was non-specific infection in four cases, while TB-associated fusions are seen in twelve specimens. Non-specific fusions developed in the lower-thoracic and lumbar spine, except one individual ankyloses involved two adjacent vertebrae. Concerning the sex and age distribution, a simple profile is found, all of these cases are belonging to the skeletal remains of adult (Adultus and Maturus age categories) females. While the fusion of the vertebral bodies is present in all cases, posterior zygapophyseal joints remained intact in one specimen. The rest of the cases exhibits bilateral small facet joint ankyloses. Additional pathological alterations are also present in the individuals affected by

non-specific infection. The partial collapse of the vertebral bodies is seen in two individuals. However, collapses developed in the entire length of the bodies, no anterior preference is recognizable. Very slight kyphosis is seen in one specimen.

One or more cloacal openings are found in all vertebral blocks. *Post mortem* fractures or devastation and/or CT-images revealed that drainages correspond to interior lytic lesions, these break through the upper and lower plates. As a result of the infectious process extensive smooth walled cavities are visible; they are recognizable in the CT-images as radiolucent areas surrounded by sclerotic margined bony structure.

Spinal ankyloses associated with tuberculosis are recognizable in 12 individuals, 17 vertebral blocks developed including 110 joint fusions. The alterations appear twice frequently in females than in males (eight and four cases, respectively). Concerning the age distribution, a particular profile is seen. While all the involved male individuals belong to the Maturus and Senium age categories, the Adultus age category is the most represented among females (Fig. 4.20.).

The thoracic and lumbar segments were the most affected; in two specimens the lumbosacral junction is involved. Both the intervertebral discs and zygapophyseal joints are fused in these cases, the small facet joints present bilateral fusions. The number of the affected vertebrae varies, while two segments are fused in seven cases, at least seven vertebrae are included in vertebral blocks in the rest of the cases. The individuals presenting extensive alterations exhibit single (specimens SUS – 19, NYL – 82 and SZV – 483) blocks, in another two individuals two or three vertebral blocks are visible (Fig. 4.16.). Additional fusions are also seen in two specimens, unilateral costovertebral ankyloses are recognizable in these cases (Fig. 4.21.).

Concerning the manifestation of the disease, two special forms are found. If the ankyloses involved the thoracic and lumbar spine, the vertebral bodies' anterior parts collapsed in a more severe way, and the fusion of the wedged vertebrae resulted in strict angular kyphosis; the pathognomic sign of the TB (Pott's gibbus) is recognizable. In the second type, when the ankylosis is localized to the thoracolumbar junction (specimens BCS – 90 and BA - 208), only slight collapse is demonstrated, kyphotic deformation is not present.

characteristics	non-specific infections	tuberculosis
typical localization	lower thoracic and lumbar spine	thoracic and lumbar spine, lumbosacral junction
number of the involved vertebrae	small (2-3)	various (2-9)
vertebral body fusion	common	common
zygapophyseal joint fusion	common (rather bilateral)	common (bilateral)
vertebral collapse	no uncommon	common
kyphosis	only slight kyphosis	severe kyphosis
cloacal opening	common	no uncommon
costovertebral fusion	no present	present
distribution of age at death	only adults	only adults
distribution of sex	only females	females > males
coexistence with other alterations		
- carious vertebral lesions	no present	common
- hypervascularization	no present	no uncommon
- endocranial lesions	no common	no common
- rib periostitis	no present	no common
- long bone periostitis	no present	no common
- cribra orbitalia et cranii	no present	no present

Figure 4.78. Characteristics of the spinal fusions caused by non-specific or tuberculous infection.

Additional skeletal alterations are also found in some cases (Fig. 4.16.); these may also be in association with tuberculosis. Carious vertebral lesions are visible in five cases; periostitis of the ribs and/or long bones and lytic signs of the cold abscess on the ventral side of the sacrum is found, each type of the lesions are see in two skeletons. Paravertebral new bony mass formation is recognizable in three specimens. Hypervascularization of the vertebral bodies or *cribra orbitalia et cranii* are not seen. Previous and present CT-analyses confirmed the complete fusions of the vertebral bodies and the zygapophyseal joint surfaces, the severe destruction of some vertebral bodies are also recognizable. Our diagnosis was supported by molecular biological techniques in some cases as well, DNA-fragments of the *Mycobacterium tuberculosis* complex were found in three samples (specimens BCS – 65, SUS – 19) (Haas *et al.*, 1999; Haas *et al.,* 2000). The recognizable characteristics of the non-specific and TB-infections are seen in the Figure 4.78.

Non-specific infection-associated and TB-associated ankyloses of the limbs and girdles are also present in our analytical material (Fig. 4.50 and Fig. 4.55.), they exhibit diverse appearance.

No TB-associated fusions were found in the upper extremities (Fig. 4.50.), only six probable cases of non-specific infections characterized with multiple ankyloses are recognizable. The carpals and two to four metacarpals are fused in two specimens, the radioscaphoid joints were also involved in two individuals. In another case the

metacarpophalangeal and proximal interphalangeal joint fusion resulted in the complete block of the proximal part of the 3rd finger in the specimen Szeged – Vár - 516. We found no common characteristics in these cases. The bones are completely ankylosed, but the joint gaps are partly recognizable in some instances. No distinctive erosive or proliferative lesions in and around the bones are visible, only two samples demonstrated porosity and/or slight osteolytic changes, which may refer to the infection. Ligament ossification is found in two individuals, the development of them may be associated with some physical stress. Although the small number of cases may distort the age and sex distribution, but balanced distribution according to sex is found (2 males, 2 females, 1 undetermined sex), ankyloses developed only in adult individuals Adultus and Maturus age categories).

The lower limbs and girdles demonstrate ankyloses associated with non-specific ad specific infectious processes in 15 cases. Non-specific infection seems to be the most probable underlying disease in ten specimens; some traumatic event (e.g. open fractures) may have played the initial role in the development of the infection in five of these cases (Fig. 4.55.). Concerning the age and sex distribution, a simple picture is seen, except one specimen (Bácsalmás- Homokbánya – 153) only males are involved. Only adults are affected, the ankyloses are found in elderly individuals (Maturus and Senium age categories) in nine cases. Various localization is seen, the mainly monoarticular fusions exhibit typical morphological appearance. Slight or extensive periosteal reaction, the presence of one or more cloacae in the involved bones is found in all cases. The presence of smooth surfaced shallow depressions with 'flowing' appearance is recognizable in three cases, which may be suggestive of the bony involvement of skin ulcer. Characteristic radiologic alterations are visible in the CT images. Irregular shaped multiple cavities with lightly sclerotic margins are present in the meta- and diaphyses of the affected bones, these cavities correspond to the cloacae. In some cases more radiodense areas may suggest the presence of dead bone, they are surrounded by more radiolucent zone.

The probable cases of TB-associated ankyloses are found in four specimens, the pubic symphysis is fused in one case (specimen Orosháza – Béke – TSZ -63; Fig. 4.56), while the rest of the cases are localized to the knee (specimens Bélmegyer – Csömöki-domb – 215, Bátmonostor

– Pusztafalu – 993 and Bátmonostor – Pusztafalu – 465). Other fusions are also seen in the latter individuals, femoropatellar ankyloses are found in two cases, while the proximal tibiofibular joint is affected in the third case. Concerning the age and sex distribution, these alterations are belonging to elderly male individuals (Fig. 5.55.). We did not found cloacal openings in these samples, both proliferative and osteolytic signs of periosteal reactions are present in almost all involved bones. Traces of traumatic processes are not recognizable, among additional lesions *cribra orbitalia et cranii* was seen in two case (specimens BMP-465 and BMP – 993), while multiple granular endocranial lesions developed in one frontal bone (specimen BMP-993).

CT images (Fig. 4.62, Fig. 4.65. e-i, Fig. 4.67. c-h) reveal that the interior bony structure, the found alterations helped to make a more precise diagnosis. Saggital and axial images confirm the presence of the periostitis involving the diaphyses; the lesions do not infiltrate the medullar cavity. Saggital reconstructions demonstrate that the original joint surfaces are recognizable, although irregular borders are visible as opposed to a smooth line aspect. Oval or irregular shaped lytic lesions close the original bony ends are seen; these cavities infiltrate both the metaphysis and the epiphysis. The lamellar system of the involved areas remained fairly stable in the specimens. The specimen BMP – 993 demonstrate additional osseous signs. New anterior bony projection of irregular structure between the femur and tibia at the level of the patella is seen, the development of the alteration may be in association with long-term physical stress. The same process may have resulted in the phenomenon that the patella is slipped into superior direction and its base is ankylosed to the anterior surface of the femoral metaphysis.

3D reconstructions were made in two cases (specimens BMP-465 and BMP – 993). These confirm the pattern visible in 2D images (Fig. 4.66.); furthermore, they helped to demonstrate the observed lytic lesions' precise morphological character. In the specimen BMP – 465 the lesions found in the meta- and epiphyses correspond to an intra-medullar volume occupying the trabecular space of the distal femoral and proximal tibial metaphyses, finger-like projections are recognizable Fig. 4.66. a). These 'mirror-image' lesions extend to the fused joint gaps. In the 3D reconstruction of the specimen BMP – 993 similar radiological traces are found, a lytic lesion parallel to the growth line n the proximal tibia (Fig. 4.66. b). The lytic alterations

found in the femorae and tibiae are strongly suggestive of a “tumeur blanche du genou” (Sorrel and Sorrel-Déjerine, 1932), which is corresponding to tuberculous arthritis of the knee. It may be associated with the produce of the tuberculous pus within the metaphyseal trabeculae, the infection may spread to the joint space, later bony ankylosis developed (Paja *et al.*, 2012a, 2012b).

All individuals survived the tuberculous infections, and the involved extremities seem to be used after the healing process. The long-term survival is supported by the presence of bony alterations, both degenerative joint distortions and the fairly strong lamellar system of the involved bones may refer to the utilization of the limbs. In the specimen BMP – 993 the utilization of a crutch cannot be excluded either. The wedge shaped anterior bony projection at the level of the original femorotibial joint gap and the superior direction of the kneecap may have developed as a result of the long-term physical stress caused by the utilization of prosthesis (Józsa and Farkas, 2009; Paja *et al.*, 2012a, 2012b).

Characteristic traces of leprosy are present in one individual (Pálfi, 1991). The specimen Sárrétudvari – Hízóföld -237 shows multiple fusions of the right foot, which may associated with the leprosy-associated degeneration of the peripheral nerves (Fig. 4.75.). Six ankyloses are present, two bony blocks formed. The calcaneocuboid joint is completely disappeared; slight periosteal bone formation is present around the fusion area. The second osseous block includes the strongly distorted navicular and the three cuneiforms, complete ankyloses and partly recognizable joints are also seen. Cloacae are not present. The majority of the opposite side foot joints and both hips exhibit severe osteoarthritis, flattening and lipping refer to the presence of the degenerative process. Additional alterations may also be in association with leprosy. Slight superficial apposition in the right tibia, widening of the pyriform aperture, erosive periosteal reactions localized to the maxilla, slight, smooth surfaced depressions on the anterior surfaces of the both side maxilla and new bony deposits in the sinuses are found. The diagnosis of leprosy was confirmed by molecular biological techniques, positive identification of DNA-fragments of *Mycobacterium leprae* was possible from the bone samples (Haas et al, 2000b).

4.2.5. Metabolic diseases

Osseous fusions associated with metabolic diseases are present a single disease, only cases of diffuse idiopathic skeletal hyperostosis were found. The disease-related fusions are localized in the spine and the sacroiliac joint(s) in the individuals diagnosed with DISH, early-DISH and probable DISH. These typical localizations are discussed in the same chapter (see: 4.1.1.5. Metabolic diseases), thus the analysis of the diffuse idiopathic skeletal hyperostosis has already performed. On the basis of above mentioned, we do not present the analysis of the disease in this chapter, the result are seen in the chapter 4.1.1.5.

4.2.6. Rheumatic diseases

No characteristic cases of ankylosis associated with rheumatoid arthritis are found in the skeletal remains of our examination material. However, we cannot exclude the rheumatoid arthritis as aetiological factor in the specimen Szeged – Vár 516 (Maturus, male), where the right 3rd metacarpal, and two phalanges are fused in a palmar flexion.

4.2.6.1. Seronegative spondylarthropathies

Concerning the complex group of the seronegative spondylarthropathies, ankylosing spondylitis (AS) and probable cases of AS were diagnosed in our analytical series. The fragmentary state of preservation impeded to find the precise diagnosis in two additional cases, but we cannot rule out the presence of some seronegative spondylarthropathy as an underlying disease in these cases.

Among the SNSA-associated specimens the diagnosis of AS was possible in seven cases. Concerning the age and sex distribution, we can say that only males were found in this category, the majority of the cases are belonging to the Maturus age category (Fig. 4.39.). The lower lumbar spine is involved the most; the 4th and 5th connections are affected in all cases. In three cases the involvement of the upper lumbar segments are also seen, while the specimen

Pitvaros – Víztározó – 215 presents a very extensive form of the disease, we can follow the complete ankylosis till the 7th cervical vertebra (Fig. 4. 42.). Concerning the involved joints, fusions of both the intervertebral discs and the posterior facet joints are recognizable, skip lesions are not found. Syndesmophyte fusion resulted in 'bamboo-vertebra' phenomenon is seen in all of those cases, where the vertebral bodies are available for the analysis (Fig. 4.42 - 4.43.). These fusions developed bilaterally, symmetrical appearance is also recognizable. The zygapophyseal ankyloses also present bilateral appearance, the joints themselves are fused. The third localization of the ankyloses are the costovertebral joints, bilateral fusions of these articulations are seen in one case (specimen Pitvaros – Víztározó – 215). Both the heads and tubercles are involved, ligament ossification is also recognizable.

X-ray and CT-images present characteristic appearance, it is in correspondence with the macromorphological picture (Pálfi, 1996, 1999, Paja, 2012). The vertical syndesmophyte connections are clearly visible; the intervertebral disc height demonstrates no prolapse (Pálfi, 1996). New bony elements are seen inside the zygapophyseal joints (Fig. 4.41.), the ligament ossification is also recognizable at these sites.

Additional skeletal changes are also present among AS cases. Although bilateral sacroiliac fusion is found in one case, uni- and bilateral sacroiliitis, the ossification of the ligaments (e.g. ligamentum flavum, supraspinous and interspinous ligaments) can be seen. These latter ossifications may be result in the disappearance of the physiological lordosis of the lumbar spine.

Probable cases of ankylosing spondylitis were found in two specimens, the uncertainty of the diagnosis in these cases is caused by the very fragmentary state of preservation and by the presence of skip lesions.

The diagnosis of other seronegative spondylarthropathies has arisen in two cases, when uni- or bilateral sacroiliac fusions are present. Although the diagnosis of the ankylosing spondylitis cannot be ruled out, but other SNSAs (e.g. Reiter disease) may also be possible candidates in the background (Resnick and Kransdorf, 2005).

5. Conclusions, perspectives

Man of past populations - likewise the members of modern societies - is biological and socio-cultural being. Archaeological studies can help us to get more knowledge about the past populations' life primarily through the recovery and analysis of environmental data and the material culture that are examinable int he present. The analysis of the populations would not be complete without the 'science of biological being', and biological anthropology is one of the candidates who focuses on this scientific approach. Palaeopathology is the study of ancient diseases; its results help us to understand the natural history and progression of the diseases. It can reveal such pathological conditions that were more frequent in the past, or such alterations that are quite rare in the modern medical practice. Ankyloses (particularly the true bony fusions) are one of those pathological lesions that nowadays appear seldom in the developed countries, thus getting more information about their diagnostic or epidemiological characteristics may be helpful both in the biological reconstruction of the past populations and in the utility of the medicine.

Our analytical sample contained skeletal remains of 29 cemeteries from the Great Hungarian Plain, and skeletal remains of 10976 individuals have been included in the examined material. We collected all the osseous ankyloses from our analytical sample, the characteristics of the ankyloses and the presence of additional pathological lesions were described.

346 individuals presented one or more ankyloses, all of the archaeological period yielded bony fusions. However, we have to state that Sarmatian skeletal remains have very poor state of preservation, thus the number of the detected ankyloses are very low in this period (Paja and Marcsik 2009). The Gepids gave only three cases, but the sample size belonging to the Gepids is small. The rest of the cemeteries provided more fusions, we cant se ebig differencies among them, in general.

Two ankylosis types were found among them. In the first type no osseous fusion is recognizable in the distal tibiofibular joints and between the involved ribs, but newly built bony bridges fix the bones and the process resulted in functional fusions. The rest of the ankyloses

can be interpreted as osseous functional fusions, the capacity of the movement is inhibited by complete bony connections between the involved joints.

Concerning the aetiological categories, the developmental defects are demonstrated in the biggest number, but as these ankyloses involved two bones in most of the cases, the number of the affected bones was not extremely high. In contrast, we found more complex cases as well, in the next categories numerous joints were fused. These are:

- DISH

- spinal tuberculosis

- ankylosing spondylitis

- ankyloses of the hand caused by probable infectious processes.

In the first three categories the high-degree involvement may be in association with slowly developing long-term processes, while the multiple wrist and hand fusions may possibly be explained by two anatomical characteristics: in the first place numerous carpal joints incorporate more than two bones, on the other hand the small distance between the joints may let the effective spread of the disease.

Concerning the characteristics (age and sex distribution, laterality, localization) of the ankyloses, our findings, except one ankylosis type (LV5 – S1 sacralization) answer to the descriptions found in the medical or palaeopathological literature. In the LV5 – S1 sacralization cases a very strong male predominance is seen, the imbalance may be explained by fact that the determination of the sex was not possible in several individuals.

One of our aims was to realize, whether a systematic analysis helps us to find special, disease-associated alterations. We found additional signs in two nosological groups; these may help us to diagnose the disease in a more efficient way.

In DISH cases, the ossification of certain ligaments may be diagnostically useful alterations. In the majority of the cases the *ligamentum flavum* and supraspinous ligament ossification were recognizable, but the ossification has developed at other sites as well. The presence of these and other observed lesions (e.g. extra-axial enthesopathies) has raised a new

question. On the basis of the diagnostic criteria of Waldron (2009), the differentiation and separation of DISH and early-stage DISH cases seems to be very artificial, the very thin line between the two categories is based on the difference of only one alteration (ossification of the anterior longitudinal ligament). In those cases, where fusions at least four adjacent vertebral bodies are present, the diagnosis is DISH, while if less than four contiguous vertebrae are fused, the diagnosis is early-stage DISH. Concerning other spinal and extra-spinal alterations there's no difference between the two categories, diffuse ossification and calcification processes are found in all cases of the two categories. Interestingly enthesopathies were not seen in all cases, but ossification in the vertebral foramen (possibly as a result of ligamentum flavum ossification) is visible in all of them. Although the little number of cases does not let to draw unequivocal conclusions, on the basis of these facts, diagnostic criteria for DISH and early-stage DISH may need to be reconsidered in the future. In our previous opinion, the diagnosic criteria of DISH in osteoarcheological samples possibly need to be expanded, and some pathologic features (e.g. ligamentum flavum ossification) and patterns (number and relation of vertebrae with complete and not complete fusions) should be taken into account. As we found characteristic radiological signs (e.g. 'coating phenomenon' at the anterior ligament ossification), we would like to underline the importance of the utilization of medical imaging techniques in those cases, when lack of the predilectional site(s) or pathognomic sign(s) impedes the precise diagnosis.

The second aetiological group, where interesting characteristics ('image mirror' lacunar lesions of the meta- and epiphyses) were found is the tuberculosis. Beside the classical Pott's disease cases probable TB-associated knee fusions were found in two specimens, and we wouldd like to point out those medical imaging techniques, especially high precision of the reconstruction opens up new possibilities for approaching real anatomy. In the medical practice mainly 2D reconstruction analyses are accepted to make a proper diagnosis. We used these different directional 2D CT images to find the background aetiology resulted in ankylosis, but our 3D high precision reconstructions helped to compare interior alterations to those ones found in early medical literature (Sorrel and Sorrel-Déjerine, 1932; Alfer, 1892).

The coexistence of the ankyloses and other diseases is present in some aetiological groups.

- developmental diseases may have appeared as a single ankylosis, but in numerous cases one or more additional developmental defects were recognizable in the skeleton. It correspond in the data found in both the medical and palaeopathological literature;
- ankyloses associated with degenerative processes presented strong correlation with traces of other degenerative diseases, spondylosis deformans and degenerative osteoarthritis were found in the majority of these fusion cases;
- strong correlation between the vertebral fractures and osteoporosis of the skeletal elements are recognizable;
- in DISH cases characteristic ossification of certain ligaments are present, the ossification of the *ligamentum flavum* and the supraspinal ligament may be in association with the development of DISH; the presence of them may let us to use these alterations as diagnostically useful criteria.

Concerning the epidemiological approach, the strict prevalence of a disease is not given by our study. The lack of complete population statistics and the facts that the ankylosis is only a special phenomenon or appearance form of the diseases hinder the strict calculation. However, special tendencies as conclusions can be drawn, they correspond to those characteristics that are found in the literature.

Our data on distribution of DISH corresponds to those found in the literature. The onset of the disease is at younger age Adult age category), but the majority of the cases, when well-developed skeletal changes are present, belongs to older individuals (Maturus and Senium age categories). The mid-thoracic spine is involved the most, and disease continues toward the upper thoracic and lumbar spine in some cases. In our cases DISH affected only males, no females are found even among the early-stage DISH cases.

Classical appearance of ankylosing spondylitis is found, and only males are involved in the disease. Skeletal alterations affected the lower lumbar vertebrae in the majority of cases; in one extensive case almost the entire spine is ankylosed by syndesmophytes and zygapophyseal

joint fusions. Individuals belonging to the Maturus and Senium age categories demonstrated the classical alterations associated with AS, younger individuals (at least with severe osseous alterations) are not affected.

Concerning the presence of tuberculous alterations, specific characteristics are seen. The development of bone fusions in the skeletons suggest that the disease exhibited in rather chronic than acut form, healing processes refer to the fact that the involved people survived the disease. Beside the pathognomic spinal Pott's disease, lower limbs and girdles are also demonstrate ankyloses where TB is the most probable aetiological factor. Although the small sample size impedes the precise analysis, the lower thoracic and upper lumbar segments of the spine are affected the most frequently in our analytical sample. Both the disc joints and the facet joints were involved in all of our cases; zygapophyseal joint fusions present a balanced development according to laterality.

The alterations developed twice frequently in females than in males. Concerning the age distribution of sexes, the Adultus and Maturus age category is the most represented, vertebral fusions associated with tuberculosis were found only in two individuals belonging to the Senium category. If we separate the two sexes, it is clearly seen that the peek is found in the Adultus age category in females, while the cases belonging to a male individual are more represented in the older age categories.

Concerning the utility of the diagnostic tools, there is a significant difference between the analytical techniques. Classical macromorphological examinations are unavoidable and useful techniques in most of the cases. Medical and palaeopathological diagnostic criteria or descriptions were applicable and reliable sources, and the underlying disease can be found with certainty. The limiting factors are associated with the nature of the examined material, the skeletons' incompleteness or poor state of preservation made the diagnosis more uncertain.

We did not find diagnostically useful traces during the histological analyses. As the development of the true bony ankyloses may take a long time, mature bone tissue of normal structure can develop. As a consequence of the long-term ossification process, no observable

difference is visible in histological sections taken out from newly built bone tissue with difference aetiology in all histological samples.

Medical imaging techniques were useful diagnostic tools. Although X-ray images revealed the interior structure of the involved bones, no diagnostic traces were found in a remarkable portion of the images. However, the lack of certain signs excluded several diseases as an etiological factor. Computed tomography proved to be more useful than roentgenograms. As during the scanning numerous pictures will be created, the superimposition effect can be removed, bone tissue is examinable slice by slice. Additional 2D reconstructions gave us a chance to precise the appearance of a pathological lesion. Particular 3D reconstructions created with TIVMI software allowed for us to find the very precise morphological appearance of some rare pathological conditions (tuberculous osteomyelitis and arthritis of the knee). The combined use of radiological techniques, modern medical descriptions and books or reports from the pre-antibiotic era is a useful diagnostic method.

Concerning the future studies, some possibilities have arisen:

- more precise histological and medical imaging analyses need to be done to investigate the ankyloses;
- examination of those early-stage alterations need to be done which may be in association with ankyloses;
- the calculation of a disease's prevalence would be informative, it may lead to precise comparison of present and past populations;
- the co-existance of DISH and other diseases with ligament ossification (ossification of ligamentum flavum and ossification of posterior longitudinal ligament) are present in both medical (Ehara *et al*,. 1998, Epstein, 2000) and palaeopathological literature (Pálfi et al. 2009). Further palaeopathological analyses of the associations among these diseases may be helpful in the understanding of these diseases.

- Comparative analysis of disease-specific ankylosis prevalences (*e.g.* in cases of DISH, AS, TB) in ancient populations can furnish relevant information about the past and the evolution of these pathological conditions.

Acknowledgements

First of all, I would like to express my personal gratitude to my supervisors, **Professor Olivier Dutour** (Laboratoire de Paléoanthropologie de l'EPHE, École Pratique des Hautes Études) and **Professor György Pálfi** (Department of Biological Anthropology, University of Szeged), for accepting the supervision of my Ph.D. studies and contributing with their professional support to my endeavour from the beginning. Furthermore, I owe thanks for their personal attitude, providing me with support and encouragement. Without them my dissertation could not have been accomplished.

I also convey my grateful thanks to **Professor Antónia Marcsik** and **Professor Gyula L. Farkas** (Department of Biological Anthropology), so that they introduced me to anthropology and palaeopathology, and inspired my first steps in the field of anthropology.

My special thanks go to **Dr. Erika Molnár** and **Zsolt Bereczki** at the Department of Biological Anthropology, University of Szeged, for their effective collaboration in several anthropological projects, and for their professional and linguistic guidance that helped me reach my current goals.

I would also like to thank **Professor András Palkó** (Department of Radiology, University of Szeged), **Dr. László Tiszlavicz** (Department of Pathology, University of Szeged), **Professor László Józsa**, **Dr. Csaba Vandulek** (Health Center of the Kaposvár University, Kaposvár) and **Dr. Péter Zádori** (Health Center of the Kaposvár University and Kaposi Mór Teaching Hospital, Kaposvár) for their support in radiological or histological analyses without who the main aims of our studies could not have been realized.

I convey my special thanks to **Dr. Hélène Coqueugniot** (CNRS, Laboratoire d'Anthropologie des Populations du Passé, Université de Bordeaux 1) for receiving me with open arms and also for her professional support at the laboratory in Bordeaux.

I would like to thank **Dr. Didier Haguenauer** (Science and University Cooperation attaché) and to Mr. Bob Kaba Loemba (Director of the Fellowship Office of the French Embassy, Budapest), the possibility to study in France as a French Govermental scholarship holder.

My special thanks go to **Dr. Attila Gyucha** (National Heritage Protection Centre, Hungarian National Museum), who permitted and supported my scientific research.

The photos included in the dissertation were prepared by **Anikó Edina Tihanyi** *(Tiha)*, to her I am very grateful.

For her administrative help, let me thank here **Judit Dunainé,** secretary at the Department of Biological Anthropology, University of Szeged, and I am also grateful to *the* **PhD students** and **staff** of the Department of Biological Anthropology in Szeged.

Last but not least, I am deeply indebted to my **family**, **friends** and **colleagues** who believed in me, could support and tolerate during my workaholic days, weeks, months or years.

Bibliography

A

Acsádi, Gy, Nemeskéri, J. 1970. *History of human life span and mortality*. Academic Press, Budapest.

Al-Tubaikh, JA, Reiser, MF. 2009. *Congenital diseases and syndromes*. Springer – Verlag, Berlin-Heidelberg.

Anton, S, Polidoro, GM. 2000. Prehistoric Radio-ulnar Synostosis: Implications for Function. *Int J Osteoarchaeol*, 10:189–197.

Arlet J, Mazières B. 1985. Hyperostotic disease. *Rev Med Interne*, 6:553-564.

Aufderheide, AC, Rodríguez-Martín, C. 2006. *The Cambridge Encyclopedia of Human Paleopathology*. Cambridge Unversity Press.

B

B. Nagy, K, Révész, L. 1986. Hódmezővásárhely-Nagysziget. *ArchErt*, 1986:280.

B. Nagy, K. 1984. Hódmezővásárhely-Nagysziget. *ArchErt,* 1984: 277.

B. Nagy, K. 2003. A székkutas-kápolnadűlői avar temető. In B. Nagy, K.: A székkutas-kápolnadűlői avar temető. *Móra Ferenc Múzeum Évkönyve, Monographia Archaeologica 1*. Szeged. pp. 11-181.

Bácsmegi, G, Bóka, G. 2010. Hódmezővásárhely – Kopáncs – Kishomok III. (Csongrád megye, Hódmezővásárhely XI.homokbánya). In Kvassay, J. (Szerk.): *Évkönyv és jelentés a Kulturális Örökségvédelmi Szakszolgálat 2008. évi feltárásairól*. Budapest, p. 59.

Balázs, J. 2005. *Paleopatológiai vizsgálatok egy XII-XVI. századi széria (Nyárlőrinc Hangár út) leletein*. Szakdolgozat. Szegedi Tudományegyetem, Természettudományi Kar, Embertani Tanszék. Szeged.

Bálint, A. 1960. Árpád-kori temető Szatymazon. *Móra Ferenc Múzeum Évkönyve*, 17:101-123.

Bánosi, Gy, Veresegyházi, B. 1999. *Eltűnt népek, eltűnt birodalmak kislexikona*. Anno, Budapest. pp. 130–131.

Barnes, E. 1994. *Developmental Defects of the Axial Skeleton in Paleopathology*. Univ. Press of Colorado, Colorado.

Barnes, E. 2008. Congenital Anomalies. In Pinhasi, R, Mays, S. (Eds.): *Advances in human palaeopathology*. Wiley & Sons, Chicester. pp. 330-362.

Békei, G. 1995. *A gerincoszlop és a sternum fejlődési rendellenességeinek tanulmányozása a Bácsalmás-Homokbánya temető embertani anyagán*. Diplomamunka, JATE Embertani Tanszék, Szeged.

Bende, L. 1996. 76. sz. utalás. *Rég Füz*, 1:47:54.

Bende, L. 1997. 100. sz. utalás. *Rég Füz,* 1:48:50.

Bende, L. 1998. A pitvarosi késő avar kori temető 51. sírja. (Das Grab 51 im spätawarenzeitlichen Gräberfeldvon Pitvaros (Beiträge zur Verzierung der spätawarenzeitlichen Pferdegeschirre). *Móra Ferenc Múzeum Évkönyve - Stud. Arch. IV*. pp. 195-230.

Bende, L. 2000. Fülkesírok a pitvarosi avar kori temetőben. Adatok a fülkés és lószerszámos temetkezések kronológiájához. - Stollengräber im awarenzeitlichen Gräberfeld von Pitvaros. Angaben zur Chronologie der Stollengräber und Bestattungen mit Pferdegeschir. In Bende, L, Lőrinczy, G, Szalontai, Cs. (Szerk.): *Hadak útján*. Szeged. pp. 241-279.

Bende, L. 2003. Temetkezési szokások a székkutas-kápolnadűlői avar kori temetőben (Bestattungssitten im awarenzeitlichen Gräberfeld von Székkutas-Kápolnadűlő). In: B. Nagy, K.: *A székkutas-kápolnadűlői avar temető. Móra Ferenc Múzeum Évkönyve - Monographia Archaeologica 1*. Szeged. pp. 305-330.

Bereczki, Zs. 2004. *Oszteoarchológiai adatok Hódmezővásárhely X-XI. századi történetéhez*. Diplomamunka. Szegedi Tudományegyetem, Természettudományi Kar, Embertani Tanszék. Szeged.

Bereczki, Zs, Paja, L, Lovász, G, Maczel, M, Molnár, E, Marcsik, A, Pálfi, Gy. 2009. New infectious conditions from Bácsalmás - Óalmás, Hungary – Possible cases of skeletal TB. In Pálfi, Gy, Molnár, E, Bereczki, Zs, Pap, I. (Eds): *Des lésions du passé aux diagnostics modernes*. – Szeged University Press, pp. 46–47.

Béres, M. 1994. Az óföldeáki templom 15–17. századi erődítésrendszerének régészeti kutatása (Archäologishe Erforschung der Wehranlage der Kirche von Óföldeák aus den 15–17. Jahrhunderten). In Lőrinczy, G. (Szerk.): *Kőkortól a középkorig*. Szeged. pp. 473-493.

Béres, M. 1995. Az óföldeáki erődtemplom. *A Makói Múzeum Füzetei*, 81:7-41.

Biczó, P. 1981. Ásatások a középkori Bátmonostor területén. *Műemlékvédelem*, 25:105-109.

Biczó, P. 1984. A középkori Bátmonostor feltárásának tanulságai. *Múzeumi kutatások Bács-Kiskun megyében 1983.* Bács-Kiskun Megyei Múzeumigazgatóság**,** Kecskemét**.** pp. 36-39.

Bilsel N, Aydingöz Ö, Kesmezacar H. 2003. An ankylosing spondylitis patient with no joints. *Clin Rheumatol,* 22:502.

Bölkei, Z. 2005. *Embertani vizsgálatok egy középkori széria (Nyárlőrinc Hangár út) leletein.* Szakdolgozat. Szegedi Tudományegyetem, Természettudományi Kar, Embertani Tanszék. Szeged.

Bozsik, K. 2003. Szarmata sírok a Kiskundorozsma-subasai 26/78. lelőhelyen. In Szalontai, Cs. (Szerk.): *Úton-útfélen. Múzeumi kutatások az M5 autópálya nyomvonalán*. Móra Ferenc Múzeum – Csongrád Megyei Önkormányzat Múzeuma, Szeged. pp. 97-106.

Braun J, Bollow M, Remlinger G, Eggens U, Rudwaleit M, Distler A, Sieper, J. 1998. Prevalence of spondylarthropathies in HLA-B27 positive and negative blood donors. *Arthritis Rheum*, 41:58–67.

Bron, JL, van Royen, BJ, Wuisman, PIJM. 2007. The significance of lumbosacral transitional anomalies. *Acta Orthop Belg*, 73:687-695.

Brothwell, DR. 1981. *Digging up bones*. Cornell University Press, Ithaca, New York, 208 p.

Bullough, PG. 1992. *Atlas of Orthtopedic Pathology with Clinical and Radiologic Correlations*. Gower Medical Publishing, New York.

Burner TW, Rosenthal AK. 2009. Diabetes and rheumatic diseases. *Curr Op Rheumatol*, 21:50-54.

C

Cameron HU, Fornasier, VL. 1974. The manubriosternal joint - an anatomicoradiological survey. *Thorax*, 29:472.

Cammisa M, De Serio A, Gugliemi G. 1998. Diffuse idiopathic skeletal hyperostosis. *Eur J Radiol*, 27(Suppl 1):7-11.

Campillo, D, Rodríguez-Martin, C. 1994. Spinal congenital malformations in Spanish prehistoric populations. A comparative study between the Iberina Peninsula and Tenerife (Canary Islands, Spain). *Paleopathology Newsletter*, 88(Supplement):6.

Chhem, RK, Brothwell, DR. 2008. *Paleoradiology. Imaging Mummies and Fossils*. Springer-Verlag, Berlin-Heidelberg.

Csáki, É. 2004. *V. és VI. századi human csontvázanyag embertani vizsgálata*. Szakdolgozat. Szegedi Tudományegyetem, Természettudományi Kar, Embertani Tanszék. Szeged.

Csányi, B. 2001. *Egy 10-11. századi széria embertani anyagának feldolgozása különös tekintettel a koponyákra (Magyarhomorog – Kónyadomb)*. Szakdolgozat. Szegedi Tudományegyetem, Embertani Tanszék. Szeged.

Csillag, L. 2000. *Az óföldeáki középkori széria embertani feldolgozása*. Szakdolgozat. Szegedi Tudományegyetem Embertani Tanszéke. Szeged.

Csiszár, V. 1998. *A Biharkresztes-Ártánd környéki gepida temetők összehasonlító, általános embertani feldolgozása*. Diplomamunka. József Attila Tudományegyetem, Embertani Tanszék.

D

Dávid, K, Kasó, G, Thorogood, PV, Stevens JM, Crockard HA. 2002. A nyaki gerinc és a craniocervicalis átmenet csontos-fúziós fejlődési rendellenességeinek molekuláris genetikai háttere. (The molecular genetic control of bony developmental malformations affecting the craniocervical junction and the cervical spine). *Ideggy Szle (Clin Neurosci)*, 55(7–8):253–262.

Denko CW, Boja B, Moskovitz RW. 1996. Growth factors, insulin-like growth factor –I and growth hormone, in synovial fluid and serum of patients with rheumatic disorders. *Osteorthr Cartil,* 4:245-249.

Denko CW, Malemud CJ. 2005. Role of the growth hormone/insulin-like growth factor-1 paracrine axis in rheumatic diseases. *Semin arthritis Rheum*, 35:24-34.

Dimén, O. 2003. *Adatok a szarmata időszak embertani feldolgozásához (Madaras – Halmok).* Szakdolgozat. Szegedi Tudományegyetem, Természettudományi Kar, Embertani Tanszék. Szeged.

Ducolone, A, Vandevenne, A, Fraisse, P, Burghard, G. 1984. Fibrose pulmonaire et spondylarthrite ankylosante. *Rev Pneumol Clin*, 40:145-179.

Dutailly B, Coqueugniot H, Desbarats P, Gueorguieva S, Synave R. 2009. 3D surface reconstruction using HMH algorithm. *IEEE International Conference on Image Processing (ICIP09)*, pp. 2505-2508.

E

Ebnezar, J. 2010. Skeletal tuberculosis. In Ebnezar, J. (Ed.): *Textbook of Orthopedics with Clinical Examination Methods*. Jaypee Brothers Medical Publishers, New Delhi. pp. 551-574.

Ehara S, Shimamura T, Nakamura R, Yamazaki K (1998) Paravertebral ligamentous ossification: DISH, OPLL and OLF. *Eur J Radiol,* 27:196-205.

Al Elayan, SSA, Al Hamdan A. 2012. Ankylosis of the hips and knees due to sickle cell disease. *F1000 Research*, 1:32. (doi: 10.3410./f1000research.1-32.v.1)

Epstein, NE. 2000. Simultaneous cervical diffuse idiopathic skeletal hyperostosis and ossification of the posterior longitudinal ligament resulting in dysphagia or myelopathy in two geriatric North Americans. *Surg Neurol,* 53:427-431.

Éry, K, Kralovánszky, A, Nemeskéri, J. 1963. Történeti népességek rekonstrukciójának reprezentációja. *Anthropológiai Közlemények*, 7:41-90.

Eylon, S, Beeri, M, Joseph, K, Meyer, S. 2007. Femorotibial Ankylosis in a Child With Roberts Syndrome. *J Pediatr Orthop,* 8:926-929.

F

Farkas, LGy. 1998. Az Ópusztaszer-monostori antropológiai leletek metrikus, morfológiai és taxonómiai elemzése. In Farkas, LGY (Ed.): *Ópusztaszer – Monostor embertani leletei*. József Attila Tudományegyetem Embertani Tanszéke. Szeged. pp. 7-76.

Farkas, LGy, Józsa, L, Bereczki, Zs. 2007. Examination of the human remains from the mediaval cemetery of Bátmonostor – Pusztafalu in Hungary. *Acta Biol Szeged*, 51(2):87-92.

Fazekas, IG, Kósa, F. 1978. *Forensic fetal osteology*. Budapest, Akadémiai Kiadó, 290 p.

Ferembach, D, Schwidetzky, I, Stloukal, M. 1979. Recommandations pour determiner l'âge et le sexe sur le squelette. *Bull Mém Soc Anthropol Paris*, 6/13:7-45.

Fernandes, T, Costa, C. 2007. Klippel-Feil syndrome with other associated anomalies in a medieval Portuguese skeleton (13th–15th century). *J Anat*, 211:681–685.

Forestier, J, Rotes-Querol, J. 1950. Senile ankylosing hyperostosis of the spine. *Ann Rheum Dis,* 9:321–330.

G

Gallina, Zs. 1998. Temetkezési szokások egy X-XI. századi (Homokmégy - Székes) temetőben. *Múzeumi kutatások Bács-Kiskun megyében 1997*. Bács-Kiskun Megyei Múzeumigazgatóság, Kecskemét. pp. 79−88.

Gallina, Zs. 2000. Honfoglalás kori köznép temetője Homokmégyen. *Kalocsai Múzeumi Kiskönyvtár* 6. Kalocsa.

Gallina, Zs, Hajdrik, G. 1998. 10-11. századi temetőrészlet Homokmégy - Székesen. *Cumania*, 15, Kecskemét. pp. 133−178.

Gazdapusztai, Gy. 1958. Hódmezővásárhely-Nagysziget. *ArchErt*, 1958:207.

Gazdapusztai, Gy., 1959. Hódmezővásárhely-Nagysziget. *ArchErt*, 1959:209.

Giuffra V, Giusiani S, Fornaciari A, Villari N, Vitiello A, Fornaciari G. 2010. Diffuse idiopathic skeletal hyperostosis in the Medici, Grand Dukes of Florence (XVI century). *Eur Spine J*, 19:S103–S107.

Gömör, B (Ed.). 2001. *Reumatológia*. Medicina Könyvkiadó, Budapest.

Gyurkó, Á. 1995. *Bácsalmás-Homokbánya leletanyagának paleoodontológiai vizsgálata*. Diplomamunka. JATE Embertani Tanszék, Szeged.

H

H. Tóth, E. 1968. Archaologische Forschungen im Jahre 1967. (Völkerwanderungszeit) Kunszállás – Fülöpjakab. *ArchErt*, 95:134.

H. Tóth, E. 1971. Archaologische Forschungen im Jahre 1970. (Völkerwanderungszeit) Kunszállás – Fülöpjakab. *ArchErt*, 98:275.

H. Tóth, E. 1981. Sajátos temetkezési szokások a Duna-Tisza közi avarkori temetőkben (Peculiar burial riten in Avar period cemeteries between the Danube and Tisza rivers). *ArchErt*, 108:157-193.

H. Tóth, E. 1995. Hetényegyháza – Mária út (M5 autópálya 72. Lelőhely) avar temetőjének feltárása 1994. Ápr. 4. – 1994. Dec. 9. *Múzeumi Kutatások Bács-Kiskun megyében 1995*. Kecskemét. pp. 153-160.

Haas CJ, Zink A, Molnar E, Szeimies U, Reischl U, Marcsik A, Ardagna Y, Dutour O, Palfi G, Nerlich AG. 2000a. Molecular evidence for different stages of tuberculosis in ancient bone samples from Hungary. *Am J Phys Anthropol*, 113(3): 293-304.

Haas, CJ, Zink, A, Molnár, E, Marcsik, A, Dutour, O, Nerlich, AG, Pálfi, Gy. 1999. Molecular evidence for tuberculosis in Hungarian skeletal samples. In: Pálfi, Gy, Dutour, O, Deák, J, Hutás, I. (Eds./Szerk.): *Tuberculosis: past and present*. Budapest: Golden Book Publisher Ltd. - Tuberculosis Foundation. pp. 383-391.

Haas, CJ, Zink, A, Palfi, G, Szeimies, U, Nerlich, AG. 2000b. Detection of leprosy in ancient human skeletal remains by molecular identification of Mycobacterium leprae. *Am J Clin Path*, 114(3):428-436.

Harisinghani, MG, Theresa, C. McLoud, TC, Shepard, J-AO, Jane, P. Ko,JP Shroff, MM, Mueller, PR. 2000. Tuberculosis from Head to Toe. *RadioGraphics*, 20:449–470.

Hegedűs, K. 1982. Derekegyház – Ibolyásdomb. *Rég Füz*, 35:88-89.

Hershkovitz, I, Latimer, B, Dutour, O, Jellema, LM, Wish-Baratz, S, Rothschild, C, Rothschild, BM. 1997. Why do we fail in aging the skull from the sagittal suture? *Am J Phys Anthropol*, 103:393-399.

Ho, H-H, Lin, M-C, Yu, K-H, Wang, C-M, Jan Wu, Y-J, Chen, J-Y. 2009. Pulmonary Tuberculosis and Disease-Related Pulmonary Apical Fibrosis in Ankylosing Spondylitis. *J Rheumatol, 36(2):355-360.*

Horváth, A, H. Tóth, E, V. Székely, Gy. 1988. *Elődeink a Duna-Tisza közén: a Kiskunság és környéke története a régészeti leletek tükrében.* Katona József Múzeum, Kecskemét. pp. 54-56.

Horváth, F. 2009. Un Abrege de L'Histoire des Fouilles du Chateau de Szeged et de son Eglise. In Pálfi, Gy., Molnár, E., Bereczki, Zs., Pap, I. (Eds.): *From Past Lesions to Modern Diagnostics. 2009 GPLF Meeting Abstract Book.* Szeged University Press, Szeged. pp. 64-65.

Horváth, G, Molnár, E, Kovács, J, Wicker, E, Bérato, J, Pálfi, Gy. 1994. Paleopathological diagnosis and interpretation of seronegative spondylarthropathies from the 17th century. *Acta Biol Szeged*, 40:103-115.

Huizinga, TWJ, Breedveld, FC. 2009. The onset of the rheumatoid arthritis. In Hochberg, MC, Silman, AJ, Smolen, JS, Weinblatt, ME, Weisman, MH (Eds.): *Rheumatoid arthritis*. Mosby – Elsevier, pp: 41-48.

I

Isenberg, DA, Maddison, PJ, Woo, P, Glass, D, Breedveld, FC (Eds.). 2004. *Oxford Textbook of Rheumatology*. Oxford University Press.

J

Jancsó, M. 1996. *Metodikai tanulmány a sükösd-ságodi avar kori temető embertani anyagán*. Szakdolgozat. József Attila Tudományegyetem Embertani Tanszéke. Szeged.

Jankauskas, R. 2003. The incidence of diffuse idiopathic skeletal hyperostosis and social status correlations in Lithuania. *Int J Osteoarchaeol,* 13:289–293.

Jayanthi, V, Kulkarni, R, Kulkarni, RN. 2003. Atlanto-occipital Fusion – Report of Two Cases. *J Anat. Soc. India*, 52(1):71-73.

Jeanneret B, Magerl F. 1990. Congenital fusion C0–C2 associated with spondylolysis of C2. *J Spinal Disord***,** 3:413–416.

Józsa, V. 1990. *Pathologiás elváltozások egy avar kori széria (Bélmegyer-Csömöki-domb) embertani anyagában*. Diplmamunka. JATE Embertani Tanszéke. Szeged.

Juhász, I. 1983. Ein awarenzeitlicher Nadelbehälter mit Kerbschrift aus Szarvas. *Acta Archaeol Hung*, 35: 373-377.

Juhász, I.1984. Szarvas, 68. sz. lelőhely. *Rég Füz*, 37:75.

Juhász, I. 1985: Szarvas, 68. sz. lelőhely. *Rég Füz*, 38:69.

Juhász, I. 1987.Szarvas, 68. sz. lelőhely. *Rég Füz*, 40:68.

Juhász, I. 1995. Awarenzeitliche Gräberfelder in der Gemarkung Orosháza. In Garam, É, Vida, T. (Szerk.): *Monumenta Avarorum Archaeologica*. Budapest.

Julkunen H, Heinonen OP, Knekt P, Maatela J. 1975. The epidemiology of hyperostosis of the spine together with its symptoms and related mortality in a general population. *Scand J Rheumatol,* 4:23-27.

K

Kalla, AK, Khanna, S, Singh, IP, Sharma, S, Schnobel, R, Vogel, F. 1989. A genetic and anthropological study of atlanto-occipital fusion. *Hum Gen*, 81:105-112.

Khong, TK, Rooney, PJ. 1982. Manubriosternal joint subluxation in rheumatois arthritis. *J Rheumatol*, 9(5):712-715.

Kinnear, WJ, Shneerson, JM. 1985. Acute pleural effusions in inactive ankylosing spondylitis. *Thorax*, 40(2):150–151.

Klippel, M, Feil, A.1912. Un cas d'absence des vertèbres cervicales. Avec cage thoracique remontant jusqu á la base du crâne (cage thoracique cervicale). *Nouvelle Iconographie Salpetrière*, 25:223-50.

Korom, A. 2003. Szarmata sírok Röszkén a 48/75-76. lelőhelyen. In Szalontai, Cs. (Ed.): *Úton-útfélen. Múzeumi kutatások az M5 autópálya nyomvonalán*. Móra Ferenc Múzeum – Csongrád Megyei Önkormányzat Múzeuma, Szeged. pp. 117-122.

Kovács, I. 1979. XI. századi temető Hódmezővásárhely-Nagyszigeten. *Vásárhelyi Tanulmányok*, IX:15-32.

Kovács, L. 1997. István Dienes' grösste Ausgrabung in Magyarhomorog – Kónyadomb. *Acta Archaeol Hung*, 49:363-384.

Kovács, L. 2006. A magyarhomorog-kónyadombi X–XII. századi magyar köznépi temető érméiről (Coins from the Hungarian common cemetery of Magyarhomorog-Kónyadomb from the tenth–twelfth century). In Romhányi, F,B: Testis temporum, vita memoriae. Ünnepi tanulmányok Pálóczi Horváth András 65. születésnapjára. *Studia Caroliensia*, 7:215–248.

Kőhegyi, M. 1971. Előzetes jelentés a Madaras-Halmok későszarmata, hunkori temetőjének ásatásáról (Vorlaufige Mitteilung über die Freilegung der spätsarmatisch, hunnenzeitlichen Gräberfeldes von Madaras-Halmok.) *ArchErt*, 98:210-215.

Kőhegyi, M. 1994. Szarmata sírok kifosztása Magyarországon. In Lőrinczy, G. (Ed.): *A kőkortól a középkorig*. Csongrád Megyei Múzeumok Igazgatósága, Szeged. pp. 277-283.

Kőhegyi M, Marcsik, A. 1971. The Avar-age cemetery at Sükösd. *Acta Ant. Et Arch*., 14:87-94.

Kőhegyi, M, Marcsik, A. 1976. Anatómiai variációk, fejlődési rendellenességek és patológiás leletek egy avar kori sorozatból. *Orvostörténeti Közlemények*, 77:9-27.

Kőhegyi, M, Vörös, G. 1996. A Madarasi temető római pénzei. In Krankovics, I. (Szerk.): *A numizmatika és a társtudományok II.* Déri Múzeum - Magyar Numizmatikai Társulat, Debrecen. p. 183-199.

L

Lapis, K. 1989. *Pathologia III*. Medicina Kiadó, Budapest.

Lipták, P, Farkas, LGY. 1967. Anthropological examination of the Arpadian age population of Szatymaz (10^{th} to 12^{th} centuries). *Acta Biol Szeged*, 13:71-119.

Lipták, P, Varga, I. 1974. Charakterisierung des Anthropologischen Materials des Awarischen Gräberfeldes von Kunszállás. *Móra Ferenc Múzeum Évkönyve,* 1971/2: 71-83.

Lipták, P. 1980. *Embertan és emberszármazástan*. Tankönyvkiadó, Budapest.

Lőrinczy, G. 1998. Kelet-európai steppei népesség a 6.7. századi Kárpát-medencében. Régészeti adatok a Tiszántúl kora avar kori betelepüléséhez (OsteuropäischeSteppenbevölkerung im 6. und 7. Jahrhundert im Karpatenbecken. Archäologische Beiträge zur frühawarenzeitlichen Einsiedlung des Gebietes jenseits der Theiß. Móra Ferenc *Múzeum Évkönyve – Stud Arch*, 4:343-372.

Loth, S, Iscan, MY. 1989. Morphological assesment of age in the adult: the thoracic region. In Iscan, MY (Ed.): *Age markers in the human skeleton*. Springfield, pp. 105–135.

Lovász, G. 2005. *Bácsalmás-Óalmás 16-17. századi temető általános embertani feldolgozása*. Szakdolgozat. Szegedi Tudományegyetem, Embertani Tanszék. Szeged.

M

M. Nepper, J, Sz. Máthé, M. 1972. A Hajdú-Bihar megyei múzeum régészeti tevékenysége (1969-1971). *Debreceni Déri Múzeum Évkönyve 1971*. Debrecen. p. 35-54.

Maczel, M. 2003. *'Sur les Traces de la Tuberculose'. Critères diagnostiques des atteintes infectieuses du squelette humain et leur application dans des séries anthropologiques francaises et hongroises*. – PhD Thesis, University of Szeged / University of La Mediterranée (TTK-49/2004).

Madadi, F, Kahlaee, AH, Sarmadi, A, Madadi, F, Sadeghian, R, Emami, TMM, Abbasian, MR. 2010. Congenital bony fusion (absence) of the knee: A case report. *The Knee*, 17:421–423.

Maddison, PJ, Isenberg, DA, Woo, P, Glass, DN, Breedveld, F. (Eds.). 1993. *Oxford Textbook of Rheumatology*. Oxford University Press, New York.

Marcelli, C, Yates, AJ, Barjon, MC, Pansard, E, Angelloz-Pessey, L, Simon, L. 1995. Pagetic vertebral ankylosis and diffuse idiopathic skeletal hyperostosis. *Spine*, 20(4):454-459.

Marcsik, .A. 2011. Szarmaták az Alföldön. Újabb adatok a szarmata időszak embertani arculatához (Madaras – Halmok). In Kőhegyi, M, Vörös, G. (Eds.): *Madaras – Halmok. Kr. U. 2-5. századi szarmata temető. Monográfiák a Szegedi Tudományegyetem Régészeti Tanszékéről 1*. Szeged. pp. 419-444.

Marcsik, A, Molnár, E, Ősz, B, Donoghue, H, Zink, A, Pálfi, Gy. 2009. Adatok a lepra, tuberculosis és syphilis magyarországi paleopatológiájához. *Folia Anthropologica*, 7:(1): 5-34.

Marcsik, A, Molnár, E, Szathmáry, L. 2006. The antiquity of tuberculosis in Hungary: the skeletal evidence. *Mem Inst Oswaldo Cruz,* 101(Suppl. II):67-71.

Marcsik, A, Paja, L. 2009. Examination of Sarmatian Age Human Skeletal Remains from the Madaras Graves. In Smrcka, V, Walker, PhL. (Eds.): Social History and Anthropology. Proceedings of the Symposium. *Acta Univ Carol, Medica Monographia*, CLVI. pp. 65-72.

Marcsik, A, Szentgyörgyi, R, Gyetvai, A, Finnegan, M, Pálfi, Gy. 1999. Probable Potts paraplegia from the 7th-8th century A.D. In: Pálfi Gy, Dutour O, Deák J, Hutás I (Eds.): *Tuberculosis: Past and Present*. Szeged: Golden Book Publisher Ltd - Tuberculosis Foundation, 1999. pp. 331-336.

Masiero, S, Padoan, E, Bazzi, M, Ponzoni, A.2001. Dysphagia due to diffuse idiopathic skeletal hyperostosis: an analysis of five cases. *Rheumatol Int* 30:681–685.

Masson, M, Molnár, E, Donoghue, HD, Minnikin, D, Lee, OY, Pálfi, Gy. 2012. 7000 year-old tuberculosis cases from Hungary – osteological and biomolecular evidence. In: Pálfi, Gy, Bereczki, Zs, Molnár, E, Dutour, O. (Eds.): *ICEPT-2 The past and present of Tuberculosis: a multidisciplinary overview on the origin and evolution of TB.* Szeged: JATEPress - Szegedi Egyetemi Kiadó, p. 54.

Mease, PJ, Helliwell, PS. (Eds.). 2008. *Atlas of psoriatic arthritis*. Springer – Verlag, London.

Medgyesi, P. 1991. Késő avar kori temető Bélmegyer-Csömöki-dombon. (Előzetes jelentés). Spätawarenzeitliches Gräberfeld auf Hügel Bélmegyer-Csömök (Vorbericht). *Móra Ferenc Múzeum Évkönyve 1984/85.* pp. 241-257.

Medgyesi, P. 1998. Bélmegyer. In Jankovich, B.D. (Szerk.): *Magyarország régészeti topográfiája 10. Békés megye régészeti topográfiája*. Akadémiai Kiadó, Budapest. IV/3:342-348.

Milgram, J.W. 1990. *Radiologic and histologic pathology of nontumorous diseases of bones and joints. Vol 1.* Northbrook Publishing Company, Inc., Northbrook, Illinois.

Miller, EM. 1922. Congenital ankylosis of joints of handsand feet. *J Bone Joint Surg Am,* 4:560-569.

Miller, BF, Keane, CB, O'Toole, MT. 2003. *Miller-Keane Encyclopedia and Dictionary of Medicine, Nursing and Allied Health*. Saunders, Philadelphia.

Minnikin, DE, Besra, GS, Lee, OY-C, Spigelman, M, Donoghue, HD. 2011. The interplay of DNA and lipid biomarkers in the detection of tuberculosis and leprosy in mummies and other skeletal remains. In Gill-Frerking, G, Rosendahl, W, Zink, A, Piombino-Mascali, D. (Eds): *Yearbook of Mummy Studies 1*. – Verlag Dr. Friedrich Pfeil, Munich, pp. 109–114.

Mittal, R. 1995. Prenatal diagnosis and management of a new autosomal recessive skeletal dysplasia. *Internat J Gynecol Obst, 49*:47-50.

Miyamoto, K, Sugiyama, S, Hosoe, H, Iinuma, N, Suzuki, Y, Shimizu, K. 2009. Postsurgical recurrence of osteophytes causing dysphagia in patients with diffuse idiopathic skeletal hyperostosis. *Eur Spine J*, 18:1652–1658.

Molnár, E. 1992. *A zománc hypoplasia megjelenése és gyakorisága a különböző régészeti korokból származó leleteken*. Szakdolgozat. JATE Embertani Tanszék. Szeged.

Molnár, E. 2000. *Egy avar kori temető (Pitvaros-Víztározó) szisztematikus embertani feldolgozása.* PhD értekezés. Szegedi Tudományegyetem, TTIK Embertani Tanszék. Szeged.

Molnár, E, Marcsik, A. 2003. Paleopatológiai elváltozások egy avar kori széria (Szarvas 68. lelőhely) embertani anyagában. *A Békés Megyei Múzeumok Közleményei*, 24-25:411-428.

Molnár, E, Marcsik, A, Farkas, LGy, Dutour, O, Panuel, M, Pálfi, Gy. 1996. Szatymaz - Vasútállomás X-XII. századi embertani széria paleopatológiai felolgozása. In Pálfi, Gy, Molnár, E, Farkas, LGy. (Eds.): *Honfoglaló magyarság, Árpád kori magyarság. Antropológia – Régészet, Történelem*. JATE Embertani Tanszéke. Szeged. pp. 235-250.

Molnár, E, Pálfi, Gy. 1994. Probable cases of skeletal infections in the 17th century anthropological series from Bácsalmás (Hungary). *Acta Biol Szeged,* 40:117-132.

Molnar, RE. 2001. Theropod paleopathology: a literature survey: In Tanke, DH and Carpenter K (Eds.): *Mesozoic Vertebrate Life*. Indiana University Press, pp. 337-363.

O

Ojima, T, Yokogawa, A, Yamakado, K, Ogawa, K, Kobayashi, T, Nakashima A, Ogawa, H. 2005. Bilateral total knee arthroplasty after spontaneous osseous ankylosis in rheumatoid arthritis. *Mod Rheumatol*, 15:139-143.

Oláh, S. 1990. *Sárrétudvari – Hízóföld honfoglalás kori temetőjének történeti embertani értékelése*. Egyetemi doktori értekezés. JATE Embertani Tanszéke. Szeged.

Old, JL, Calvert, M. 2004. Vertebral Compression Fractures in the Elderly. *Am Fam Physician,* 69(1):111-116.

Olivier, G. 1974. Précisions sur la détermination de l'âge d'un foetus d'après sa taille ou la longueur de ses diaphyses. *Méd Lég et Dommage Corp*., 7:297-299.

Olivieri, I , D'Angelo, S, Palazzi, C, Padula, A, Mader, R, Khan, MA. 2009. Diffuse idiopathic skeletal hyperostosis: Differentiation from ankylosing spondylitis. *Curr Rheumatol Rep,* 11:321-328.

Oppenlander, ME, Orringer, DA, La Marca, F, McGillicuddy, JE, Sullivan, SE, Chandler, WF, Park P. 2009. Dysphagia due to anterior cervical hyperosteophytosis. *Surg Neurol*, 72:266–271.

Ortner, DJ. 2008. Differential diagnosis of skeletal lesions in infectious disease. In Pinhasi, R and Mays, S (Eds.): *Advances in human palaeopathology*. Wiley & Sons, Chicester. pp.191-214.

Ortner, DJ, Putschar, WJG. 1981. *Identification of paleopathological conditions in human skeletal remains.* Smithsonian Contribution to Anthropology, No. 28. Smithsonian Institution Press, Washington.

Ősz B, Hajnal K, Marcsik A. 2005. Néhány súlyos paleopatológiai eset vizsgálata egy középkori szériában (Szeged-Vár). *IV. Kárpát-medencei Biológiai szimpózium,* Budapest. Előadáskötet, pp. 165-171.

Ősz, B, Hajnal, K, Marcsik, A, Fogas, O, Horváth, F, Zádori, P, Kelemen, K, Vandulek Cs, Schultz, M, Márk, L, Molnár, E, Pálfi, Gy. 2009. Preliminary report on the paleopathological research of the skeletal material from the Szeged medieval castle excavation. *Acta Biol Szeged*, 53(2):125-138.

P

Paja, L. 2000. *Patológiás elváltozások vizsgálata az óföldeáki erődtemplom XII-XVIII. századi temetőjének embertani anyagában*. Szakdolgozat. SZTE Embertani Tanszéke. Szeged.

Paja, L. 2003a. Röszkei (48/60., 48/75.) és kiskundorozsmai (26/60., 26/72.) szarmata kori embertani maradványok rövid ismertetése. In Szalontai, Cs. (Ed.): *Úton-útfélen. Múzeumi kutatások az M5 autópálya nyomvonalán*. Móra Ferenc Múzeum – Csongrád Megyei Önkormányzat Múzeuma, Szeged. pp. 165-168.

Paja, L. 2003b. Kiskundorozsmai 26/78-as számú lelőhely embertani anyagának rövid ismertetése. In: Szalontai, Cs. (Ed.): *Úton-útfélen. Múzeumi kutatások az M5 autópálya nyomvonalán*. Móra Ferenc Múzeum – Csongrád Megyei Önkormányzat Múzeuma, Szeged. pp. 157-163.

Paja, L. 2012. Anthropological analysis of the Avar period cemetery at Hódmezővásárhely-Kopáncs – III Kishomok (Csongrád County) - A Hódmezővásárhely-Kopáncs – III. Kishomok lelőhely (Csongrád megye) avar kori temetőjének antropológiai vizsgálata. In: Kvassay J. (Ed./Szerk.) *2009 Field Service for Cultural Heritage Yearbook and Review of Archaeological Investigations - Évkönyv és jelentés a Kulturális Örökségvédelmi Szakszogálat 2009. évi feltárásairól.* Budapest, pp. 421 – 430.

Paja, L, Coqueugniot, H, Dutour, O, Willmon, R, Farkas, GL, Palkó A, Pálfi, G. 2012a. Knee Ankyloses Associated with Tuberculosis from the Medieval Hungary – Differential Diagnosis Based on Medical Imaging Techniques. *Int J Osteoarcheol* (accepted manuscript). Article first published online : 7 Nov 2012 (doi:10.1002/oa.2284).

Paja, L., Coqueugniot, H., Dutour, O., Farkas, L. Gy., Palkó, A., Pálfi, Gy. 2012b. Csont-ízületi tuberkulózis okozta ankylosisok vizsgálata egy középkori monostor körüli temető anyagában –

Analysis of TB related joint ankyloses originating from the osteoarcheological series of a medieval monastery. Anthropologiai Közlemények, 53:51–60.

Paja, L, Marcsik, A. 2009. Paleopathological and Paleodemographical Analysis of Sarmatian Osteological Series Originating from Southern Hungary. In Smrcka, V, Walker, PhL. (Eds.): *Social History and Anthropology. Proceedings of the Symposium. Acta Univ Carol. Medica Monographia*, CLVI, p. 57-64.

Paja, L, Márk, L, Zádori, P, Vandulek, Cs, Ősz, B. 2010a. Well developed spinal ossifications: cases of ankylosing spondylitis from Hungarian skeletal materials: imaging and protein diagnostics. *18th European Meeting of the Paleopathology Association (EMPPA 2010) program and abstracts*. p 192.

Paja, L, Molnár, E, Marcsik, A. 2007. Homokmégy – Székes (10-11. század) lelőhely embertani anyagának ismertetése (előzetes eredmények). *Folia Anthropol*, 5:93-96.

Paja L, Molnár, E, Ősz B, Tiszlavicz L, Palkó A, Coqueugniot H, Dutour O, Pálfi Gy. 2010b. Diffuse idiopathic skeletal hyperostosis – appearance and diagnostics in Hungarian osteoarcheological materials. *Acta Biol Szeged*, 54(2):75-81.

Pálfi, Gy. 1989. *Patológiai elváltozások avar kori leleteken.* Szakdolgozat. József Attila Tudományegyetem Embertani Tanszéke. Szeged.

Pálfi, Gy. 1990. Spondylarthropathies in Avar age Human remains. *Acta Biol Szeged*, 36:81-94.

Pálfi, Gy. 1991a. The first Osteoarchaeological Evidence of Leprosy in Hungary. *Int J Osteoarchaeol*, 1:99-103.

Pálfi, Gy. 1991b. The osteoarchaeological evidence of vertebral tuberculosis in the 8th century. - *Acta Biol Szeged,* 37, 101-105.

Pálfi, Gy. 1993. *Maladies, activités et environments des populations anciennes en Europe Centrale et occidentale: approche de paleopathologie comparée*. These. Université de Provence (Aix-Marseille I). Tome I-II.

Palfi, Gy. 1997. Maladies dans l'Antiquité et au Moyen Age: Paléopathologie comparée des anciens gallo-romains et hongrois. *Bull Mém* Soc Anthropol Paris*.* Tome 9 (1-2)

Pálfi, Gy, Ardagna, Y, Molnár, E, Dutour, O, Panuel, M, Haas, CJ, Zink, A, Nerlich, AG. 1999. Coexistence of tuberculosis and ankylosing spondylitis in a 7-8th century specimen evidenced by molecular biology. In: Pálfi, Gy, Dutour, O, Deák, J, Hutás, I. (Eds.): *Tuberculosis: Past and Present*. Szeged: Golden Book Publisher Ltd - Tuberculosis Foundation, pp. 401-409.

Pálfi Gy, Csernus Z. 1990. Arthrite infectieuse ankylosante dans une série du VIIIe siècle en Hongrie. *Paleobios*, 6(2-3): 37-41.

Pálfi, Gy, Dutour, O, Deák, J, Hutás, I. (Eds.). 1999. *Tuberculosis: Past and Present*. – Golden Book and Tuberculosis Foundation, Budapest, Szeged.

Pálfi, Gy, Marcsik, A, Kovács, J. 1992. Lumbosacral and hip tuberculosis in a Migration Period skeleton. *J Paleopath*, 4(3):179-184.

Pálfi, Gy, Molnár, E, Bérato, J, Wicker, E, Dutour, O. 1996a. Deux observations ostéoarcheologiques de spondylarthrite ankylosant et leur possible relation familial. *Rev Rhum*, 62:(2):160-161.

Palfi, GY, Panuel, M, Gyetvay, A, Molnar, E, Bende, L, Dutour, O. 1996b. Advanced-stage ankylosing spondylitis in an 8th century subject. *J Radiol Electrol Med Nucl*, 77(4):283-285.

Palfi, G, Molnar, E, Berato, J, Wicker, E, Dutour, O. 1996a. Two osteoarchaeological cases of ankylosing spondylitis, possibly in genetically-related individuals. *Rev Rhum*, 63(2):148-149.

Pálfi Gy, Molnár E, Kristóf L, Cuvigny H, Brun JP, Donoghue HD, Spigelman M, Szikossy I, Pap I. 2009. Paleopathological study of two partially mummified bodies. *GPLF - Meeting of the French-speaking paleopathologists, Szeged, Hungary, 30th April -3rd May 2009, 'From Past Lesions to modern Diagnostics' Abstract Book and Program*, 99-100.

Pany, D, Teschler-Nicola, M. 2007. Klippel-Feil Syndrome in an Early Hungarian Period Juvenile Skeleton from Austria. *I J Osteoarcheol*, 17:403–415.

Posalski, J, Weisman, MH. 2009. Articular and periarticular manifestations of established rheumatoid arthritis. In Hochberg, MC, Silman, AJ, Smolen, JS, Weinblatt, ME, Weisman, MH (Eds.): *Rheumatoid arthritis*. Mosby – Elsevier, pp:49-61.

R

Rácz, P. 2004. *Kecskemét – Gerőmajor 10-11. és Derekegyház – Ibolyásdomb 11-12. századi széria mbertani feldolgozása*. Szakdolgozat. Szegedi Tudományegyetem Embertani Tanszéke. Szeged.

Resnick, D, Kransdorf, MJ. 2005. *Bone and Joint Imaging*. Elsevier-Saunders, Philadelphia.

Resnick, D, Niwayama, G. 1976. Radiographic and pathologic features of spinal involvement in diffuse idiopathic skeletal hyperostosis (DISH). *Radiol*,119:559–568.

Resnick, D, Shaul, SR, Robins JM. 1976. Diffuse Idiopathic Skeletal Hyperostosis (DISH): Forestier's Disease with Extraspinal Manifestations. *Radiol,* 115:513-524.

Rogers, J, Waldron, T. 1995. *A field guide to joint disease in archeology*. John Wiley and Sons Ltd., Chichester, England.

Rogers J, Waldron, T 2001. DISH and the Monastic Way of Life. *Int J Osteoarcheol,* 11:357-365.

Romanes, GJ. (Ed). 1972. *Cunningham's Text book of Anatomy*. Oxford University Press, London.

Róna-Tas, A. 1985. A szarvasi tűtartó felirata. *Nyelvtudományi Közlemények*, 87:225-248.

Rothschild, BM, Martin, LD. 2006. *Skeletal Impact of Disease*. New Mexico Museum of Natural History and Science, Albuquerque.

Ryan, JR, Perrin, JC, Morawa, LG. 1978. Congenital synostosis of the knee. *Clin Orthop Relat R, 135*: 34-35.

S

Schinz, HR, Baensch, WE, Friedl, E, Uehlinger, E. 1952. Ossifikationstable. In Schinz *et al*. (Eds.): *Lehrbuch der Röntgen-Diagnostik. 5.* Auflage, Thieme, Stuttgart.

Seidler, TO, Pèrez Àlvarez, JC, Wonneberger, K, Hacki, T. 2009. Dysphagia caused by ventral osteophytes of the cervical spine: clinical and radiographic findings. *Eur Arch Otorhinolaryngol,* 266:285–291.

Sieper, J, Braun, J, Rudwaleit, M, Boonen, A, Zink, A. 2002. Ankylosing spondylitis: an overview. *Ann Rheum Dis*, 61(Suppl III):iii8–iii18.

Sorrel, É, Sorrel-Dejerine, Y. 1932. *Tuberculose osseuse et ostéo-articulaire*. *Vol. 1-3*, Masson, Paris.

Spoor, CF, Zonneveld, FW, Macho, GA. 1993. Linear measurements of cortical bone and dental enamel by computed tomography: applications and problems. *Am J Phys Anthrop*, 91(4):469-844.

Stloukal, M, Hanáková, H. 1978. Die länge der Längsknochen altslawischer Bevölkerungen unter besonderer Berücksichtigung von Wachstumsfragen. *Homo*, 29:53-69.

Szalontai, Cs, Tóth, K. 2003a. Szeged-Kiskundorozsma-Nagyszék I. (26/60., M5 Nr. 33. lelőhely). In Szalontai, Cs. (Szerk.): Úton-útfélen**.** Múzeumi kutatások az M5 autópálya nyomvonalán. Móra Ferenc Múzeum – Csongrád Megyei Önkormányzat Múzeuma, Szeged. pp. 63-67.

Szalontai, Cs, Tóth, K. 2003b. Szeged-Kiskundorozsma-Nagyszék II. (26/72., M5 Nr. 34. lelőhely). In Szalontai, Cs. (Szerk.): *Úton-útfélen. Múzeumi kutatások az M5 autópálya nyomvonalán*. Móra Ferenc Múzeum – Csongrád Megyei Önkormányzat Múzeuma, pp. 69-81.

Szalontai, Cs. 2003. Múzeumi kutatások az M5 autópálya nyomvonalán. In Szalontai, Cs. (Szerk*.): Úton-útfélen. Múzeumi kutatások az M5 autópálya nyomvonalán*. Móra Ferenc Múzeum – Csongrád Megyei Önkormányzat Múzeuma, Szeged. pp. 11-27.

Szécsi, A. 1998. Bácsalmás-*Homokbánya 17. századi temető metrikus és fogpatológiai feldolgozása.* Szakdolgozat. Szegedi Tudományegyetem, Embertani Tanszék. Szeged.

Székely, Gy. 1987. Középkori templom és temető feltárása Nyárlőrincen. *Múzeumi kutatások Bács-Kiskun megyében 1986*. Bács-Kiskun Megyei Múzeumigazgatóság, Kecskemét. pp. 81-85.

Szentpéteri, J. 2002. *Archäologische Denkmäler der Awarenzeit in Mitteleuropa*. Varia Archaeologica Hungarica XIII/1–2. Budapest.

Széplaki, L. 1998. *Patológiás elváltozások vizsgálata Bácsalmás – Homokbánya XVII. századi temető embertani anyagában*. Szakdolgozat. JATE Embertani Tanszék. Szeged.

Szigeti, Cs. 2001. *A Magyarhomorog – Kónyadombi 10-11. századi temető vázcsontjainak metrikus és paleopatológiai feldolgozása*. Szakdolgozat. Szegedi Tudományegyetem, Embertani Tanszék. Szeged.

Szoboszlai-Szabó, E. 1996. *Patológiás elváltozások egy avar kori széria (Hetényegyháza) embertani anyagában.* Diplomamunka. József Attila Tudományegyetem Embertani Tanszéke. Szeged.

T

Tortora, GJ, Derrickson, B. 2007. *Principes d'anatomie et de physiologie*. (Traduction de la 11e édition américane, adaptation francaise de Michel Forest et Louise Martin). De Boeck and Larsier, Canada.

Tóth, K. 2009. Hódmezővásárhely – Kopáncs, homokbánya. In Kisfaludi, J. (Szerk.): *Régészeti kutatások Magyarországon 2008*. Budapest. pp. 200-201.

Trogmayer, O, Zombori, I. 1980. *Szer monostorától Ópusztaszerig*. Magvető Könyvkiadó, Budapest. pp. 159.

Trotter, M. 1934. Synostosis between manubrium and body of the sternum in whites and negroes. *Am J Phys Anthropol*, 18:439.

Tsirikos, AI and McMaster, MJ. 2005. Congenital Anomalies of the Ribs and Chest Wall Associated with Congenital Deformities of the Spine. *J Bone Joint Surg Am,* 87(11):2523-2536.

Tuli, SM. 2004. *Tuberculosis of the Skeletal System: Bones, Joints, Spine and Bursal Sheaths*. Jaypee Brothers Medical Publishers, New Delhi.

U

Ubelaker, DH. 1978. *Human skeletal remains: excavation, analysis, interpret*ation. Aldine, Chicago.

Utsinger, PD (1985) Diffuse idiopathic skeletal hyperostosis. *Clin Rheum Dis* 11:325-351.

V

Vanhoenacker, FM, Sanghvi, DA, De Backer, AI. 2009. Imaging features of extraaxial musculoskeletal tuberculosis. *Indian J Radiol Imaging,* 19(3):176–186.

Varga, I, Marcsik, A. 1975. Paleopathological characterization of the skeletons of an Avar series (Kunszállás-Fülöpjakab). *Acta Biol Szeged*, 21(1-4):181-192.

Verlaan, JJ, Oner, FC, Maat, GJR. 2007. Diffuse idiopathic skeletal hyperostosis in ancient clergymen. *Eur Spine J*, 16:1129-1135.

Visy, Zs. (Ed.). 2003. *Hungarian archaeology at the turn of the Millenium*. Ministry of National Heritage – Teleki László Foundation.

Vörös, G, Kőhegyi, M. 2001. A Madaras – Halmok szarmata temetőjének temetkezési szokásai. – Die Begrabungsbäuche des Sarmatenfriedhofes in Madaras – Halmok. Szolnok Megyei Múzeumok *Évkönyve XII*. Szolnok. pp. 143–152.

W

Waldron, T. 2009. *Paleopathology. Cambridge Manuals in Archaeology*. Cambridge University Press, Cambridge, UK.

Westerveld, LA, Verlaan, JJ, Oner, FC, 2009. Spinal fractures in patients with ankylosing spinal disorders: a systematic review of the literature on treatment, neurological status and complications. *Eur Spine J*,18:145–156.

Wicker, E. 1999. Bácsalmás-Óalmás későközépkori rác temetője. In Romsics, I, Wicker, E. (Szerk.): *Múzeumi kutatások Bács-Kiskun megyében 1998*. Baja. pp. 25-30.

Wicker, E. 2001. Rácok a Duna-Tisza közén a XVI-XVII. században. In Bárth János (Szerk.): *Ezer év a Duna-Tisza közén.* Kecskemét. pp:151-157.

Wicker, E. 2003. Adatok a hódoltság kori délszlávok temetkezési szokásaihoz. *Cumania*, 19:19-84.

Wicker, E, Kőhegyi, M. 1997. Avar kori temető Sükösd-Ságodon, a Sárköz peremén. In *Múzeumi kutatások Bács-Kiskun megyében 1996.* Bács-Kiskun Megyei Múzeumigazgatóság**,** Kecskemét. pp. 39-45.

Z

Zimmermann, MR, Kelley, MA. 1982. *Atlas of human palaeopathology*. Praeger Publisher, New York.

Abstract

Biological anthropology (humanbiology) is the science that focuses on the human being, man of the present and past may also be a challenging object. Human biology examines the biological characteristics of past populations. Its goal is to reconstruct the past societies on the basis of their biological characteristics, its analytical results let us to get more information about the life of ancient populations.

Palaeopathology is a discipline of the biological anthropology; it focuses on the analyses of human remains. The examination of pathological skeletal alterations may help us to reconstruct special conditions like state of health, special environmental effects on a population or characteristics of the way of living in the past. The discipline can reveal such pathological conditions that were present in an archaeological period, it is able to analyse the prevalence and manifestation of a disease. Pathological processes may leave proliferative or lytic traces in the bones, fusions of the joints or their neighbouring area may also appear. These ankyloses may lead to partial or complete loss of capacity of movement in any joint; numerous aetiological factor may be responsible for the development of them. As the prevalence of ankyloses is quite low, we can usually meet them through case reports in the palaeopathological literature. Synthetic publications based on systematic analyses generally focus on only special diseases.

Present study focuses on the analysis of the joint fusions' nosological and epidemiological characteristics. Our primary aim following the data collection is to describe and analyze those potential macromorphological, radiological and histological signs or alterations, which may support our diagnostic effort and may provide one or more useful diagnostic criteria to recognize a disease in a more precise way.

Ankyloses are relatively rarely observable alterations in osteoarchaeological series, thus we analyzed skeletal remains of numerous cemetery. Our examination material incorporated 29 series originating from the Great Hungarian Plain, the skeletal remains represent several

archaeological periods. The oldest specimens are dated back the Sarmatian period (1st-5th c. AD), while the most present series are dated to the early modern times (18th c. AD). Summarizing the data, we can say that skeletal remains of 10.976 individuals have been included the examined material; our series are very diverse in their completeness and state of preservation.

During the analysis basic anthropological data (sex, age at death, age categories) were available for us from previously carried out anthropological studies. Macromorphological examinations were made in the majority of the cases, but medical imaging techniques (X-ray, computed tomography) and histological methods were also utilized in certain cases. Results of previously carried out molecular biological analyses were available for us in some instances, these results helped to confirm our diagnosis.

During our analyses one or more ankyloses were found in the skeletal remains of 346 individuals, they are associated with numerous nosological categories.

Concerning the number of ankyloses, developmental diseases were found in the biggest number among our findings, the alterations were seen in all age categories. Their recognition was fairly easy, and the most typical predilectional areas are the spine and the thorax. The manifestation and distribution of the *synostosis vertebralis* and sacralization cases corresponds to the characteristics found in the literature. Fusions involving the sternal segments and functional ankyloses of the ribs are also seen, the recognition of the aetiology is not difficult in these cases, similarly to the developmental defects of the previous group. The distribution of the cases corresponds to the data seen in medical and palaeopathological references.

Joint fusions associated with degenerative processes developed in the spine and the limbs. Concerning the axial localization, both the vertebral bodies and the posterior elements are involved. Common features of these fusions that irregular ankylosis line and fusion area characterized with irregular bony structure are recognizable. The cervical spine is involved the most; in the majority of cases signs of other degenerative processes (e.g. traces of spondylosis deformans and/or osteoarthritis) are also visible in the bony elements. An increasing tendency

with ageing is recognizable, ankyloses of degenerative origin developed in more males than females.

Ankyloses associated with traumatic events are easily recognizable in those cases, when dislocation or shortening of a bone (e.g. in compression fractures) directly refer to the aetiology. Traumatic alterations may develop both in the segments of the vertebral column and in long bones; strong male predominance is seen in this group. In the majority of cases, alterations associated with some infection are also present, ankyloses can be interpreted as the sign of the healing. Particular phenomenon appears in four distal tibiofibular ankyloses; the joints themselves are not involved in the bony fusions, but a bony bridge hinders the movement of the joint. In the cases of vertebral compression fractures slight or moderate vertebral collapse is recognizable, but kyphosis is not found. Ankyloses developed mainly between the bodies, but zygapophyseal joints are also involved in some cases.

Joint fusions are found in association with healing process following both non-specific and specific infections. Concerning non-specific infections, the spine and the extremities are also involved, characteristic periosteal reactions and cloacal openings (drainages of the pus) refer to the presence of some non-specific infection. In extravertebral localization, distal areas of the limbs are more involved, bony fusions localized to ankles and hands are recognizable.

Identification of tuberculosis and leprosy was possible among the specific infection cases. In cases of vertebral fusions associated with TB, the thoracic and upper lumbar spine is affected the most, pathognomic Pott's disease is recognizable here. The collapse of the vertebral bodies result in wedge shape bodies, multiple ankyloses may appear. Concerning the affected elements, all vertebral parts are involved in most of the cases. In the second localization kyphosis is not present, but other lesions, like new periosteal bone formations, cold abscess and extensive paravertebral bony mass are suggestive of TB. Concerning the sex distribution, much more females than males are involved in TB-associated ankyloses. Analyses of CT scans and 3D reconstructions together with analysis of written sources from the preantibiotic age helped to clarify the aetiology of two rare knee ankyloses, the probable underlying disease is tuberculous infection in these cases.

The ossification of the anterior longitudinal ligament (OALL) is pathognomic sign in the cases of diffuse idiopathic skeletal hyperostosis. The alteration is recognizable only in males in our series, individuals belonging to Maturus and Senium age categories were affected. Other typical diagnostic criteria, the preserved intervertebral spaces and intact zygapophyseal joint gaps were also seen in the individuals diagnosed with DISH. An association between the OALL and ossification of other ligaments (e.g. *ligamentum flavum*, supraspinous ligament) is found, the development of enthesopathies presents similar association. Our results suggest that the utilized diagnostic criteria used for the separation of DISH and early-DISH cases may lead to too thin boundary between the categories, thus the classification will become too strict. In our opinion, some individuals diagnosed as early –DISH – on the basis of extravertebral manifestation - case should be moved to DISH category.

In those cases, where characteristic ankyloses were found in the spine and/or in the sacroiliac joint(s), we were able to diagnose the representative disease of the so-called seronegative spondylarthropathies. Except one case, when almost the entire spine is fixed, our ankylosing spondylitis cases present lumbar spine involvement. Sacroiiliac fusions are not associated with ligament ossification, but sacroiliitis is seen as a typical concomitant alteration. Only males are affected in the disease, all of them are belonging to the Maturus or Senium age categories.

Concerning the utility of the diagnostic tools, distinct conclusions can be drawn. Classical macromorphological examinations are unavoidable and useful techniques in most of the cases. By systematic and thoroughgoing analyses the underlying disease can be found with certainty. We did not find diagnostically useful traces during the histological analyses. As the development of the true bony ankyloses may take a long time, mature bone tissue of normal structure can develop in different diseases. The use of radiological techniques helped us to gain more information on the development of a disease, on the other hand, a more precise diagnosis is obtainable by these techniques. While the conventional X-ray images give us overlapping 2D picture, CT is able to reveal the fused bones' interior structure from multiple directions. Thus computed tomography proved to be a more useful technique from diagnostical point of view. We have to note those precise 3D reconstructions (e.g. with the help of TIVMI

software) that enable us to evaluate the alterations; furthermore the comparison to descriptions found in the literature will also be possible with the help of these reconstructions.

Concerning the experienced morphological, epidemiological or methodological traits and statements, present study may provide some helpful or supportive information for those researches that focus on the biological reconstruction of past populations.

Összefoglaló

A biológiai antropológia (embertan) a jelen és a múlt emberének vizsgálatával foglalkozó tudomány. Fontos feladatköre a régen élt népességek biológiai jellemzőinek tanulmányozása, ami hasznos segítséget nyújt a korabeli populációk életének pontosabb rekonstruálásához.

A paleopatológia a biológiai antropológia résztudománya, amely emberi maradványokon, elsősorban csontvázakon megfigyelhető patológiás elváltozások vizsgálatával segítheti az egészségi állapot, illetve bizonyos környezeti hatások és életmódbeli viszonyok rekonstrukcióját. Információkat szolgáltat arról, hogy az egykori populációban és/vagy történeti korban milyen betegségek voltak jelen, hogy ezek a kórfolyamatok hogyan manifesztálódtak és milyen gyakorisággal jelentkeztek. A kórfolyamatok építő vagy pusztító jellegű nyomokat hagyhatnak a csontmaradványokon, bizonyos esetekben az ízületek, vagy ízületek körüli területek fúziója (ankylosis) is megfigyelhető. Ezek, az ízületek mozgási lehetőségét részben vagy teljesen megakadályozó ankylosisok bármely ízületben megjelenhetnek, és kialakulásukban sokféle etiológiai faktor szerepet játszhat. Mivel az ankylosisok megjelenési gyakorisága viszonylag alacsony, ezért a paleopatológiai szakirodalomban általában esetismertetések formájában találkozhatunk velük, összefoglaló elemzések csak egyes betegségcsoportokra vonatkozóan jelennek meg.

Jelen tanulmány régi leleteken megfigyelhető ankylosisok nozológiai és epidemiológiai jellegzetességeinek, továbbá diagnosztikai metodikáinak elemzését tűzte ki célul. Elsődleges célkitűzése az adatgyűjtést követően a közvetlenül látható és radiológiai, hisztológiai módszerek segítségével észlelhető morfológiai jegyek elemzése, és olyan elváltozások azonosítása, amelyek diagnosztikai segítséget jelenthetnek a léziók hátterében álló betegségek biztosabb felismerésében.

Ankylosisok viszonylag ritkán figyelhetők meg oszteoarcheológiai leleteken, ezért jelentős számú temető anyagának átvizsgálására került sor, hogy megfelelő számú eset elemzésére legyen lehetőség. Az adatgyűjtés vizsgálati alapját az Alföld területéről származó 29

széria jelentette, amelyek jelentős időintervallumot, számos régészeti korszakot fogtak át. A legelső érintett régészeti periódus a szarmata kor volt (i. sz. 1-5. század), míg a legfiatalabb csontmaradványok a kora újkorból (18. század) származnak. A vizsgálati anyag mindösszesen 10976 egyén eltérő megtartási állapotú csontvázát jelentette.

A vizsgálatok során a leletek nemére és elhalálozási életkorára vonatkozó adatok korábbi irodalmi forrásokból kerültek felhasználásra. A csonttani elváltozások elemzése elsősorban makromorfológiai jellegű volt, de számos esetben orvosi képalkotó (röntgen- és CT) vizsgálatok, továbbá hisztológiai módszerek alkalmazására is sor került. Bizonyos esetekben a diagnózist korábban elvégzett molekuláris biológiai vizsgálatok eredményei támasztották alá.

Vizsgálataim során 346 egyén csontmaradványain találtam egy vagy több csont-ízületi ankylosist, melyek számos nozológiai csoporthoz kapcsolhatók.

A detektált ankylosisok számát illetően a valamennyi korcsoportban megjelenő, és viszonylag jó biztonsággal felismerhető fejlődési rendellenességek jelentették a legnagyobb csoportot. Két fő anatómiai területen, a gerincoszlopon és a mellkas csontjain figyeltem meg ilyen jellegű fúziókat. A gerincoszlopon talált *synostosis vertebralis* és szakralizáció megjelenési formái és népességen belüli megoszlása általában megfelelt az irodalmi adatoknak. A nagyszámú szegycsonti fúzió mellett a bordák funkcionális ankylosisai jelentették a fejlődési rendellenességek másik fő csoportját, amelyek az előző csoporthoz hasonlóan könnyen felismerhetőek voltak és szakirodalmi forrásokban szereplő jellegzetességeket mutattak.

A degeneratív elváltozásokhoz köthető ízületi fúziók a gerincen és a végtagokon jelentek meg. A gerinc elemeinél egyaránt érintettek voltak a csigolyatestek és a hátsó csigolyaelemek. Közös morfológiai jellemzőjük, hogy a szabálytalan lefutású fúzió vonalában irreguláris szerkezetű csontfelszín jelent meg. A nyaki gerincszakasz területei voltak a leginkább érintettek, és a legtöbb esetben egyéb degeneratív folyamatok nyomai - *spondylosis deformans, arthrosis* - is megjelentek a csontokon. Összefüggést állapítottam meg a degeneratív ízületi folyamathoz kapcsolódó ankylosisok előfordulása és az életkor növekedése között, a nemeket tekintve erőteljes férfi dominanciával.

A traumás elváltozásokhoz köthető csontfúziók esetében a csontvégek elmozdulásával vagy a csontok rövidülésével járó folyamatok (pl. diszlokált törés, kompressziós törés) jelenlétében könnyen azonosítható volt az ankylosis oka. A férfivázak esetében lényegesen gyakrabban észlelt elváltozások mind a gerincoszlop elemein, mind a végtagok csontjain megjelentek, és az esetek jelentős részében fertőzés nyomait is megfigyelhettünk; a fúzió általában a fertőzést követő gyógyulás jeleként volt értelmezhető. Sajátos jelenségként jelent meg a disztális tibio-fibuláris ízületek funkcionális ankylosisa (amely esetében a csontfelszínek nem érintettek, de a kialakuló csontos híd megakadályozza a két csont elmozdulását). A gerincoszlop elemein megjelenő kompressziós fraktúrák esetében a csigolyatestek magasságának kisebb-nagyobb mértékű csökkenését lehetett megfigyelni, de kyphosis nem jelentkezett. A kialakult ankylosis elsősorban a csigolyatesteket érintette, de a hátsó ízfelszínek is érintettek voltak néhány esetben.

A vizsgált szériákban non-specifikus és specifikus fertőzéseket követő gyógyulási folyamatokhoz köthetően is megfigyelhetők voltak ankylosisok. A non-specifikus fertőzésekhez kapcsolódóan a gerinc és a végtagok is érintettek voltak, a legtöbb esetben jellegzetes periosztealis újcsontképzés és sipolynyílások nyomait is megfigyeltük ezeken a csontokon. Extravertebrális lokalizációban fertőzéses eredetű ankylosist leggyakrabban a végtagcsontok disztális területein, a bokaízület és a kéz csontjain figyeltünk meg.

A specifikus fertőzések közül tuberkulózist és leprát sikerült azonosítani. A tuberkulózisra utaló ankylosisok esetében a legnagyobb számban a háti és felső lumbális csigolyaszakasz volt érintett, jellegzetes Pott-gibbus kialakulásával. A csigolyatestek általában ék alakban roppantak össze, így alakult ki az olykor számos csigolyaelemet érintő többszörös fúzió. A lumbosacrális határon kialakult TBC-s spondylitis okozta fúziók nem vezettek kyphosishoz, de jellegzetes elváltozások, így pl. periosztealis újcsontképződmények, hidegtályog és paravertebrális léziók utaltak a betegségre. A TBC-s eredetű ankylosisok nemi megoszlása erőteljes női dominanciát mutatott. CT-vizsgálatok, az azokra épülő 3D rekonstrukciók, illetve az antibiotikumok alkalmazását megelőző korból származó szakirodalmi források segítségével sikerült ritka, a térdízület ankylosisát okozó TBC-s ízületi gyulladás kialakulását bizonyítani két esetben.

A metabolikus betegségek csoportjába sorolható diffúz idiopathiás szkeletális hyperosztózis (DISH) pathognomikusnak tekinthető elváltozását, az elülső hosszanti szalag osszifikációját kizárólag Maturus és Senium korú férfiak vázmaradványain figyeltem meg. A regisztrált DISH eseteknél jellemző volt a csigolyák közötti terek megtartottsága és a hátsó ízületek érintetlensége, melyek szintén a klasszikus diagnosztikai kritériumok közé sorolhatók. Összefüggés figyelhető meg az elváltozás és egyéb ligamentumok (pl. *ligamentum flavum*, *ligamenta interspinalia*) elcsontosodása, illetve az enthesopathiák megjelenése között. Az eredmények azt sugallják, hogy a „valódi" és „korai" DISH diagnózisának felállítására alkalmazott diagnosztikai kritériumok közötti határvonal túl éles és a felosztás túl merev: a korai DISH esetként diagnosztizált leletek egy része az extravertebrális léziók összessége alapján súlyosabb kategóriába kellene, hogy tartozzon.

A gerincoszlopra és a sacro-iliacális ízületekre lokalizálódó ankylosisok együttese alapján több esetben a szeronegatív spondylarthropáthiák körébe tartozó speciális kórkép, a spondylitis ankylopoetica diagnózisát sikerült felállítani. Az esetek egy kivételével - ahol majdnem a teljes gerinc fúzionált - a lumbális gerincszakaszra lokalizálódtak. A sacroiliacalis fúziók esetében ligament osszifikáció nem jelentkezett, de a sacroileitis jellegzetes kísérőtünetként megfigyelhető volt. A betegség csak férfiakat érintett, az észlelt elváltozások a Maturus és Senium korcsoportba tartozó egyénekre korlátozódtak.

A vizsgálati módszerek diagnosztikai lehetőségeit, jelentőségét illetően különböző megállapításokat tehetünk. A klasszikus morfológiai jegyek alapján történő vizsgálatok megkerülhetetlen és a legtöbb esetben hasznos módszernek bizonyultak, a szisztematikus és alapos elemzések segítségével az ankylosisok hátterében álló kórokok nagy valószínűséggel feltárhatók. A hisztológiai elemzések során diagnosztikai erővel bíró egyedi jellegzetességeket nem sikerült azonosítani. A valódi csontos ankylosisok kialakulása a legtöbb esetben hosszabb időt vesz igénybe, így a szövettani képen megjelenő csontszövet közel azonos jellegekkel rendelkezik a különböző kórokok esetében is. A radiológiai vizsgálatok segítségével számos kórfolyamat pontosabb megismerésére és pontosabb diagnózis felállítására volt lehetőség. A röntgenfelvételek mellett az ankylosisok területének többirányú elemzésére is lehetőséget adó komputertomográfiás szkennelések fontos, nagyobb biztonsággal felállítható diagnózisokhoz

vezető diagnosztikai eszközt jelentenek. Külön kell megemlíteni a pontos háromdimenziós rekonstrukciók létrehozását (pl. a TIVMI program segítségével), amelyek nagy precizitású modellek kialakításával teszik lehetővé az elváltozások értékekését, továbbá azok összevetését más irodalmi forrásokban szereplő leírásokkal, jellegzetességekkel.

A tapasztalt morfológiai, epidemiológiai vagy módszertani megállapítások, jellegzetességek együttesét tekintve a dolgozat olyan információkkal szolgál, amely segítséget nyújthat az egykoron élt populációk biológiai rekonstrukcióját célul kitűző további kutatások számára.

Résumé

L'anthropologie biologique est une discipline qui étudie l'homme dans ses aspects présents et passés. L'étude des caractères biologiques des populations anciennes rend possible une meilleure approche de reconstruction de la vie de ces populations. La paléopathologie fait partie de l'anthropologie biologique: elle peut contribuer à la reconstruction des états de santé, des environnements et des modes de vie par l'examen des malformations pathologiques observées sur les restes humains (principalement des squelettes). Elle peut aussi aider en nous renseignant sur les maladies d'une population et/ou d'une période donnée(s) ainsi que de leurs manifestations et fréquence. Les maladies peuvent laisser des traces constructives ou destructives sur les restes osseux; dans certains cas, on peut même observer la fusion des articulations ou des régions les entourant. Ces ankyloses empêchant partiellement ou entièrement la liberté du mouvement des articulations peuvent apparaître dans n'importe quelle articulation; la genèse est due à divers facteurs étiologiques. Comme la fréquence d'apparition des ankyloses est relativement basse, nous les retrouvons dans la littérature paléopathologique le plus souvent sous forme d'études de cas, les analyses complexes n'étant publiées que dans le cas de certains groupes de maladies.

La présente étude a pour but d'examiner les particularités nosologiques et épidémiologiques des ankyloses et d'évaluer les aspects méthodologiques de leur diagnostic. L'objectif principal consistait à observer, par l'analyse des caractères morphologiques repérables à l'aide de méthodes visuelles, radiologiques ou histologiques, des particularités ou modifications qui pourraient offrir un repère diagnostique à une reconnaissance plus solide des maladies provoquant ces lésions.

Le nombre d'ankyloses observables dans les échantillons ostéoarchéologiques étant relativement bas, j'ai dû procéder à l'examen de beaucoup de cimetières, afin d'obtenir la possibilité d'analyser un nombre suffisant de cas. La base du relevé a été constituée par les 29 séries provenant de la Grande Plaine hongroise (Alföld). Elles recouvrent un intervalle assez important donc plusieurs périodes archéologiques. La première période concernée était celle

des Sarmates (1er-5^{e} siècle), alors que les restes osseux les plus récents datent de l'époque moderne (18^{e} siècle). La matière de recherche se composait en somme des squelettes – d'états différents – de 10976 individus.

Lors des examens, le sexe et l'âge au décès ont été établis à l'aide de la littérature spécialisée; je n'ai pas procédé à de recherches supplémentaires à ce sujet. L'analyse des dégénérations osseuses était surtout de caractère macromorphologique; dans de nombreux cas, on a dû aussi recourir à des méthodes d'imagerie médicale (radiographie, tomodensitométrie) ou d'histologie. Dans certains cas, j'ai soutenu le diagnostic à l'aide de méthodes de biologie moléculaire, réalisées au préalable.

Lors de mes recherches, j'ai trouvé un ou plusieurs ankyloses d'articulations osseuses sur les restes osseux de 346 individus, ces résultats pouvant être liées à de multiples groupes nosologiques.

Le groupe le plus important était constitué des malformations développementales présentes dans toutes les classes d'âge; leur reconnaissance a été réalisée avec certitude. Des fusions de ce type ont été observées sur deux entités anatomiques principales, la colonne vertébrale et le thorax. Les formes d'apparition et la répartition démographique de la *synostosis vertebralis* et de la sacralisation repérées sur la colonne vertébrale correspondent en grande partie aux caractères affirmés dans les sources littéraires. A côté d'un grand nombre de fusions du sternum, les ankyloses fonctionnelles des côtes ont constitué le deuxième grand groupe des malformations. Tout comme celles appartenant au premier groupe, elles étaient facilement repérables, et présentaient les caractères décrits par la littérature spécialisée.

Les fusions articulaires que l'on peut lier à des malformations dégénératives ont apparu sur la colonne vertébrale et les extrémités. Les corps vertébraux ainsi que les éléments postérieurs des vertèbres étaient également touchés: le caractère commun consiste en l'apparition d'une surface osseuse de structure irrégulière dans la ligne de la fusion de processus anormal. La région cervicale est la plus touchée; dans la plupart des cas, d'autres processus dégénératifs, comme la *spondylosis deformans* et l'ostéoarthrite peuvent aussi être

observés sur les os. On peut aussi observer un lien entre leur apparition et l'avancement de l'âge; quant à la répartition sexuelle, une importante majorité masculine peut être enregistrée.

Dans le cas des fusions osseuses que l'on peut attribuer à des traumatismes, en présence de processus entraînant le déplacement des fragments osseux ou le raccourcissement des os (par exemple les fractures disloquées ou compressées), on peut facilement identifier la cause de l'ankylose. Les cas présentant une forte dominance masculine ont apparu et sur les éléments de la colonne vertébrale et sur les os des membres et, pour une partie importante, des traces d'infections sont également apparues. La fusion peut alors être interprétée comme un signe de guérison suivant l'infection. L'ankylose fonctionnelle des articulations distales tibio-fibulaires est apparue comme un phénomène particulier. Dans ce cas, les surfaces osseuses ne sont pas touchées, alors que le pont osseux naissant empêche le déplacement des deux os. Dans le cas des fractures par compression apparaissant sur les éléments de la colonne vertébrale, on peut observer une diminution plus ou moins importante de la hauteur somatique, mais sans cyphose déclarée. L'ankylose naissante a principalement touché les corps vertébraux, alors que les surfaces articulaires postérieures ont aussi été touchées dans certains cas.

Des ankyloses peuvent aussi être observées en relation avec des processus de guérison suivant des infections spécifiques ou non spécifiques. En ce qui concerne les infections non spécifiques, la colonne vertébrale et les membres sont aussi touchés; dans la plupart des cas, une nouvelle formation osseuse périostale caractéristique et des orifices de cloaque représentant les traces de l'évacuation du pus se trouvent aussi sur ces os. Les régions les plus touchées du squelette appendiculaire sont les fusions qu'on trouve dans les parties distales des membres, sur les os de la cheville ou des mains.

En ce qui concerne les infections spécifiques, on a réussi à identifier la tuberculose et la lèpre. Dans le cas des ankyloses rapportées à la tuberculose, les vertèbres thoraciques et les vertèbres lombaires supérieures sont touchées, et il apparaît un mal de Pott caractéristique par sa gibbosité. Les corps vertébraux ont un tassement cunéiforme caractéristique: c'est ainsi que la fusion multiple touchant plusieurs éléments vertébraux se constitue. Dans le cas de fusions d'origine tuberculeuse localisées à la charnière lombo-sacrée, la cyphose ne peut pas être

reconnue, mais des malformations caractéristiques comme les ossifications périostées, des abcès froids ou une masse osseuse paravertébrale étendue témoignent de cette infection. La répartition sexuelle des ces malformations présente une nette dominance féminine. Les examens CT, les reconstructions tridimensionnelles basées sur ceux-ci, les sources de la littérature provenant des périodes antérieures à l'usage des antibiotiques nous ont permis de prouver dans deux cas la présence d'une infection de tuberculose rare, provoquant l'ankylose du genou.

L'ossification du ligament longitudinal antérieur, considérée comme un signe pathognomique de la maladie hyperostosique (DISH) que l'on range parmi les maladies métaboliques, ne peut être observée que sur les ossements d'hommes Maturus et Senium. Les disques intervertébraux intacts et les articulations postérieures, considérées comme des critères de diagnostic classiques sont également observables. On peut relever une relation entre la malformation et l'ossification d'autres ligaments (comme par exemple le *ligamentum flavum*, les ligaments supra-épineux) ou l'apparition d'enthésopathies. D'après les observations réalisées, les critères diagnostiques relatifs aux diagnostics des DISH (ou Maladie de Forestier) réelle ou débutante paraissent artificiels, une partie importante des individus diagnostiqués comme des formes débutantes de DISH présente un ensemble de symptômes semblable à ceux observés dans les cas de DISH avérés.

Les ankyloses localisées aux vertèbres et aux articulations sacro-iliaques représentent un groupe spécifique de fusions. Dans les cas où l'on a réussi à établir le diagnostic de la *spondylitis ankylopoetica* relevant des arthropathies séronégatives, tous les cas se sont révélés être localisés à la région lombaire (sauf pour un cas où presque l'ensemble de la colonne est fusionné). Dans le cas des fusions sacro-iliaques, l'ossification des ligaments ne se présente pas; ces fusions sont toujours accompagnées des signes caractéristiques de la sacroiliite. Cette maladie touche uniquement des hommes; les malformations étaient limitées aux classes d'âge Maturus et Senium.

En ce qui concerne l'importance diagnostique des méthodes d'analyse, les situations apparaissent différentes. Les examens réalisés sur la base des critères morphologiques classiques se sont avérés dans la plupart des cas incontournables et, pour la majorité des cas,

utiles. A l'aide des analyses systématiques et minutieuses, les facteurs étiologiques peuvent être établis avec une forte probabilité. Lors des analyses histologiques, on n'a pas réussi à identifier de caractéristiques particulières disposant de valeur diagnostique. La formation de réelles ankyloses osseuses nécessite un temps plus long dans la majorité des cas. Ainsi le tissu osseux apparaissant sur l'image histologique dispose de caractéristiques presque identiques même en cas de facteurs étiologiques différents.

A l'aide des examens radiologiques, il se révèle possible de mieux connaître de nombreux processus étiologiques et d'établir de diagnostics plus précis. A côté des clichés radiologiques simples, l'utilisation du scanner tomographique assisté par ordinateur rend possible l'analyse pluridirectionnelle des ankyloses et représente un procédé diagnostique important, conduisant à des diagnostics établis avec plus de certitude. On remarquera surtout la création des reconstructions tridimensionnelles précises (par exemple à l'aide du logiciel TIVMI) qui, par la création des modèles de haute définition, rend possible l'évaluation des atteintes pathologiques, la recontruction des processus originaux ainsi que leur comparaison avec les données de la littérature.

Vu l'ensemble des affirmations et particularités morphologiques, épidémiologiques ou méthodologiques enregistrées, la thèse offre des informations pouvant servir de support aux recherches ultérieures se fixant comme objet la reconstruction biologique des populations du passé.

Appendix I

Demographical distribution of the anthropological series

1. Madaras - Halmok
2. M5 motorway - Kiskundorozsma, site 26/60
3. M5 motorway - Kiskundorozsma, site 26/72
4. M5 motorway - Kiskundorozsma, site 26/78
5. M5 motorway - Röszke, site 48/60
6. M5 motorway - Röszke, site 48/75
7. Biharkeresztes - Ártánd - Kisfarkasdomb
8. Bélmegyer - Csömöki domb
9. Hetényegyháza - site 72
10. Hódmezővásárhely - Kopáncs III. homokbánya
11. Kunszállás - Fülöpjakab
12. Orosháza Béke TSZ
13. Pitvaros - Víztározó
14. Sükösd - Ságod
15. Szarvas - site 68
16. Székkutas - Kápolnadűlő
17. Derekegyház – Ibolyásdomb
18. Hódmezővásárhely - Nagysziget
19. Homokmégy - Székes
20. M5 motorway - Kiskundorozsma, site 26/78
21. Magyarhomorog - Kónyadomb
22. Sárrétudvari - Hízóföld
23. Szatymaz- Vasútállomás
24. Bácsalmás - Homokbánya
25. Bátmonostor - Pusztafalu
26. Nyárlőrinc - Hangár út
27. Óföldeák
28. Ópusztaszer - Monostor
29. Szeged – Vár

Madaras - Halmok	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	3	-	33	-	60	-	10	26	132
female	-	-	-	-	-	5	-	90	-	51	-	6	53	205
undetermined sex	-	48	28	9	-	15	-	1	-	1	-	-	25	127
total	0	48	28	9	0	23	0	124	0	112	0	16	104	464

M5 motorway - Kiskundorozsma, site 26/60	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	-	-	1	-	-	-	1
female	-	-	-	-	-	-	-	-	-	-	-	1	-	1
undetermined sex	-	-	-	1	-	-	-	-	-	-	-	-	-	1
total	0	0	0	1	0	0	0	0	0	1	0	1	0	3

M5 motorway - Kiskundorozsma, site 26/72	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	-	-	6	-	-	3	9
female	-	-	-	-	-	-	-	1	-	2	-	-	1	4
undetermined sex	-	2	-	3	-	-	-	-	-	-	-	-	3	8
total	0	2	0	3	0	0	0	1	0	8	0	0	7	21

M5 motorway - Kiskundorozsma, site 26/78	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	1	-	2	-	12	-	1	3	19
female	-	-	-	-	-	4	-	2	-	5	-	3	3	17
undetermined sex	-	6	1	1	-	2	-	1	-	-	-	-	10	21
total	0	6	1	1	0	7	0	5	0	17	0	4	16	57

M5 motorway - Röszke, site 48/60	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	1	-	1	-	-	-	2
female	-	-	-	-	-	-	-	-	-	1	-	-	-	1
undetermined sex	-	-	-	2	-	-	-	-	-	-	-	-	9	11
total	0	0	0	2	0	0	0	1	0	2	0	0	9	14

M5 motorway - Röszke, site 48/75	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	-	-	-	-	-	1	1
female	-	-	-	-	-	-	-	-	-	-	-	-	1	1
undetermined sex	-	-	-	-	-	-	-	-	-	-	-	-	-	0
total	0	0	0	0	0	0	0	0	0	0	0	0	2	2

Biharkeresztes - Ártánd - Kisfarkasdomb	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	6	-	10	-	1	-	17
female	-	-	-	-	-	-	-	8	-	1	-	1	-	10
undetermined sex	-	5	-	-	-	4	-	1	-	1	-	1	3	15
total	0	5	0	0	0	4	0	15	0	12	0	3	3	42

Bélmegyer - Csömöki-domb	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	1	-	17	-	27	-	9	-	54
female	-	-	-	-	-	3	-	26	-	13	-	2	-	44
undetermined sex	-	15	13	-	-	5	-	-	-	-	-	-	-	33
total	0	15	13	0	0	9	0	43	0	40	0	11	0	131

Hetényegyháza - site 72	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	19	27	10	-	-	6	62
female	-	-	-	-	-	-	-	50	31	12	-	-	8	101
undetermined sex	-	30	33	-	-	30	-	-	-	-	-	-	-	93
total	0	30	33	0	0	30	0	69	58	22	0	0	14	256

Hódmezővásárhely - Kopáncs III. homokbánya	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	8	-	34	-	30	-	3	7	82
female	-	-	-	-	-	8	-	24	-	13	-	-	4	49
undetermined sex	-	27	19	2	-	11	-	2	-	3	-	-	15	79
total	0	27	19	2	0	27	0	60	0	46	0	3	26	210

Kunszállás - Fülöpjakab	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	5	-	6	-	-	-	11
female	-	-	-	-	-	4	-	10	-	3	-	3	1	21
undetermined sex	-	8	9	-	-	1	-	-	-	-	-	-	-	18
total	0	8	9	0	0	5	0	15	0	9	0	3	1	50

Orosháza - Béke TSZ	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	11	-	17	-	2	3	33
female	-	-	-	-	-	-	-	23	-	11	-	2	2	38
undetermined sex	-	9	10	-	-	7	-	-	-	-	-	-	3	29
total	0	9	10	0	0	7	0	34	0	28	0	4	8	100

Pitvaros - Víztározó	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	2	2	30	2	38	2	8	1	85
female	-	-	-	-	-	7	2	49	4	17	-	4	2	85
undetermined sex	2	23	18	5	-	5	-	-	-	-	-	-	3	56
total	2	23	18	5	0	14	4	79	6	55	2	12	6	226

Sükösd-Ságod	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	2	-	9	2	24	3	7	2	49
female	-	-	-	-	-	2	3	23	2	15	2	2	2	51
undetermined sex	-	44	13	6	-	2	-	-	-	-	-	-	6	71
total	0	44	13	6	0	6	3	32	4	39	5	9	10	171

Szarvas - site 68	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	4	-	47	-	87	-	10	6	154
female	-	-	-	-	-	15	-	68	-	52	-	8	8	151
undetermined sex	-	46	42	-	-	16	-	1	-	1	-	-	3	109
total	0	46	42	0	0	35	0	116	0	140	0	18	17	414

Székkutas - Kápolnadűlő	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	2	-	47	-	91	-	15	3	158
female	-	-	-	-	-	25	-	82	-	81	-	22	2	212
undetermined sex	-	54	52	-	-	14	-	4	-	2	-	2	20	148
total	0	54	52	0	0	41	0	133	0	174	0	39	25	518

Derekegyház - Ibolyásdomb	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	6	-	11	-	5	7	29
female	-	-	-	-	-	-	-	2	-	5	-	4	2	13
undetermined sex	-	4	4	-	-	4	-	-	-	1	-	-	1	14
total	0	4	4	0	0	4	0	8	0	17	0	9	10	56

Hódmezővásáshely - Nagysziget	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	8	-	10	-	14	-	9	3	44
female	-	-	-	-	-	5	-	26	-	15	-	10	6	62
undetermined sex	-	10	12	1	-	1	-	-	-	-	-	-	1	25
total	0	10	12	1	0	14	0	36	0	29	0	19	10	131

Homokmégy - Székes	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	1	-	13	-	29	-	14	5	62
female	-	-	-	-	-	12	-	32	-	23	-	12	5	84
undetermined sex	-	22	14	-	-	3	-	-	-	-	-	-	-	39
total	0	22	14	0	0	16	0	45	0	52	0	26	10	185

M5 motorway - Kiskundorozsma, site 26/78	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	-	-	3	-	-	-	3
female	-	-	-	-	-	-	-	-	-	1	-	-	-	1
undetermined sex	-	-	-	-	-	-	-	-	-	-	-	-	-	0
total	0	0	0	0	0	0	0	0	0	4	0	0	0	4

Magyarhomorog - Kónyadomb	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	8	-	35	-	47	-	11	12	113
female	-	-	-	-	-	14	-	43	-	36	-	22	12	127
undetermined sex	-	77	28	-	-	5	-	-	-	1	-	-	17	128
total	0	77	28	0	0	27	0	78	0	84	0	33	41	368

Szatymaz - Vasútállomás	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	28	-	45	-	20	21	114
female	-	-	-	-	-	-	-	33	-	24	-	7	25	89
undetermined sex	-	15	38	-	-	7	-	-	-	1	-	1	21	83
total	0	15	38	0	0	7	0	61	0	70	0	28	67	286

Bácsalmás - Homokbánya	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	9	3	22	4	43	2	37	7	127
female	-	-	-	-	-	5	3	42	3	28	2	19	9	111
undetermined sex	20	126	56	6	2	21	1	-	-	-	-	-	11	243
total	20	126	56	6	2	35	7	64	7	71	4	56	27	481

Bátmonostor - Pusztafalu	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	38	-	310	-	595	-	234	165	1342
female	-	-	-	-	-	66	-	199	-	262	-	127	66	720
undetermined sex	52	584	833	41	-	49	-	8	-	25	-	5	123	1720
total	52	584	833	41	0	153	0	517	0	882	0	366	354	3782

Nyárlőrinc - Hangár út	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	-	-	10	-	12	-	4	67	93
female	-	-	-	-	-	-	-	7	-	6	-	2	26	41
undetermined sex	18	131	60	-	-	30	-	4	-	2	-	-	104	349
total	18	131	60	0	0	30	0	21	0	20	0	6	197	483

Óföldeák	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	9	-	32	-	39	-	13	9	102
female	-	-	-	-	-	5	-	29	-	20	-	6	6	66
undetermined sex	-	73	36	10	-	34	-	21	-	17	-	5	55	251
total	0	73	36	10	0	48	0	82	0	76	0	24	70	419

Ópusztaszer - Monostor	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	20	-	108	-	229	-	76	36	469
female	-	-	-	-	-	9	-	75	-	120	-	34	22	260
undetermined sex	-	99	195	2	-	30	-	3	-	5	-	1	25	360
total	0	99	195	2	0	59	0	186	0	354	0	111	83	1089

Szeged - Vár	foetus/ neonate	Infans I.	Infans II.	Inf I - Inf II.	Inf II - Juv.	Juvenis	Juv-Ad.	Adultus	Ad-Mat.	Maturus	Mat-Sen.	Senium	adult	total
male	-	-	-	-	-	15	-	37	10	62	21	9	12	166
female	-	-	-	-	-	15	-	46	6	28	11	18	17	141
undetermined sex	17	106	85	20	22	24	-	9	1	11	6	3	30	334
total	17	106	85	20	22	54	0	92	17	101	38	30	59	641

Appendix II

Personal data sheets

1. Madaras - Halmok
2. M5 motorway - Kiskundorozsma, site 26/60
3. M5 motorway - Kiskundorozsma, site 26/72
4. M5 motorway - Kiskundorozsma, site 26/78
5. M5 motorway - Röszke, site 48/60
6. M5 motorway - Röszke, site 48/75
7. Biharkeresztes - Ártánd - Kisfarkasdomb
8. Bélmegyer - Csömöki domb
9. Hetényegyháza - site 72
10. Hódmezővásárhely - Kopáncs III. homokbánya
11. Kunszállás - Fülöpjakab
12. Orosháza Béke TSZ
13. Pitvaros - Víztározó
14. Sükösd - Ságod
15. Szarvas - site 68
16. Székkutas - Kápolnadűlő
17. Derekegyház – Ibolyásdomb
18. Hódmezővásárhely - Nagysziget
19. Homokmégy - Székes
20. M5 motorway - Kiskundorozsma, site 26/78
21. Magyarhomorog - Kónyadomb
22. Sárrétudvari - Hízóföld
23. Szatymaz- Vasútállomás
24. Bácsalmás - Homokbánya
25. Bátmonostor - Pusztafalu
26. Nyárlőrinc - Hangár út
27. Óföldeák
28. Ópusztaszer - Monostor
29. Szeged – Vár

1. Madaras - Halmok (Sarmatian period, 2nd-5th c. AD, 464 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	194	Maturus	M	TV? - TV?	Osteophytosis of the vertebral bodies is resulted in osseous fusion. Wavy fusion line is visible, zygapophyseal joints are not involved.	degenerative origin (spondylosis deformans)	LV5	Single osteophyte on the inferior part of the vertebra.	spondylosis deformans
2	208	Adultus	F	TV? - TV?	Osteophytosis of the vertebral bodies is resulted in osseous fusion. Wavy fusion line is visible, zygapophyseal joints are not involved.	degenerative origin (spondylosis deformans)	V-e left os coxae	Slight osteophytosis on the vertebral margins. Round-shaped (1cm in its diameter) lytic lesion in the area of left sulcus preauricularis.	spondylosis deformans unknown
3	230	Adultus	M	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-
4	235	Maturus	M	TV? - TV?	Osteophytosis of the vertebral bodies is resulted in osseous fusion. Wavy fusion line is visible, zygapophyseal joints are not involved.	degenerative origin (spondylosis deformans)	LV-e	Slight osteophytes at the vertebral bodies' margins.	spondylosis deformans

2. M5 motorway - Kiskundorozsma, site 26/60 (Sarmatian period, 3rd-4th c. AD, 3 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / etiology	localisation	description	diagnosis / etiology
-	-	-	-	-	-	-	-	-	-

3. M5 motorway - Kiskundorozsma, site 26/72 (Sarmatian period, 2nd-3rd c. AD, 21 individuals)

No. of cases	grave No.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
-	-	-	-	-	-	-	-	-	-

4. M5 motorway - Kiskundorozsma, site 26/78 (Sarmatian period, 4th c. AD, 21 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / etiology	localisation	description	diagnosis / aetiology
1	229/3	Maturus	M	manubrium sterni - corpus sterni	Complete fusion of the two segments.	developmental defect	-	-	-

5. M5 motorway - Röszke, site 48/60 (Sarmatian period, 3rd-4th c. AD, 14 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
-	-	-	-	-	-	-	-	-	-

6. M5 motorway - Röszke, site 48/75 (Sarmatian period, 3rd-4th c. AD, 2 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
-	-	-	-	-	-	-	-	-	-

7. Biharkeresztes - Ártánd - Kisfarkasdomb (Gepids, 5th c. AD, 42 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	1	Adultus	M	2 right ribs - TV?	Ankylosis of two costovertebral joints (only fovae of the costal tuberosities are investigatable).	unknown	TV2 - TV3, TV8 - S1	Slight osteophytes on the vertebral bodies' anterior margins.	spondylosis deformans
				corpus sterni - manubrium sterni	Partial fusion (interior part of the joint) of the two segments can be seen.	developmental defect	CV4, S1	Flattening and pitting of the right upper facet of VC4; eburnation on the left facet of S1.	degenerative osteoarthritis
							right os coxae	Rim formations around the acetabulum (unilateral development).	degenerative osteoarthritis
							2 clavicles, sternum	Pitting on both ends of the clavicles and clavicular incisures of the sternum.	degenerative osteoarthritis
							2 tibiae, 2 calcanei, 2 clavicles	Strengthened entheses.	enthesopathy
							right clavicle	Callus formation on the clavicular mid-shaft, dislocation is not seen.	healed fracture
							no rib PO,CO, CC, ECL, HV		
2	5	adult	U	LV5 - S1	Bilateral ankylosis of the zygapophyseal joints, bodies are not involved. Fusion lines are irregular, original gaps are partly recognizable at the left joint.	degenerative origin	LV4 - LV5	Very strong distortion of the facet surface with appositions and rim formations.	degenerative osteoarthritis
							2 ossa coxae	Slight rim formation of the acetabuli.	degenerative osteoarthritis
							no CO, CC, ECL		
3	35	Adultus	F	left ulna - humerus	Bony fusion at the region of olecranon fossa and olecranon Very small area is involved, fusion developed only at the top of the olecranon. No signs of previous fracture or infection are seen.	unknown	left humerus	Oval shape opening in the fossa olecrani.	anatomic variation
							no CO, CC, ECL		

8. Bélmegyer - Csömöki domb (Avar age, 6-8th c. AD, 239 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	12	Adultus	M	left tibia - fibula	Fusion above the distal tibiofibular joint. The fusion area is smooth surfaced, no signs of infection or fracture are found. It may be the result of ligament ossification. Thickening at the distal epyphyses of tibia and fibula. The facture healed with osseous bridge at the level of incisura fibularis.	post-traumatic ankylosis (healed fracture)	left fibula	Thickening (callus formation) is found in the proximal shaft of fibula.	healed fracture
							right tibia, fibula	Strong thickening (callus) in the mid-shaft of the bones.	healed fracture
							2 femori, 2 tibiae, 2 fibulae	Distorted articular surfaces of the knee, tibiofibular and ankle joints.	degenerative osteoarthritis
							2 femori, 2 calcanei, 2 fibulae (proximal and distal ends)	Strengthened entheses.	enthesopathy
							left orbit	Unilateral porotic lesions on the orbital roof (right: no alteration)	cribra orbitalia (porotic stage, unilateral)
							ribs	Strong spongious bony apposition on ribs' visceral surfaces.	infection (due to TB or due to general post-traumatic infecton?)
							no ECL, CC		
2	65	Maturus	F	LV2 - LV4	Bony fusion of the three vertebral bodies and facet joints. V-shaped vertebral bodies of the LV2 and LV3 are recognizable. Ankylosis of LV3 and LV4 has began, strong bony outgrows at margins of vertebral bodies.	TB - Pott's disease	LV1	Distortion of the upper facet surfaces.	degenerative osteoarthritis
							right humerus	Lytic lesions of oval/round-shape and of moth-eaten edges on the lesser tubercle are found.	unknown
							no CO,CC,ECL, rib PO		
				TV8 - TV11	Collapse of the vertebral bodies, bilateral ankyloses at the posterior elements (facet joints,posterior arch).	TB (Pott's disease)			
				manubrium sterni - corpus sterni	Fusion of the two segments.	developmental defect			

3	68	Maturus	M	sacrum - left os coxae	Periarticular fusion of the left os coxae and sacrum is found. The fusion developed as a result of ligament ossification above the auricular surface. The auricular space is not involved.	unknown	left os coxae TV7 - TV9, LV1-LV5 (LV2 is missing) TV4, TV8 - TV12 LV1 right os coxae - ilium S4-S5	Lytic lesions (macroporosity) on the inferior part of the auricular surfaces. Slight-moderate osetophytes on the anterior margins of the vertebral bodies. Distorted facet surfaces (rims, irregular surface, macroporosity) are present. The anterior side of the body is a bit smaller resulted in slight kyphosis. Drop-shaped opening above the acetabulum is seen, a cavity behind it is present. Opened posterior arches.	degenerative osteoarthritis (sacroileitis) spondylosis deformans degenerative osteoarthritis spondylosis deformans degenerative osteoarthritis (associated with infection?) sacrum bifidum (partial)
4	90	Maturus	M	S1- LV5	Complete fusion of the vertebrae, dripstone curtain-like new bone formation at the upper margin of the VL5's body. The anterior surface of the sacrum is eroded, rough.	TB	left femur, os coxae, sacrum no CO, CC, LEH, ECL	The left femoral head and neck are completely athrophied. The acetabulum is shallow, the original joint surface is not recognizable. The acetabulum is surrounded by strong exostoses.	TB - coxitis tuberculosa
5	133	Senium	M	CV4 - CV5	Complete ankylosis between the left articular process (spongious outgrows are at the level of the original space) and partial ankylosis at the right side are seen. Right zygapophyseal joint and vertebral bodies are not involved.	degenerative origin	CV1 - CV2 CV3 - CV7, TV-e LV-e, S1 right os coxae, right clavicle no CO,CC, ECL, rib PO, HV	Moderate distortion of atlanto-axial joint. Vertical outgrows (osteophytes) on the lower margin of vertebral bodies and macroporosity on the endplates. Joint surfaces (acetabular surface, acromial end) are eroded and rough.	degenerative osteoarthritis spondylosis deformans degenerative osteoarthritis

6	189	Adultus	M	sacrum - 2 os coxae	Bony fusion of the auricular surfaces is found. No sign of ligament ossification is recognizable. Fusion line is no visible, smooth areas are present.	TB	2 ossa coxae 2 os pubis - symphyseal surfaces 2 ossa coxae no CO, CC, rib PO, HV	New articular surfaces developed bilaterally at the posterior part of the iliac wing (facing to VL5). Symphyseal surfaces are rough, the original shape of the area has changed. Small swelling on the upper surface of the pubic arch (close to the symphysis) is found. Slight distortion of the acetabular rims.	degenerative and/or developmental origin unknown (degenerative origin ?) degenerative osteoarthritis
7	215	Maturus	M	right tibia - femur - patella CV2 - CV3	Complete ankylosis of the right knee (both the femorotibial and the femoropatellar articulations are involved) developed in the elderly male individual. The involved long bones are in extended position of 165-170 degrees. Bony bridges connect the femoral and tibial condyles; a tunnel is seen between them. The patella dislocated upwards, its base is attached to the femur's patellar surface. No signs of fracture or cloacal openings can be seen, but the diaphyseal surfaces of the involved long bones are undulating; slight-moderate, but extensive periostitis is recognizable in the entire length of the shafts. The severe distortion of the same side femoral head indicates that the limb was used throughout the individual's life. Fusion of the vertebrae. Left zygapophyseal joint, left lateral and posterior margins of the bodies are involved. Chondrocalcinosis is seen between the vertebral plates. Fusion lines/areas are bumpy. Right zygapophyseal joint is not affected.	unknown (TB ?) degenerative origin (?)	right tibia, femur LV2 - LV3 TV-e, LV-e TV7 - TV12 LV5 lower TV-e right femur, os coxae right calcaneus, talus no ECL, CC, CO, HV	Swollen midshafts are found, the surface of the bones is irregula (undulating). Vertical outgrows on the margins of vertebral bodies. Adjacent upper and lower surfaces of the bodies are rough, small lytic lesions are present. Slight -moderate osteophytes on the vertebral bodies' margins. Ossification of the ligamentum flavum. Ossification of the right iliolumbar ligament (left is not examinable). Distortion of the foveae on the vertebral bodies. Strong distortion and bony rims around of femoral head are found, distortion of the acetabular area is present. Distortion and lytic lesions on the calcanotalar surfaces.	periostitis (osteitis?) degenerative osteoarthritis spondylosis deformans OLF OILL degenerative osteoarthritis degenerative osteoarthritis degenerative osteoarthritis

9. Hetényegyháza - Site 72 (Avar age, 6-8th c. AD, 256 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	11	Senium	F	os occipitale - CV1	CV1 and occipital bone are asymetrically fused at the occipital condyles, right side joint is not involved.	segmentational problem - developmental defect	spine	Lateral (left) curve of the spine.	scoliosis
							spine	Very porotic vertebral bodies are present.	senile oteoporosis
				CV7 - TV2	Complete fusion of the three vertebrae, all parts are involved. The vertebral bodies' anterior side is rough, small cavity is seen between the CV6 and CV7.	degenerative origin (infection?)		Ossification of the interspinous ligament.	
							TV11 - TV12	Distortion of the costal fovae and zygapophyseal joints is seen.	OISL
							TV-e	Strong distortion of the zygapophyseal joints.	degenerative osteoarthritis
				TV11 - TV12	Fusion of the two vertebrae in the right zygapophyseal joint. Joint gap is not recognizable, fusion area is characterized with irregular surface. Other parts are not involved. Interspinous ligament ossification is present.	degenerative origin or SPA?	LV5 - S1		degenerative osteoarthritis
				LV1 - LV3	Fusion of the three segments. Bilateral zygapophyseal fusions are present (bumpy area). Bodies are almost completely disappeared as a result of post mortem loss, but the remain of the LV2 body presents slightly collapsed phenomenon, the upper plate of it is fused to the lower plate of the LV1.	degenerative origin or SPA?			
				corpus sterni - processus xyphoideus	Complete fusion of the two elements.	compression fracture (?)			
						developmental (?)			
2	34	Adultus	M	LV5 - S1	Bony fusion of the lateral processes of the segments and of the posterolateral corner of the verebral bodies. Facet joints and posterior arches are not involved.	sacralisation	-	-	-
3	49	Adultus	F	LV5 - S1	Bony fusion of the lateral processes of the segments and of the right zygapophyseal joint. Left facet joint is not involved, bodies are not recognizable as a result of post mortem destruction.	sacralisation	-	-	-

4	54	Adultus	F	LV5 - S1	Partial fusion of the vertebral bodies (lateral parts are affected) and complete fusion at lateral elements are seen. Posterior elements are not involved.	sacralisation	LV5 LV5, S1	Opened neural arch at spinous process. The upper plate of the vertebral bodies are not horizontal, this phenomenon resulted in both anterior and lateral (via right side) flexion of the spine.	spinabifida kyphoscoliosis
5	67	Senium	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	S1 2 calcanei, 2 patellae	Opened posterior arch at spinous process. Strengthened entheses.	sacrum bifidum (partial) enthesopathy
6	92	Adultus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	-	-	-
7	156	Maturus	M	LV4 - LV5	Large lityc lesion on the lower surface of the LV4 is seen, the posterior body is almost completely disappeared. Smaller lesions on the right side also can be found. The upper surface of the LV5 presents cavity-like lytic lesions, they involve the majority of the posterior body. Their walls are smooth or bounded by bigger/thicker trabeculae. Beside these cavities smaller (3-4 mm in their diameter) ones are present too. Five cloacal openings can be seen on bodies: -LV4: three on anterior and one on right side, - LV5: one on the left side. Bodies are not collapsed, irregular surface with extensive proliferative bony formations are present on the bodies. (LV3 and sacrum are missing)	Non-specific pyogenic infection / osteomyelitis	right nasal bone	The nasomaxillar suture completely, the internasal suture partly disappeared as a result of closure caused by some traumatic event.	postraumatic suture closure
8	163	Maturus	M	sacrum - left os coxae	Left os coxae and sacrum fused at auricular surfaces (right ones are missing). No signs of ligament ossifiaction are found, the original joint gap is not recognizable.	unknown - arthritis (?)	-	-	-
9	197	Adultus	M	LV5 - S1	Unilateral fusions developed between the left side processes and between the left sides of the vertebral bodies.	sacralisation			

10	237	Senium	M	CV2 - CV3	Bony fusion of the vertebral bodies and lateral processes; spinous processes are not involved. Fusion area is smooth, no signs of infection or degenerative processes are found.	synostosis vertebralis - developmental (?)	-	-	-
11	260	Adultus	M	LV5 - S1	Fusion of the two segments at lateral processes is found. Other vertebral parts are not involved.	sacralisation	right clavicle	The clavicle is shortened with cc. 1 cm as a result of a healed fracture of the shaft .	fracture (helaed, dislocated)

10. Hódmezővásárhely - Kopáncs III. (Avar age, 8-9th c. AD, 210 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	20	Maturus	M	LV3 - S1	Complete fusion of the posterior elements of the vertebrae. Vertebral bodies are missing.	SPA	2 os coxae rib fragment	Rim formations around the acetabuli. Rough visceral surface .	degenerative osteoarthritis infection
2	45-13	Adultus	F	CV2 - CV3 CV4 - CV6	Bodies and posterior elements of the CV2 and CV3 are completely ankylosed. CV3 and CV4 are not fused at any joints. CV4 and CV5 are fused at the left facet joint and at the bodies' left side. CV5 and CV6 are fused at the right articular processes.	post-traumatic and degenerative origin	CV5 frontal left parietal right parietal mandible	The body of the CV5 presents fracture, it healed partially (only the inner part of the body is healed). Granular depressions on the endocranial surface of the frontal bone are present. Endocranial pitting. Strenghtened vessel impressions. Big cavity developed at the level of the left first molar, it reaches the mandibular body in its whole width. Both in and around the cavity pitting is visible.	fracture (partially healed) Infection (?) Infection (?) Infection (?) infection / abscess
3	65-33	Adultus	M	LV3 - LV4	Complete fusion of the articular processes, bodies are not involved. Fusion lines are smooth, no signs of infection, trauma or degenerative processes are found.	synostosis vertebralis	VT11	Depresions on the lower plate of the vertebral body.	Schmorl's node

4	106-74	Adultus	M	LV5 - S1	Complete fusion of the two segments.	sacralisation	right maxilla 2 orbita 1st left rib, CV1, left clavicle, 2 calcanei right humerus TV-e LV4 - LV5	Cavity in the alveolar process at the level of first molar. Pitting of the orbital roofs. Rim formations on the rib head, on the upper facets of the CV1, on the sternal end of the left clavicle and on the facies articularis talaris media. Lytic lesion is seen along the deltoid tuberosity of the right humerus. Small depressions and herniation both on the upper and lower plates of the thoracal vertebral bodies are seen. Small osteophytes are present on the VL4 and VL5 bodies.	infection / abscess cribra orbitalia (porotic stage) degenerative osteoarthritis enthesopathy Schmorl's node/ herniation spondylosis deformans
5	114-81	Senium	M	LV5 - S1	Left side fusion presents between the LV5 and S1, posterior elements are not involved.	unilateral (left) sacralisation	-	-	-
6	121-88	Maturus	M	LV5 - S1	Left side fusion between VL5 and S1, right side and posterior elements are not involved.	unilateral (left) sacralisation	LV5 - S1 ribs, left 1st metacarpal	Small osteophytes on the vertebral bodies are present. Rim formations on ribs' heads and tuberculi, on the distal end of the left 1st metacarpal.	spondylosis deformans degenerative osteoarthritis

11. Kunszállás-Fülöpjakab - Alkotmány TSZ (Avar age, 8th c. AD, 50 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	7	Senium	F	LV5 - S1	Fusion of the posterior elements of the two segments, bodies and lateral parts of the vertebrae are not involved.	sacralisation	CV2-CV4 CV2 - CV4, TV9 CV1 left femur, os coxae	Flattening and pitting of the facet surfaces. Moderated osteophytes on bodies' margins are seen. Opened posterior arch. Strong rim formations (mushroom-shape) on the femoral head and strong distortion with macroporosity and rims on the acetabular surface are found.	degenerative osteoarthritis spondylosis deformans spina bifida degenerative osteoarthritis

2	49	Adultus	F	LV2 - LV3	Fusion in both zygapophyseal joints and in the interior part of bodies. Fusion lines at the facet joints are partly recognizable. The height of the LV3 is small, the interior part of the body is conoidally emerges. The presence of some depressions/shallow cavities can be seen (spaces for pus?) on the upper anterior side of the body. LV2's body covers this area, its body's interior part is thinner than the outer parts. Both bodies' anterolateral surfaces are irregular, new spiculous bony elements are present.	non-specific infection (post-traumatic / compression fracture?)	TV12 LV-e	Depression on the lower endplate is found. It corresponds with the foramen canalis and with the left side of the vertebral body by channels (cloacal openings). The anterolateral surface of the vertebral body is characterized with irregular surface, new bone formations can be seen here. Slight distortion of the facet surfaces are present.	non-specific infection degenerative osteoarthritis
3	50	Maturus	F	LV5 - S1	Fusion of the zygapophyseal joints is seen, other parts are not affected	sacralisation	sacrum	Opened posterior arches.	sacrum bifidum

12. Orosháza - Béke TSZ (Avar age, 8th c. AD,100 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	10	Maturus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	TV-e, LV-e No CO, CC, ECL, HV	Slight osteophytes on the vertebral bodies.	spondylosis deformans
2	49	Maturus	M	LV5 - S1	Partial fusion of the two segments is found. Both zygapohyseal joints, left lateral processes and the left side of the vertebral bodies are involved.	sacralisation	LV5 TV-e, LV-e sternum 2 femora, 2 tibiae, 2 fibulae, 2 ossa coxae 2 clavicles, TV2 - TV3, TV10 - TV11 skull (lamda-region)	Ossification of the right iliolumbar ligament. New (flame-like) bone formations between the the two upper small facets of the vertebrae. Ossification of the anterior costosternal ligaments. Strengthened entheses. Distortion and new bone formation developed on the acromioclavicular surfaces and on the fovae. Round-shaped ossicle among the 2 parietal and the occipital bones.	OILL degenerative osteoarthritis OACSL enthesopathy degenerative osteoarthritis os apicis (anatomic variation)

3	62	Adultus	M	LV5 - S1	Complete fusion of the two segments.	sacralisation	front teeth endocranial surface right maxilla 2 orbita	Linear lesions on the labial surfaces. Branching vessel system. New bony apposition in the right sinus. Bilateral pitting on both orbital roofs.	linear enamel hypoplasia infection (?) sinusitis (infection) cribra orbitalia (porotic stage, bilateral)
4	63	Maturus	M	2 ossa coxae 2 ribs	Fusion of 2 ossa coxae at the level of the symphyses. The anterior surface of the fusion area is irregular, posterior side is smooth, no fusion line is recognizable here. Fusion of two ribs at mid-shafts. No periosteal reactions or callus formation; smooth surfaces are visible.	infectious origin (TB?) developmental (?) synostosis costalis	left os coxae right os coxae os frontale os parietale sacrum 2 tibiae right femur, left patella, 2 radii	The acetabulum became shallow and distorted, irregular new bony formation developed in and around the acetabulum. Rim formation is seen around the acetabulum. Multiple pitting on the endocranial surface. Dense and deep vessel impressions. Opened neural arches are seen. New bone formations are seen in the midshafts. Strengthened entheses.	tuberculous coxitis degenerative osteoarthritis unknown (infection?) unknown (ageing?) sacrum bifidum periostitis enthesopathy
5	72	Maturus	F	S5 - CcV1	Complete fusion of the two segments, all parts are involved.	sacralisation	TV-e	Slight distortion of the facet joints.	degenerative osteoarthritis
6	76	Maturus	M	sacrum - right os coxae	Joint fusion at the right sacroiliac joint is found, the joint itself is involved, no ligament ossification is seen (small bony outgrowths on the left side).	unknown (SNSA?)	2 calcanei, 2 humeri CV1 - CV2, LV1 - LV2, LV4 - S1 os occipitale	Strengthened entheses. Moderate osteophytes are present on the antero-lateral margins of the vertebral bodies. Bifurcated occipital condili	enthesopathy spondylosis deformans bifurcated condili occipitales (anatomic variation)
7	90	Adultus	F	LV5 - S1	Complete fusion of the two segments.	sacralisation	CV1 - CV2 maxilla lambda region	Moderate osteophytes on the antero-lateral margins of the vertebral bodies. Round-shaped cavity at the level of the tooth 26. Irregular shape bifurcated ossicle among the two parietals and the occipital bone.	spondylosis deformans abscess os apicis bifurcatum (anatomic variation)

13. Pitvaros - Víztározó (Avar age, 7-9th c. AD, 226 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	10	Senium	M	left os coxae - sacrum	Bony fusion of the two bones, ankylosis developed at the region of the iliac tuberosity. No ligament ossifiaction or sacroiliac joint involvement.	unknown (infectious origin?)	left os coxae	Macroporosity is seen on the auricular surface.	sacroileitis
							TV11	Moderated osteophytes are present on the upper margin of the endplate (stronger on the right side).	spondylosis deformans
							left os coxae	Irregular bony surface with both resorptive and proliferative bony elements is found between the acetabulum and greater ischiadic notch (acetabulum is not examinable).	infection
								Strengthened entheses.	
							2 ossa coxae, 2 patellae		enthesopathy
							CV3	Distortion (pitting, flattening) of the right upper facet.	degenerative osteoarthritis
2	49	Maturus	M	CV3 - CV4	Complete fusion the right side zygapophyseal joint (irregular bumpy surface, irregular fusion line) and in the right posterior part of vertebral bodies.	degenerative origin	CV3 - CV4	slight distortion of the left side facet joint surfaces.	degenerative oateoarthritis
							no CO, CC, ECL, HV		
3	51	Maturus	M	sacrum, 2 ossa coxae	Bony fusion of the three bones: auricular surfaces are intact, fusion developed periarticularly as a result of the anterior sacroiliac ligament ossification.	DISH	TV? - TV?	Right side anterior longitudinal ligament ossification with no fusion, intervertebral gap is not narrow, small facet joints are not involved.	OALL (DISH)
					Complete fusion of the two segments.		2 ossa coxae, 2 patellae	Strenghtened entheses.	enthesopathy (DISH?)
				LV5 - S1		sacralisation	2 ossa coxae	Distorted acetabular surface with new rim formations.	degenerative osteoarthritis
							VL5	Opened posterior arch.	spina bifida
							no CO, CC, ECL, HV		
4	114	Infantia I	U	2 right ribs	Complete fusion of the two ribs at costal heads. Fusion line is not visible, smooth surface is recognizable.	synostosis costarum (developmental defect)	-	-	-

5	115	Senium	M	2 ossa coxae - sacrum	Bilateral bony fusion caused by periarticular ligament ossification (auricular surfaces are intact).	DISH (?)	TV6 - TV12, LV4 TV7, TV9 - TV12 TV9 - TV12 2 ossa coxae, 2 patellae LV4 LV4, 2 ossa coxae	Right side ossification of the anterior longitudinal ligament with no fusion. Intervertebral gaps are not narrow, small facet joints are not involved. slight left side ossification of the anterior longitudinal ligament without fusion. Intervertebral gap is not narrow, small facet joints are not involved. Ossification of the ligamentum flavum. Strenghtened entheses. Pitting of endplates and osteophytes on the upper margin are seen. Distorted facet and acetabular surfaces with rim formations.	OALL (DISH) OALL (DISH) OLF (DISH) enthesopathy (DISH) spondylosis deformans degenerative osteoarthritis
6	215	Maturus	M	2 ossa coxae - sacrum CV7 -S1 ribs - TV-e	Bilateral fusion developed as a result of sacroiliac joint fusion. The fusion line is smooth, hardly recognizable. No ligament ossification is seen. Extensive bamboo-spine developed as a result of the complete fusion of syndesmophytes. Bilateral ankyloses of the costovertebral joints.	SPA SPA SPA	calcified soft tissue fragment (pleura)	calcified pleura fragments	TB (DNA+)

14. Sükösd - Ságod (Avar age, 7-9th c. AD, 171 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	19		F	CV7 - TV8	Strong angular kyphosis (Pott's gibbus)	TB (Pott's disease)	TV9	Vertebral body of the TV9 (anterior-lateral side) is rough surfaced.	periostitis (TB)
				CV7 - TV2	Complete fusion of the vertebral bodies (bodies of VT1-VT2 are partially destroyed). Posterior parts are fused only in the segments of TV1 - TV2.	TB	2 ribs	Necks are widened, flattened.	athrophy (TB - lack of use, fixation of chest)
				TV3 - TV8	Complete fusion of the vertebral bodies, bodies of VT3-VT4 are completely destroyed and disappeared. Posterior elements (arches, facets) are ankylosed.	TB	2 ossa coxae - 2 femori	The acetabuli are distorted, femoral heads are flattened and distorted, rim formations are seen around them. The femora are fixed in a severe flexion (about 90 degrees).	TB - coxitis tuberculosa
					Bilateral complete fusion of the costovertebral joints.		2 femora, 2 tibiae, 2 fibulae	Bones of the lower limbs are very thin, gracile as a result of the lack of use.	atrophy (lack of use)
				TV3 - TV4 - bilateral 3rd - 4th ribs		TB	no ECL, CO, CC, HV		
2	202	Maturus	M	TV3 - TV4	Bony fusion of the two segments at the posterior part of bodies and at all posterior elements. Fusion lines are straight, smooth fusion area is seen.	developmental alteration - synostosis vertebralis	mandible	Bony apposition on mandibular surface at the level of M2 -M3.	periostitis / osteomyelitis
							sacrum (S1)	Small osteophyte is found on the upper margin of the vertebral body.	spondylosis deformans
				TV7-TV10	Fusion of five vertebrae is recognizable. Bodies are involved at the level of the TV8 - TV11. Here complete fusions of the TV8 - TV10 and right side fusion of the TV10 - TV11 are present . In the latter vertebrae a well developed and joining (but without fusion) outgrows are visible on left side . The body heights of the TV8 - TV10s are not regular, their bodies are compressed a bit. Arches are involved in the TV7 - TV10 segments (very slight kyphosis is found), original gaps are not visible.	degenerative origin (?)	LV3 (or LV4?)	granular (diameter: 6 mm, depth: 5 mm) lesion on the right side of the upper plate is visible	unknown
							no CC, CO, rib PO, HV		

3	218	Adultus	F	TV2 - TV3	Fusion of the two vertebrae, only the posterior parts of the bodies are involved (no angulation, no other changes on other vertebral segments are present).	degenerative origin	sacrum left ribs right os coxae 2 tibiae, 2 fibulae	Pattern of cold abscess on ventral surface is present. The destroyment of left part at the level of S2, new, oval shaped cavity on the distal 2/3 of the left auricular surface is found. Spongy new bone formation and roughness is seen on the visceral side in the area of rib angle. Slight spiculous new bone formation on the lateral side of the ilium, above the acetabulum. Spongy new bone formations are present in the distal shafts.	TB periostitis (TB?) periostitis (TB?) periostitis (TB?)
4	220	Maturus	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of sternum.	unknown (developmental?)	sternum os parietale LV5 LV5 - sacrum	Bony appositions (radial phenomenon) are present around the costal incisures. Divided parietal bone. Separated vertebral arch. Bony fusion of the two segments.	OACSL anatomical variation - os parietale bipartitum spondylolysis sacralisation
5	299	Adultus	F	TV12 - LV1	Complete fusion of 2 vertebral bodies, instead of a thin straight line a bit wavy appearance is present. Facets are not involved.	degenerative origin	left tibia, fibula	Very thin and short bones are present, strongly distorted distal ends are recognizable. No cutmark, no signs of previous fracture are seen.	developmental alteration or traumatic (associated with amputation) alteration (?)
6	319	Adultus	M	CV6 - TV1 CV6 - CV7 CV7 - TV1 manubrium and corpus sterni	Fusion of the three vertebrae. CV6 and CV7 is ankylosed at the right articular process and at the right side of the posterior arch. Straight fusion lines and smooth fusion areas are seen. CV7 and TV1 is fused at the left facet joint and at the left posterior arch including spinous process. Straight fusion lines and smooth fusion areas are seen Complete fusion of the two elements.	synostosis vertebralis - developmental (?) synostosis vertebralis synostosis vertebralis - developmental unknown (developmental ?)	CV6 CV7 CV7 - TV1 left femur left femur	Opened posterior arch, assymetrical position is seen. Non-union fracture of antero-posterior direction in the vertebral body is found. Broken, shortened spinous processes are seen. Smooth surfaced bony apposition on the mid-shaft of the femur is found. Missing cortical is present on the inferior-anterior part of the femoral neck.	spina bifida trauma / non-healed fracture trauma / fracture (?) traumatic alteration - myositis ossificans -like extra bone mass anatomic variation (plaque)

15. Szarvas Site 68 (Avar age, 7-9th c. AD, 414 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	78	Maturus	M	right tibia - fibula	Functional distal tibifibular ankylosis is found as a result of the fusion of the two bones in the mid-shaft. It developed as a result of the tibial dislocated fracture. The joint itself is not involved., only functional distal tibiofibular ankylosis is seen.	post-traumatic ankylosis (functional ankylosis)	2 ossa coxae 2 humeri TV-e, LV-e	Slight rim formations are around the acetabuli. Strengthened entheses. Nodes and herniations are present on the upper and lower vertebral plates.	degenerative osteoarthritis enthesopathy Schmorl - node / herniation
2	92	Adultus	F	LV3 - LV4	Complete fusion of the vertebral bodies. The body of the LV3 seems to be collapsed on the right side, this phenomenon is resulted in scoliosis. Posterior vertebral elements are missing.	postraumatic (compression fracture) ?	-	-	-
3	109	Maturus	M	2 ossa coxae	Bilateral periarticular sacroiliac fusion is developed as a result of the ossification of the anterior sacroiliac ligaments above the auricular surfaces. Sacrum is missing, only the small fused areas are recognizable.	unknown (DISH?)	left os coxae CV1 - CV2, ribs, LV? 2 ossa coxae 2 tibiae, 2 ossa coxae, 2 femora, 2 patellae	Lytic lesions of the auricular surface is found. Strong distortion of the facet surfaces, the fovea and processus dentis, the rib heads. Slight new rim formation of the acetabuli. Strengthened entheses.	sacroileitis degenerative osteoarthritis degenerative osteoarthritis enthesopathy
4	173A	Adultus	M	VL5 - S1	Fusion of the two vertebral bodies and the lateral elements. Posterior zygapophyseal joints are not involved.	sacralisation	2 tali, left clavicle, LV-e TV10 - TV12 TV10 - TV11	Distorted joint surfaces can be seen. Slight osteophytes are present on the vertebral bodies' margins. Increased vessel impressions. Deep erosive lesions on the lower vertebral plates.	degenerative osteoarthritis spondylosis deformans hypervascularization (infection - TB?) infection - TB (?)

5	367	Maturus	M	2 ossa coxae - sacrum	Periarticular fusion above the sacro-iliac joint is present as a result of the ossification of the anterior sacroiliac ligament.	SPA (?)	2 femora, 2 ossa coxae, 2 tibiae, 2 patellae, 2 calcanei	Strengthened entheses.	enthesopathy
				VT? - VT? (lower thoracic spine	Complete fusion of the vertebral bodies by ossification of left longitudinal ligament.Intervertebral disc space and zygapophyseal joint gaps are preserved.	SPA (?)	all big joint surfaces, spine (foveae, facet joints)	Distortion of the joint surfaces.	degenerative osteoarthritis
				VT? - left rib	Complete fusion of the two bones by ossification of capsule elements. Facet joint space seems to be preserved.	SPA (?)	left os coxae	Shallow acetabulum, new bone formations around it	degenerative osteoarthritis and possible infection (?)
					complete fusion of the two elements		CV-e,TV-e, LV5	Anterior-side slight-moderate osteophytes are seen on the vertebral bodies.	spondylosis deformans
				corpus sterni - processus xyphoideus		unknown (developmental - SPA?)	LV2 - LV3	Right side anterior longitudinal ligament ossifiaction with no fusion.	OALL (DISH ?)
							LV4 - LV5	Left side anterior longitudinal ligament ossification with no fusion.	OALL (DISH ?)
							TV3, TV8	Herniation on the lower vertebral plates.	Schmorl-hernia

16. Székkutas - Kápolnadűlő (Avar age, 7-9th c. AD - 518 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	21	adult	U	S5 - VCc1	Complete fusion of the two segments.	sacralisation	sacrum	Lytic lesions on the auricular surfaces.	sacroileitis
							2 calcanei	Strengthened entheses.	enthesopathy
							TV-e	Depressions on the vertebral plates.	Schmorl's node
2	58	adult	M	S5 - VCc1	Complete fusion of the two segments.	sacralisation	-	-	-

3	67	Maturus	M	LV4 - LV5	Fusion of the two vertebrae as a result of the left side ossification of syndesmophytes. The right side of the vertebral bodies is not examinable, they are post mortem disappeared. Bilateral zygapophyseal fusion is also present, but the gap is not involved, only periarticular fusion is seen (capsular ligament ossification).	SPA (?)	LV4 LV4 - LV5 LV5 LV4 - LV5 MTP and PIP joints 2 ossa coxae, 2 femora, 2 tibiae 2 ulnae, 2 ossa coxae No OLF, CO, CC, ECL, rib PO	Big vertical outgrow (osteophyte) is seen on the upper plate's left side. Ligament ossification (interspinous ligaments) right from the 2 spinous processes. Slight supraspinous ligament ossification. Slight distortion of the facets. Erosive and proliferative lesions. Proliferative changes (distortion and moderate rim formations) in hip and knee joints. Strengthened entheses.	spondylosis deformans or SPA? OISL OSSL degenerative osteoarthritis degenerative osteoarthritis degenerative osteoarthritis enthesopathy
4	80	Maturus	M	4 + 2 TV? (mid thoracic spine) 4 left TV? - ribs 2 ribs	The posterior elements of the vertebrae (bodies are lost post mortem) are fused. Slight kyphosis is recognizable. Facet joints are completely fused on the right side, no fusion (except of partial periarticular fusion of one joint) on the left side is found. Ribs are ankylosed to the fovae on the left side. Ribs are fused at the head/neck of them.	SPA (?) SPA (?) SPA (?)	TV-e sacrum TV-e No CO, CC, ECL, rib PO	Distortion and new rim formations of the facets is seen. Distortion and rim formation at the auricular surfaces are present. Slight ossifiaction of the ligamentum flavum is seen.	degenerative osteoarthritis degenerative osteoarthritis - sacroileitis OLF
5	90	adult	U	LV3 - S1	Fusion of the 4 segments. Ankylosis developed at vertebral bodies by syndesmophytes. Zygapophyseal joint are involved, original joint lines are disappeared, bumpy appearance is seen instead of them.	SPA	LV5 LV3 - LV5 TV-e, LV1 - LV2	Ossification of the right iliolumbar ligament (left is not examinable). Ossification of the interspinous ligament. Slight-moderate osteophytes are found on the vertebral margins.	OILL (SPA) OISL (SPA) spondylosis deformans

6	118	adult	U	LV5 - S1	Complete fusion of the two segments.	sacralisation	2 ulnae	Newly formed bony rims in the proximal ulnae.	degenerative osteoarthritis
7	129	adult	U	S5 - VCc1	Complete fusion of the two segments.	sacralisation	TV-e, LV-e 2 femora 2 tibiae	Slight osteophytosis and macroporosity of the vertebral bodies. Distorted proximal and distal joint surfaces are found. Striation and porosity of the tibial shafts are present.	spondylosis deformans degenerative osteoarthritis periostitis
8	136	adult	U	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-
9	145	adult	U	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-
10	265	adult	U	S5 - VCc1	Complete fusion of the two segments.	sacralisation	LV-e 2 calcanei	Slight osteophytosis of the vertebral bodies is seen. Strenghtened entheses.	spondylosis deformans enthesopathy
11	292	Maturus	F	CV7 - TV1	Fusion of the vertebral bodies and the left posterior elements (both arch and facet joint). Fusion area is smooth, no fusion line is visible. Right side elementas are not involved.	degenerative origin	TV1	strong distortion (flattening, pitting) of the right side fovea.	degenerative osteoarthritis
12	326	adult	U	S5 - VCc1	Complete fusion of the two segments.	sacralisation	CV-e, TV-e, LV-e	Slight osteophytosis of the vertebral bodies is seen	spondylosis deformans
13	343	Adultus	F	TV5 - TV6 TV5 - TV6 - left rib	Complete fusion of the two segments, both the bodies and the posterior elements are involved. Bodies are slightly collapsed at the anterior part of them. The majority of them has disappeared. Fusion of the left side rib and the bodies of theTV5 andTV6. Capsular elements are ossified/calcified.	TB - Pott's disease TB	TV7 TV5 - TV12 TV7 - TV12 No CO, CC, ECL, rib PO	The upper plate of the vertebral body is irregular, slight irregular shaped depression is seen. Slight distortion of the facets and fovae of ribs Slight ossification of the ligamentum flavum	TB degenerative osteoarthritis OLF (TB-associated?)

14	350	adult	U	CV2 - CV3 LV5 - S1	Fusion of the vertebrae, only the facet joints are involved. Fusion lines are a bit bumpy and irregular surface is seen around them. Complete fusion of the two segments. All elements are involved.	degenerative origin sacralisation	CV-e left rib fragment rib fragments 2 ossa coxae, 2 ulnae	Strong distortion (osteophytes, macroporosity) of the vertebral bodies Callus formation in the midshaft of the rib. Roughness on the visceral surface of the ribs. Distortion of the acetabuli and the proximal ulnae.	spondylosis deformans healed fracture periostitis (TB?) degenerative osteoarthritis
15	380	adult	U	S5 - VCc1	Complete fusion of the two segments.	sacralisation	CV-e, TV-e, LV-e CV-e, 2 scapulae, 2 ulnae, 2 ossa coxae 2 ossa coxae	Slight-moderate osteophytes and macroporosity of the vertebral plates are seen. Distortion of the joints (facets, glenoid fossae, proximal ulnae, acetabuli) are present. Auricular surfaces present lytic lesions (macroporosity).	spondylosis deformans degenerative osteoarthritis sacroileitis
16	381	adult	U	LV5 - S1	Fusion of the involved segments at the anterior part of the bodies (other element are not examinable).	sacralisation	CV-e, 2 claviculae, 2 ulnae, 2 radii, 2 scapulae left radius CV-e	Distortion of the joints (facets, glenoid fossae, distal ulnae, distal radii, acetabuli) are present. Fissure is seen crossing the distal radial joint surface. Macroporosity is seen on the vertebral plates.	degenerative osteoarthritis healed fracture spondylosis deformans
17	399	Maturus 40-50	M	CV5 - CV6	Fusion developed at the right zygapophyseal joint, right side facet joint elements are lost post mortally. The fusion area is bumpy, fusion line is not seen. Vertebral bodies do not show any alteration.	degenerative origin	CV5 - CV7, TV8 - TV12, LV1 - s1 LV5 2 clavicles	Degenerative distortion of the vertebral bodies. Separated posterior arch. Distortion of the sternal ends.	spondylosis deformans spondylolysis degenerative osteoarthritis
18	514	adult	U	TV11 - TV12	Fusion of the two segments by a left side osteophyte. Vertebrae are very porotic, the heights of te bodies are decreased. The vertebral body of the TV12 is biconcave as a result of a compression fracture.	posttraumatic origin (compression fracture)	CV-e, TV-e, LV-e CV-e, TV-e, LV-e ribs	Slight-moderate ostephytes developed on the vertebral bodies' margins. Slightly distorted zygapophyseal surfaces can be seen. The heads of the ribs are distorted.	spondylosis deformans degenerative osteoarthritis degenerative osteoarthritis

19	531	adult	U	S5 - VCc1	Complete fusion of the two segments.	sacralisation	-	-	-
20	544	adult	U	S5 - VCc1	Complete fusion of the two vertebrae.	sacralisation	-	-	-

17. Derekegyház – Ibolyásdomb (Early Árpád age,11-12. c. AD, 56 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	6	Maturus	M	TV? - TV?	Complete fusion of the vertebral bodies is seen (posterior elements are missing). Irregular shaped lytic lesions on the upper and lower plates of vertebral bodies. The height of the lower vertebral body is decreased as a result of collapse, but not wedge form developed.	postraumatic (compression fracture) and infectious processes (?)	TV? - TV?	Lover plates presents lytic changes.	TB (?)
							rib, 2 tibiae, sacrum, os coxae, 2 femora	New, spongious bony appositions.	periostitis
							right humerus , 2 ossa coxae , 2 ulnae , right scapula, 8 TV-e, LV1-LV5, right clavicle	Distortion of the joint surfaces is seen. Caput humeri, acetabuli, proximal and distal ulnar ends, glenoid cavity, acromion, sternal end, fovae of the ribs	degenerative osteoarthritis
							right 1st MC, 2 1st MT, leg phalanges	Distortion of the joint surfaces, lytic cavities are also seen.	rheumatoid arthritis
							LV1 - VLV5	Small osteophytes on the vertebral bodies are present.	spondylosis deformans
							3 right ribs	small thickening (callus) at mid-parts	healed fracture
							1 left rib	Non-union fracture at the mid-shaft of the rib, extensive new spongious bony appositions are found.	fracture (non-union)
									periostitis
							right clavicle	Non-union fracture close to the sternal end associated with strong (active) inflammatory process (new bone formation).	fracture (non-union)
							2 humeri, 2 ulnae, 2 radii, 2 ossa coxae, 2 femori, 2 tibiae, 2 calcanei	Strenghtened entheses.	enthesopathy
							no CO, CC, ECL, HV		

18. Hódmezővásárhely - Nagysziget (Conquest period - early Árpád age, 10-11th c. AD, 131 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	10 (j)	Maturus	F	TV12 - LV1	Osseous fusion of the two bodies is found, the fusion line is wavy, newly built irregular rough bony appositions are seen on the involved vertebral bodies' anterolateral sides. The body of the TV12 is wedge-shaped, VL1 presents only slight loss of body height. Moderate kyphosis developed. Both side zygapophyseal joints are involved too.	infectious origin or TB (?)	TV-e, LV-e TV7 - LV4 no CO, CC, HV, ECL, rib PO	Slight - moderate osteophytes at vertebral bodies. Moderate-strong ossification of ligamentum flavum.	spondylosis deformans OLF
2	20	Senium	M	corpus sterni - processus xyphoideus	Fusion of 2 parts of sternum	developmental (?)	LV-e, TV-e left parietal 2 calcanei	Slight - moderate osteophytes of the vertebral bodies are seen. Carved, oval-shaped lytic alteration (4x2,5 cm) is present close to sagittal suture. Strengthened entheses.	spondylosis deformans symbolic trephination (not finished) enthesopathy
3	48	Senium	M	CV2 - CV3	Ankylosis of the left facet joint. Bumpy fusion area and irregular fusion line are seen. Fusion continues at left posterior arch too.	degenerative origin	CV3 LV1 - LV3 LV4 - LV5 2 ulnae, 2 radii, 2 tibiae, 2 fibulae, 2 femora, 2 humeri TV7 - TV12	Distortion of the facet surfaces (the left one is much more developed). Moderate osteophytes of the vertebral bodies, macroporosity and new bony appositions of the endplates are seen. Ossification of the right side anterior longitudinal ligament without fusion. Strengthened entheses. Herniation on the upper and lower vertebral plates.	spondylosis deformans spondylosis deformans OALL enthesopathy Schmorl-herniation

							2 claviculae, 2 ulnae, 2 radii, CV-e, TV-e, LV-e LV5 mandible no OPL, OLF, No HV, ECL, CC, CO, rib PO	Distortion (new rim formations) of the articular surfaces are seen. separated posterior arch hypoplasiac, distorted mandibular heads	degenerative osteoarthritis spondylolysis developmental defect / hypoplasia
4	79	Maturus	M	CV6 - CV7 TV7 - TV8 corpus sterni - processus xyphoideus	Fusion of two vertebral bodies by bilateral ossifiaction of anterior longitudinal ligaments. No gap joints are involved, disc spaces are preserved. Fusion of two vertebral bodies by bilateral ossifiaction of anterior longitudinal ligaments, no gap joints are involved. Disc spaces are intact. Fusion of the two parts of sternum.	DISH (?) DISH (?) unknown - developmental (?)	CV6 - CV7 CV6 CV7 TV6, TV9 - TV12 TV7 - TV8 TV-e 4 ribs right tibia, 2 femora TV1 - TV12, LV1 - LV5 TV-e, sacrum, 2 clavicles, metatarsals 2 ossa coxae, 2 tibiae, 2 fibulae, 2 humeri, 2 clavicles, 2 radii, 2 ulnae, 2 patellae, 2 calcanei, tarsals, metatarsals	Slight ossification of the supraspinous ligament. Strong ossification of the posterior longitudinal ligament. Moderate distortion of the lower facet surfaces. Slight ossification of the anterior longitudinal ligament. Slight ossification of the supraspinous ligament. Moderate ossification of the ligamentum flavum. Small thickening (callus) is found at the angle (4 cases) and at close to the sternal ends (3 cases). New spongious bone formation in the shafts is seen. Moderate osteophytes of the vertebral bodies are present. distortion of articular surfaces strengthened entheses	OSSL (DISH?) OPLL (DISH?) degenerative osteoarthritis OALL (DISH ?) OSSL (DISH?) OLF (DISH?) healed dislocated fracture periostitis spondylosis deformans degenerative osteoarthritis enthesopathy

5	87	Infantia II	U	TV6 - TV7	Ankylosis of the two vertebrae at right side of the vertebral arches . Zygapophyseal joints are not involved (bodies are not examinable).	synostosis vertebralis - developmental (?)	left parietal	Narrow branching endocranial lesions (strengthened venous impressions).	infection (?)
6	88	Senium	M	CV2 - CV3	Ankylosis of the two vertebrae, the fusion involves only the right zygapophyseal joint. The fusion area is bumpy and rough surfaced, the fusion line is irregular. Right posterior corner of bodies are fused too.	degenerative origin	CV3 2 rib fragments right ulna 2 ossa coxae CV-e, TV-e, LV-e 2 clavicles	The right side of the CV3's inferior facet presents srtong macroporosity and distortion. Left side is slightly involved. Strong thickening on the mid-shafts of the ribs (two callus / rib) Small thickening on the distal part of the shaft is present, slight dislocation is seen. Lytic lesions on the auricular surfaces. Slight - moderate osteophytes of thevertebral bodies are present. Strengthened entheses (imp. ligam. clavicularis).	degenerative osteoarthritis healed fracture healed fracture degenerative osteoarthritis - sacroileitis spondylosis deformans enthesopathy

19. Homokmégy-Székes (Conquest period - early Árpád age, 10-11th c. AD, 185 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	47	Senium	M	TV5 - TV9 corpus sterni and processus xyphoideus	Complete fusion of the five segments caused by the ossification of the right side anterior longitudinal ligament (facet joints and disc spaces are preserved). Complete fusion of the two segments.	DISH developmental or DISH (?)	TV1 - TV4 TV10 TV11 - TV12 TV11 - TV12 2 femora, 2 tibiae, 2 ossa coxae	Ossification of the anterior longitudinal ligament (both sides), no fusion Right side ossification of the anterior longitudinal ligament, no fusion. Ossification of the longitudinal ligament (both sides), no fusion. Ossification of the ligamentum flavum. Strengthened entheses.	OALL (DISH) OALL (DISH) OALL (DISH) OLF (DISH) enthesopathy

							right scapula, right humerus right scapula CV-e, TV-e, LV-e, two ankles, elbows	Deep fissure is seen on the distal part of the glenoid fossa. Eburnation and bony outgrows around the joint surfaces (humeral head and glenoid fossa). Newly built spongious bony appositions are present beside the spina scapulae.	fracture degenerative osteoarthritis (posttraumatic ?) periostitis - infection
2	73	Senium	M	LV5 - S1	Complete fusion of the two segments.	sacralisation	S4 - S5 mandible (left side), 2 scapuilae, 2 clavicles, left ulna, humerus (elbow joint)	Opened posterior arches are seen. Strong distortions of the joint surfaces are present, slight pitting is seen on the surfaces.	sacrum bifidum (partial) degenerative osteoarthritis
3	75	Maturus	F	CV2 - CV3	Bony fusion of the two segments, the left zygapophyseal joint is involved. The fusion line is irregular, the area of the fusion is bumpy.	degenerative origin	CV3 - CV4 VC1 V-e frontal	Distortion and pitting in the right zygapophyseal joint. Opened right foramen transversarium. Porotic vertebral bodies are present. Small, lentille-like, smooth surfaced outgrowth on the frontal bone.	degenerative osteoarthritis anatomic variation - developmental defect osteoporosis (metabolic) osteoma (benign tumor)
4	93	Maturus	M	S5 - Cc1	Complete bony fusion of the two segments.	sacralisation	vertebrae CV-e, TV-e, LV-e	Moderate osteophytes are present on the antero-lateral margins of the vertebral bodies. Distortion of the facet joints is seen.	spondylosis deformans degenerative osteoarthritis

5	210	Maturus	F	LV5 - S1 LV5 - S1 LV2 - LV3 VC2-VC3	Fusions between the lateral processes and between the posterior elements of the two segments are present. Fusion between the two segments as a result of the presence of a right side bony bridge (ossification of the anterior longitudinal ligament). Fusion between the two segments by a right side bony bridge is seen (OALL?). Fusion between the left side zygapophyseal joint is seen. Fusion line is irreagular, the fusion area is bumpy.	sacralisation (coexistence with DISH) DISH (coexistence with sacralisation) DISH (?) degenerative origin	sacrum 2 ossa coxae, 2 tibiae, 2 femora, CV2 - dens axis, CV1 - fovea dentis, CV3 - CV4 2 calcanei, right patella, bones of the legs CV1 ribs	Opened posterior arches (S1-S5) are present. Distortion of the articular surfaces and slight pitting is seen. Strengthened entheses. Divided upper joint surfaces. Rough visceral and posterior surfaces of the ribs are present.	sacrum bifidum - complete degenerative osteoarthritis enthesopathy developmental alteration - anatomical variation periostitis (infection?)
6	241	Maturus	M	right os coxae - sacrum manubrium sterni - corpus sterni	Periarticular bridging at the superior part of the auricular surface is present. Auricular surfaces are preserved. Complete fusion of the two segments.	DISH ? Developmental (?)	2 ossa coxae TV4 - TV7, LV1 - LV5 TV7 - TV12 LV1 - LV5, TV1 - TV6, CV1 - CV7 TV5 - TV11 TV1 - TV12 sternum left clavicle, 2 ossa coxae, 2 calcanei, 2 patellae, 1st ribs CV1 - CV7 TV6	Macroporosity of the auricular surfaces s seen. Small osteophytes are present in both sides of the vertebral bodies. Slight anterior longitudinal ligament ossification without fusion is present on the right side of vertebral bodies (no chondrocalcinosis). Pitting and eburnation of the zygapophyseal facets are found. Ossification of the yellow ligament is present. Distortion of the costal foveae is seen. Ossification of the anterior costosternal igaments is found (radial phenomenon). Strengthened tendon and ligament insertions are present. Macroporosity of the verteral endplates is present. Smooth-walled cavity	sacroileitis spondylosis deformans OALL (DISH?) degenerative osteoarthritis OLF (DISH?) degenerative osteoarthritis OACSL enthesopathy spondylosis deformans vascular alteration (aneurism?)

7	276	Maturus	M	S5 - VCc1	Complete fusion of the two segments.	sacralisation	-	-	-
8	286	Senium	M	S5 - VCc1 TV3 - TV4	Complete fusion of the two segments Complete fusion of the vertebral bodies and fusion along the posterior arches (no bumpy or irregular surface is seen, smooth fusion-lines are present).	sacralisation synostosis vertebralis (developmental)	TV1 - TV12 TV5 - TV6 LV4	Slight distortion of the fovae of the ribs. Slight distortion of the zygapophyseal joint surfaces is developed. Small osteophyte is present on the anterior margin of the superior endplate.	degenerative arthritis degenerative arthritis spondylosis deformans

20. M5 motorway - Kiskundorozsma, site 26-78 (Conquest period, 10th c. AD, 4 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	229/3	Maturus	M	LV5 - S1	Fusion of the two segments. Lateral parts are fused, but bodies, posterior elements and facet joints are not involved.	sacralisation	LV5 LV-e 2 clavicles, right os coxae sternum rib	Opened posterior arch at the spinous process is present. Small osteophytes are seen on the margins of the vertebral bodies. Strengthened entheses. Porosity is seen on the visceral surface. Roughness is present on the visceral surface.	spina bifida spondylosis deformans enthesopathy infection (?) infection (?)

21. Magyarhomorog - Kónyadomb (Conquest period - early Árpád age, 10-11th c. AD, 368 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	37	Senium	F	TV2 - TV5	Osseous fusion of 4 vertebrae is present. The vertebral body of the TV3 is wedge shaped, the fusion involves only the posterior elements (facet joints, posterior arches). The fusion lines are irregular, slight roughness is visible in these areas.	posttraumatic - degenerative origin (compression fracture)	TV12 LV3 - LV4 sternum CV5 - CV7 LV1 - LV2, S1	The body of VT12 is vedge shaped. Biconcave vertebral bodies. Large, deep (fissure-like) lesion on the dorsal side is present. Macroporosity and small osteophytes on the vertebral plates are seen. Slight osteophytosis is present on the vertebral plates.	compression fracture - osteoporosis osteoporosis osteoporosis spondylosis deformans spondylosis deformans

							CV3 - CV7, TV1, TV12 - VL5 TV11 - TV12 2 scapulae, 2 ossa coxae no CO, CC, ECL, rib PO, HV	Distorted, macroporositic facet surfaces. Distortion of the costal foveae. Distortion and new rim formations of the glenoid cavities and the acetabuli are present.	degenerative osteoarthritis degenerative osteoarthritis degenerative osteoarthritis
2	41	Senium	M	LV2 - LV3 VL5 - S1	Complete fusion of the two vertebrae. The ankylosis involves the posterior-interior part and the right anterior margins of the vertebral bodies. Zygapophyseal joints are involved too (the joint gap did not disappeared completely). The right part of the VL2's vertebral body is collapsed, its height is smaller than the opposite side's height. This phenomenon is resulted in severe scoliosis. Bilateral fusion of the two segments is found, the lateral processes and the right anterior parts of the bodies are fused.	posttraumatic (fracture) (?) sacralisation	LV2 LV5 no CO, CC, ECL, rib PO, HV	The upper and lower vertebral plates are not parallel, this alteration is resulted in right side curvature of the spine. Opened posterior arch.	scoliosis spina bifida

3	80	Maturus	M	left tibia -femur	The fusion is recognizable in the femorotibial joint; neither femoropatellar nor tibiofibular joints are involved. Medial and lateral condyles are completely fused. Extra bony bridges formed between the two bones on the posterior side. The fusion line at the level of the original joint gap is not recognizable. Extensive new bone formation of cancellous structure (more than 1.5 cm in its height) developed on the antero-lateral side of the lateral femoral condyle. The individual seems to be used both the left and right legs after the development of the ankylosis. Strong distortion and lipping of the acetabuli, the femoral head and bones of the right knee refer to the overuse of the extremities. Fusions of 2+2 vertebral bodies are present as a result of the right side ossification of the anterior longitudinal ligament. Chondrocalcinosis is seen, intervertebral gaps and zygapophyseal spaces are preserved.	septic arthritis - posttraumatic ankylosis	left femur	Strong callus formation in the left femoral diaphysis is in association with a fracture. The lesion healed with dislocation, as a result of the dislocation the left limb is shortened with about 5 centimeters.	healed fracture
								Round-shape drainage cloacae are seen at the level of the fracture on both the anterior and posterior sides of the femur. The presence of them may be associated with osteomyelitis caused by some infection; the pathogens may have reached the bone from the environment as a result of an opened fracture.	infection - periostitis - osteomyelitis
							left femur, tibia	Rough periosteum, new bony apposition on the shaft, cloacal openings at the level of the fracture	periostitis
							left femur, os coxae	Strong distortion and rim formations at the femoral head and in and around the acetabulum is seen.	degenerative osteoarthritis
				TV6 - TV7, TV8 - TV9		DISH	right tibia , femur	Distortion and strong lipping affect the knee joint (overuse the right side)	degenerative osteoarthritis
							left fibula right clavicle 8 ribs	Callus formation is at mid-shaft. Ribs: - mid-shaft: 6, - neck: 2	healed fracture
							right humerus, right scapula, ulna	Strong distortion of the humeral head, the glenoid cavity and the ulnar head is seen.	degenerative osteoarthritis
							TV5	Ossification of the right anterior longitudinal ligament with no fusion.	OALL (DISH)
							TV10 - TV11	Ossification of the right and left anterior longitudinal ligaments with no fusion.	OALL (DISH)
							TV12	Moderate osteophytes on the anterior margin of the vertebral body are present.	spondylosis deformans
							LV1 - LV5	Moderate distortion of the joint surfaces is seen.	degenerative osteoarthritis
							no CO, CC, ECL, rib PO, HV		
4	110			LV5 - S1	Complete left side fusion of the two segments	complete, unilateral sacralisation	no CO, CC, ECL, rib PO, HV	-	-

5	214	Maturus 50-59	M	VC2 - VC4	Complete fusion of 3 vertebrae is seen. Vertebral bodies, arches and articular processes are also involved. Irregular surface around the facet fusions, slight right side scoliosis are seen.	degenerative origin	vertebrae	Slight- moderate-strong exostoses are present in the vertebral bodies.	spondylosis deformans
							TV1 - TV12	Slight ossification of the ligamentum flavum is seen.	OLF
				S5 - Cc1	Complete fusion of the two segments.	sacralisation	CV1 - CV2	Strongly distorted joint surfaces of the atlanto-axial joint.	degenerative osteoarthirits
							LV1 - LV5	Slight distortion of the facets.	degenerative osteoarthirits osteoporosis
							LV1, LV4 - LV5	The height of the vertebral bodies is decreased, concave upper endplate is visible in the VL.	degenerative osteoarthritis
							right tibia, fibula	Distorted distal joint surfaces are present.	enthesopathy (post-traumatic?)
							right tibia, fibula	Ossification of the ligaments are present beside the distal tibio-fibular joint (no fusion).	
							2 right ribs	Small thickening (callus) on the mid -shaft of the bones.	healed fracture
							2 clavicle	Distorted sternal and acromial ends	degenerative osteoarthritis
							sternum	Ossification of the anterior costosternal ligaments (radial appearance).	OACSL
							corpus sterni	Oval foramen in the distal 1/3 on the corpus	foramen sterni -anatomical variation
							no CO, CC, ECL, rib PO, HV		

6	217	Maturus	M	TV5 - TV11	Complete bony fusion of 7 vertebrae as a result of the ossification of the anterior longitudinal ligament: TV5 -TV9: right side, TV9 - TV1: both side. Facet joints are not involved, dsic spaces are preserved.	DISH	CV5 - CV6, TV12 - LV3	Ossification of the right anterior longitudinal ligament without fusion.	OALL (DISH)
							TV12, LV2, LV4	Ossification of the left anterior longitudinal ligament without fusion.	OALL (DISH)
							sternum,	Moderate ossification of theanterior costosternal ligaments (radial phenomenon).	OACSL (DISH?)
				LV5 - S1	Complete bony fusion of the two segments as a result of the right anterior longitudinal ligament. Right side facets and ligaments between the both side of the posterior arches are also involved.	DISH (or coexistence with SPA?)	LV1 - LV5	Ossification of the supraspinous ligaments without fusion.	OSSL (DISH)
							2 ossa coxae, bones of legs, 2 humeri	Strengthened entheses.	enthesopathy (DISH)
				sacrum - right os coxae	Periarticular fusion above the auricular surface as a result of the sacroiliac ligament ossification. The sacroiliac joint is not involved.	DISH			
							LV1 - LV5, 2 clavicles, 2 scapulae, ribs	Distorted joint surfaces of the zygapophyseal joints, in the glenoid cavities, in the acromial end of the clavicles and on the heads of the ribs.	degenerative osteoarthritis
							LV5	The height of the right anterior side of the body is decreased, small round shape opening is in its centre.	infection (?)
							no CO, CC, rib PO, HV; ECL not examinable		
7	310	Senium	F	CV2 - CV3	Complete bony fusion is present in vertebral bodies and in all posterior elements. A bit bumpy appearance is seen on the anterior side of the body fusion.	synostosis vertebralis - developmental or degenerative origin (?)	LV5 no CO, CC, ECL, rib PO, HV	The left side of the posterior arch is not fused to the rest of the vertabra.	spondylolysis
				LV4	The spondylolysed VL5 posterior arch (left lateral part and spinous process) is fused to VL4's posterior arch.	spondylolysis -physical stress (?)			

8	370	Maturus	M	LV2 - LV3	Complete bony fusion of the vertebral bodies by bilateral syndesmophyte-like ossifications, bamboo-vertebra-like phenomenon is seen. The beginning of the fusion of the zygapophyseal joints are present, no ligament or capsular element ossification are founfd here.	SPA (or degenerative osteoarthritis?)	LV1 LV2 - LV3 TV11 TV12 - LV1, LV4 no other vertebral or sacro-iliac lesions no CO, CC, ECL, rib PO, HV	Vertical bony outgrows are present on the anterior side of the vertebral body (right side: strong, left side: slight). Osteophytes are seen on the upper plate of the LV2 bilaterally and on the right side of f the lower plate of LV3. Ossification of the left side anterior longitudinal ligament (or non-typical syndesmophyte?) developed on the left side of the vertebral body's lower margin. Slight ligament ossification is present in the left side of the posterior arches.	degenerative oseoartritis or SPA (?) degenerative osteoarthritis syndesmophyte ossification or OALL (?) ligament ossification

22. Sárrétudvari - Hízóföld (Conquest period - early Árpád age, 10-11th c. AD, 269 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	31	Maturus	F	left 1st and 2nd ribs LV5 - S1	Osseous fusion of two right side ribs in the mid-shafts is present. Fusion of the two segments, the lateral parts are involved. Vertebral bodies remained intact, the posterior elements are missing post mortally.	developmental defect, segmentational failure sacralisation	-	-	-

2	39	Senium	M	TV12 - LV1 S5 - VCc1	Fusion developed by a smooth surfaced osteophyte-like bony bridge between the the two segments on the left anterior side of the bodies. No posterior elements (neither arches, nor zygapophyseal joints) are involved. Collapse of the vertebral body of the VL1 is seen. Complete fusion of the two segments.	post-traumatic / compression fracture sacralisation	LV1 right 1st and 2nd metatarsals CV2 LV3 - LV4 CV3 - CV7, TV6 - TV10, LV2 - S1 2 tali	Concave upper vertebral plate Osteophytes, erosion and eburnation in the distal ends of the metatarsals. Distortion and eburnation of the dens axis. Distortion of the zygapophyseal joint surfaces. Small - moderate osteophytes on the margins of the vertebral bodies are seen. Ossification of the talus and 2 ossa trigonum.	compression fracture degenerative osteoarthritis degenerative osteoarthritis degenerative osteoarthritis spondylosis deformans ossification defect
3	81	Senium	M	TV? - TV? (mid thoracis spine)	Bony fusion of the vertebral bodies. Irregular fusion line is seen, the fusion area is bumpy. Posterior elements are missing.	degenerative origin (spondylosis deformans)	TV-e sternum	Slight osteophytes are present on the vertebral bodies' margins. Extensive ossification of the costosternal cartilages are present on the sternal manubrium.	spondylolysis deformans unknown (ageing?)
4	182	Senium	M	CV3 - CV4 TV4 - TV5 right proximal and middle palanges (hand)	Fusion of the two segments. Vertebral bodies and zygapophyseal joints are involved. Irregular fusion lines are seen. Fusion of the posterior parts of the vertebral bodies is present, ankyloses of the facet joints are also seen. The proximal and the middle phalanx is ankylosed. The fusion fixed the elements in flexed position (cca 80 degrees), irregular fusion line and new bony projection of irregular structure are seen around the fusion area. The middle phalanx seems to be slipped to the palmar direction, it may be in association with the presence of a (sub)luxation.	degenerative origin (spondylosis deformans) degenerative origin degenerative (and posttraumatic - ((sub)luxation) origin?	CV-e, TV-e 2 ossa coxae 2 clavicles, 2 distal tibiae, 2 tali, carpals, phalanges of the legs and hands, VT-e	Distortion of the facet joints are developed. Lytic lesions (macroporosity) are seen on both auricular surfaces. Distortion and lytic lesions are present in numerous articulations of the upper and lower extremities and in costal foveae of the thoracic spine.	degenerative osteoarthritis sacroileitis osteoarthritis

5	237	Maturus	M	3 right cuneiformes - navicular right calcaneus - cuboid	In the calcaneocuboid joint complete fusion is seen, the joint is not recognizable. Around the fusion area slight proliferative periosteal reaction is seen, but no other osseous lesions are found. The second-fourth fusions are seen among the navicular and the three cuneiforms, where the joint is not recognizable. The shape of the navicular is strongly distorted, its base presents macroporosity and flattening, the length of it is extremely shortened. The latter two ankyloses formed among the three cuneiforms; while at the posterior parts complete fusions developed, the anterior parts of the cuneiforms are not involved. Cloacal opening are not seen in these bones, but moderate periosteal reaction is recognizable on the bone surfaces. The majority of the not affected articulations of the foot is strongly distorted, very strong flattening and lipping are found in the talo-navicular, tarso-metatarso joints, erosive lesions are present in the left calcaneotalar joint.	leprosy (DNA +)	2 ossa coxae 2 ossa coxae right tibia 2 maxillae 2 maxillae	The hip joints are distorted. Strengthened entheses are seen in the hips. Slight periosteal reaction (striation and slight porous bony apposition) in the right tibial shaft is found. Moderate widening of the pyriform aperture with the loss of the nasal spina are found. erosive periosteal reactions localized to the maxilla, slight, smooth surfaced depressions on the anterior surfaces of the both side maxilla (below the pyriform aperture) and new bony deposits in the sinuses are found.	degenerative osteoarthritis enthesopathy periostitis (leprosy) leprosy periostitis, sinusitis (leprosy)

23. Szatymaz- Vasútállomás (10-12th c. AD - 286 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	1	Maturus	F	LV5 -S1 corpus sterni - manubrium sterni - processus xyphoideus	Complete fusion of the two segments. Fusion of the three parts of the sternum.	sacralisation developmental defect	sacrum 2 calcanei Skull is lost.	Opened vertebral arches. Strengthened entheses.	sacrum bifidum (complete) enthesopathy

2	11	adult	F	TV2 - TV3	Fusion of the vertebral bodies and posterior elements: - bodies: only small, left side ankylosis is found, the rest seems to be intact, - posterior elements: complete fusion is found, even spinous processes are involved. Smooth fusion area is visible, borders of the original joints and bony elements are not recognizable. The fusion is resulted in a slight left side scolisos of the upper spine.	synostosis vertebralis - developmental defect	TV3 right ulna right calcaneus no CC, CO, ECL, rib PO	Distortion (new bone formation) on the right lateral process (costal fovea) is found. Widened flat bony exostosis on the coracoid process is present Strengthened entheses	degenerative osteoarthritis (scoliosis?) enthesopathy enthesopathy
3	14	adult	F	S5 - CcV1	Complete fusion of the two segments.	sacralisation	left ulna left calcaneus 2 tibia, 2 femora no CO, CC, ECL, rib PO	Distortion, slight angulation and callus formation on the distal end of the ulna are seen. Strengthened enthesis. Slight new bony appositions on the long bones' shafts are present.	healed fracture enthesopathy periostitis
4	15	Maturus	M	corpus sterni - manubrium sterni	Complete fusion of the two segments.	developmental (?)	no CO, CC, ECL	-	-
5	17	Adultus	F	corpus sterni - manubrium sterni	Fusion of the two parts of the sternum.	developmental (?)	LV5 - S1 V? sternum skull - left parietal skull - calvarium no CO, ECL, rib PO	New joint surfaces developed between the lateral parts of the two segments. Increased blood vessels on the lateral part of the body are seen. Not united 1st and 2nd sternal segments. 4 cm long narrow lesion close to the lambdoid point is found. Porosity /pitting on the two parietals and occipital squama is present.	partial sacralisation hypervascularization (infection ?) developmental defect healed cutmark cribra cranii (porotic) - posttraumatic(?)

6	21	Maturus	M	corpus sterni - manubrium sterni S5 - Cc1	Fusion of the two parts of the sternum. Complete fusion of the two segments.	developmental (?) sacralisation	2 radii, right humerus, sternum 2 calcanei, fibula maxilla, mandible no CO, CC, ECL, rib PO, HV	Distorted articular surfaces (caput radii, incisura clavicularis) and eburnation on capitulum radii are present. Strengthened entheses. Oval cavities at the level of - maxilla: left I1, M1 - mandible: right I1 are found.	degenerative osteoarthritis enthesopathy infection - abscess
7	32	Maturus	F	LV5 - S1	Complete fusion of the two segments is seen.	sacralisation	LV5	Opened neural arch at the spinous process is seen.	spina bifida
8	38	Maturus	M	corpus sterni - manubrium sterni	Fusion of the two parts of the sternum.	developmental (?)	sacrum (S4-S5) right ulna 2 calcanei skull -calvarium no CO, ECL, rib PO, HV	Opened vertebral arches. Small thickening (callus) in the mid-shaft of the ulna is present. Strenghtened entheses. Pitting on the frontal, parietals and occipital.	sacrum bifidum (partial) healed fracture enthesopathy cribra cranii (porotic)

9	39	Adultus	F	2 left ribs	Osseous bridges developed at the level of the costal tubercles. Smooth surface, sharp edges, distinct line in the middle of the fusion area are seen.	synostosis costarum - developmental (?)	sacrum (S1 - S5) sacrum (S1) sacrum (S1) skull - calvarium skull - left frontal skull - frontal skull - calvarium right tibia	Opened vertebral arches. Non-united left side lateral elements between the S1 and S2. Distorted upper facets. Pre-mature closure of the sagittal suture. Round-shape (1.5 cm in its width) shallow lesion close to the lambdoid point is present. Porotic lesions /pitting on the orbital roofs are found. Porosity (pitting) on the 2 parietals along the sagittal suture. Bony spongious apposition in the distal-shaft is present.	complete sacrum bifidum lumbalisation degenative osteoarthritis sutural pre-mature synostosis trauma - healed cut cribra orbitalia (porotic, bilateral) cribra cranii (porotic) periostitis no ECL, rib PO, HV

10	40	Adultus	F	LV1 - LV2	2 cm wide smooth surfaced bony arch between the right antero-lateral parts of the vertebral bodies is present. Intervertebral space is preserved. Zygapophyseal gaps have disappeared as a result of some ossification process (ossification of capsular elements?). Ligaments between spinous processes are also ossified. Slight supraspinous and right side collateral ligament ossification without fusion are present.	SPA	LV1	Ossification of the posterior longitudinal ligament (only the upper part of the body is involved).	OPLL
							LV2	Slight ligament ossification (intertransversal ligament) between the right lateral process with no fusion.	OITL
								Distortion of zygapophyseal joint surfaces.	
							LV1 - LV2	Irregular shape depressions on the vertebral plates are present.	osteoarthritis
					complete fusion of the two segments.		TV8 - TV9, TV12, LV2, LV4	Opened vertebral arches (S1-S5).	Schmorl-nodes
				S5 - CcV1		sacralisation	sacrum	increased blood vessels.	sacrum bifidum (complete)
							TV-e	Thickening (callus) in the mid-shaft.	hypervascularisation (infection?)
							left rib	Slight ossification of the costosternal ligaments (radial appositions).	healed fracture
							sternum	Slight bony apposition on the proximal shaft is found.	OACSL
							2 tibiae		periostitis

11	48	Senium	M	sacrum - right os coxae	Periarticular ankylosis is found at anterolateral angulation of the auricular surface caused by sacroiliac ligament ossification. Auricular surfaces are intact.	unknown (DISH ?)	2 ossa coxae, 2 calcanei sacrum sacrum 2 TV? VL1-VL2 right ulna 2 tibiae, 2 fibulae no CC, CO, ECL, HV, rib PO	Strengthened entheses. Plain sacrum, missing ventral concavity. Opened neural arches (S1 - S5). Strong vertebral osteophytes (no ligament ossification) at the right side of the vertebral bodies without fusion Small thickening in the mid-shaft of the ulna. Dislocation is not seen. Bony appositions are present in the mid-shafts.	enthesopathy sacrum plana (developmental defect) sacrum bifidum (complete) spondylosis deformans (related to DISH ?) healed fracture periostitis
12	53	Adultus	F	S5 - CcV1	Complete fusion of the two segments	sacralisation	LV2 - LV3 left rib (9th or 10th) right tibia 2 fibulae, 2 calcanei mandible	Ligament ossification at costal processes (stronger at left side). Callus formation in the shaft. Strong bony apposition on the mid-shaft Strenghtened entheses. Single striations on the front teeth are present.	OITL healed fracture periostitis enthesopathy linear enamel hypoplasia
13	58	Maturus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	skull	Pitting at the lambda region (both the parietals and othe ccipital are involved).	cribra cranii (porotic stage)

14	59	adult	M	LV5 - S1	Fusion of the two segments. The anterior part of the vertebral body is completely, the right facet joint is partly involved. Other vertebral parts arenot affected.	sacralisation	LV4 TV-e, LV-e rib right radius, 2 calcanei	Separated posterior arch. Slight osteophytes on the vertebral bodies' margins are present. Callus formation in the shaft is seen. Strenghtened entheses.	spondylolysis spondylosis deformans healed fracture enthesopathy
15	67	adult	U	LV5 - S1	Fusion of the two segments, the lateral parts of the vertebrae are involved. The bodies, posterior arches and facet joints are intact.	sacralisation	S1 2 fibulae no CO, CC, ECL, HV, rib PO	Opened vertabral arch Slight bony apposition in the mid-shaft.	sacrum bifidum (partial) periostitis
16	78	Maturus	M	S5 - CcV1 corpus sterni - processus xyphoideus	Complete fusion of the two segments. Fusion of the two parts of the sternum.	sacralisation developmental defect	corpus sterni corpus sterni corpus sterni 2 tibiae VL1 - VL5 no CO, CC, ECL	Small, round shape opening. Distorted joint surfaces of the costal incisures are present. Slight ssification of the anterior costosternal ligaments are present (radial bony apposition). Slight spongious bony apposition in the midshaft. Slight osteophytes on the vertebral bodies' margins.	anatomic variation - fenestratio sterni degenerative osteoarthritis OACSL periostitis spondylosis deformans
17	81	adult	F	S5 - CcV1	Complete fusion of the two segments.	sacralisation	right ulna	Callus formation is present close to the proximal end.	healed fracture
18	87	Maturus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	LV5 TV-e, LV-e sacrum skull skull no ECL, rib PO, HV	Unilateral rupture of the vertebral arch is seen. Granular depressions on the vertebral plates are seen. Macroporosity on the auricular surfaces is present. Linear, smooth edged depression on the left parietal and occipital is seen. Sharp-edged paralell cutmarks on the left parietal are recognizable, no signs of infection or healing are present.	spondylolysis Schmorl - nodes sacroileitis healed cutmark cutmarks (cause of death?)

19	90	Maturus	M	sacrum - right os coxae	Ankylosis above the auricular surface is seen. It developed as a result of the sacroiliac ligament ossification. Small lytic lesions on auricular surfaces are present.	unknown (DISH ?)	TV13 TV9 - TV10 left os coxae 2 ossa coxae, 2 femora, 2 patellae CV3 - TV9, TV1 - TV13 VTV7 - TV8 CV2 - CV4, TV7, TV9 - Tv10, LV5 - S1, ribs sacrum left clavicle 1 right , 1 left rib 2 femora right radius no skull	extra numerous vertebra Ossification of the right anterior longitudinal ligament with no fusion. Slight ossification of the sacroiliac ligament with no fusion. Strengthened entheses. Degenerative alterations of the vertebral bodies, small osteophytes. Slight ossification of the ligamentum flavum is seen. Distorted facet joints are present. Opened vertebral arches (S1 - S5). Strong callus formation in the mid-shaft, the bone is shortened, the presence of post-traumatic infection cannot be ruled out. Thickening in the mid-shaft. Slight new bony appositions of the mid-shaft are present. Radial tuberosity of irregular structure, new bone-formations are found.	developmental defect - extra vertebra OALL (DISH) OSIL (DISH?) enthesopathy (DISH ?) spondylosis deformans OLF (DISH?) degenerative oseoarthritis sacrum bifidum (complete) healed fracture - osteomyelitis (?) healed fracture periostitis non-specific infection (osteomyelitis?)
20	100A	Adultus	F	LV5 - S1	Fusion of the two segments. Vertebral bodies and the lateral parts and left zygapophyseal joint are ankylosed, theright facet joint is not involved.	sacralisation	-	-	-

21	101	Adultus	F	S5 - CcV1 CcV1 - CcV2	Complete of the three segments	sacralisation	S1 TV-e left rib (8th or 9th) left humerus	Opened posterior arch. callus formation in the shafts Dislocation and callus formation in the mid-shaft is seen.	sacrum bifidum (partial) healed fractures healed fracture
22	105	Adultus	M	corpus sterni - processus xyphoideus	Fusion of the two parts of the sternum	developmental (?)	corpus sterni TV? left rib 2 tibiae, 2 radii, 2 ulnae, right humerus no skull	Ossification of the anterior costosternsal ligaments (radial bony apposition). increased vessels on the lateral part of the vertebral body Roughness on the visceral surface of the rib. Strengthened entheses. Distorted articular surfaces are present.	OACSL infection - hypervascularisation periostitis (infection?) enthesopathy degenerative osteoarthritis
23	108	Senium	F	S5 - CcV1	Complete fusion of the two segments.	sacralisation	TV-e S1, LT-e, TV-e S1 no skull	Increased vessels on the lateral parts of the bodies. Slight-moderate osteophyes on the vertebral bodies' margin. Distortion and macroporosity of the small facets are found.	hypervascularisation (infection?) spondylosis deformans degenerative osteoarthritis
24	110	Inf I-II	U	2 right ribs	Osseous bridge is present abetween the costal tubercles (smooth surface, sharp edges).	synostosis costarum - developmental defect	TV-e, LV-e, sacral segments only skull fragments	Increased blood vessels on the anterior and lateral parts of the vertebral bodies.	infection - hypervascularisation

25	112	Maturus	M	LV5 - S1	Complete fusion of the two segments.	sacralisation	LV5 LV5 LV3 LV3 LV3 LV5, LV3, TV1 (?) sternum 2 patellae, 2 calcanei 2 fibulae no skull	Opened vertebral arch is present. Concave upper plate covered with new bony apposition is seen. Biconcave vertebral plates are found. Light, porotic vertebral body. Osteophytes on the upper margin of the vertebral body is found. Distortion of the facet surfaces. Ossifiaction of the anterior costo-sternal ligaments (radial bony appositions). Strengthened entheses. Slight new bony apposition in the mid-shafts.	spina bifida ostoporosis compression fracture osteoporosis spondylosis deformans degenerative osteoarthritis not known enthesopathy periostitis
26	119	Maturus	F	LV5 - S1	Complete fusion of the two segments.	sacralisation	LV3 - LV5 no CO, CC, ECL	Slight-moderate osteophytes on the vertebral bodies' margins are present.	spondylosis deformans

27	121	Senium	F	corpus sterni - manubrium sterni	Complete fusion of the two segments.	developmental (?)	TV7 - TV12 TV1 - TV12 TV8 - TV12 sacrum sacrum 2 ossa coxae right radius, right ulna, 2 femora, 2 tibiae left rib no CO, CC, ECL	Increased vessels on the lateral part of the vertebral body. Distorted facet surfaces and fovae are present. Osteophytes on the anterior margins of the vertebral bodies. Bony apposition of the anterior side of the S1 is seen. Irregular anterior surface (not active process) is present. Slight new spongious bony apposition on the iliac wings (lateral side, above the acetabuli) is found. Bony apposition in the mid-shafts and distal metaphyses. Bony appositions (inactive periostitis) on dorsal side are present.	hypervascularisation (infection - TB?) degenerative osteoarthritis spondylosis deformans periostitis cold abscess / infection (TB?) periostitis (TB?) periostitis (TB?) periostitis (TB)
28	130	Maturus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	TV-e rib left tibia - fibula no CO, CC, ECL	Increased vessel impressions on the lateral parts of the vertebral bodies. Callus formation in mid-shafts. Moderate bony apposition is seen in the mid-shafts.	hypervascularisation (infection ?) healed fracture periostitis
29	132	Senium	F	CV2 - CV3	Ankylosis of the right-side facet joint is present. The fusion area is bumpy, the outgrows are identical with distorted facet rims).	degenerative origin	CV3 - TV1 CV4 - CV5 no skull	Distorted facet surfaces (pitting, rim, eburnation) are present, thethe alterations are stronger on right side. Slight osteophytes o the anterior margins of the vertebral bodies.	degenerative osteoarthritis spondylosis deformans

30	154	Maturus	M	S5 - CcV1 CcV1 - CcV2	Complete fusion of the three segments.	sacralisation	LV5 LV5 - S1 rib left os coxae left femur no CO, CC, ECL, HV	Separated posterior arch. Slight osteophytes on the vertebral bodies ' margins. Callus formation in the mid-shaft is seen. Enlarged acetabulum with newly built rim formations. Distorted femoral head is seen.	spondylolysis spondylosis deformans healed fracture degenerative osteoarthitis degenerative osteoarthritis
31	158	adult	F	LV5 - S1	Fusion of the two segments, only the lateral parts are involved.	sacralisation	S1 sacrum	Opened posterior arch. Porous bony apposition on the ventral side of the sacrum.	sacrum bifidum (partial) periostitis
32	5 (stray find)	Adultus	F	S5 - VCc1	Complete fusion of the two segments.	sacralisation	- no CO, CC, ECL	-	-
33	34 (stray find)	Adultus	F	LV5 - S1	Fusion of the two segments, the posterior part of the vertebral bdies and the lateral parts are involved.	sacralisation	TV-e	Increased vessels on the lateral sides of the vertebral bodies.	hypervascularization (infection?)
34	41 (stray find)	Adultus	M	LV5 - S1	Complete fusion of the two segments.	sacralisation	sacrum rib left patella	Undulating surface on the ventral side of the sacrum. Callus formation in the mid-shaft. Strengthened entheses.	cold abscess (TB?) healed fracture enthesopathy

24. Bácsalmás - ÓHomokbánya (late Middle ages - early modern times, 16-17th c. AD, 481 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	80A	Senium	M	CV5 - CV6	Fusion of the two vertebrae. Lateral and posterior parts of the bodies and the upper part of the left facet surfaces are involved.	degenerative origin	CV3 - TV1	Erosive lesions (macroporosity) on the vertebral discs, small osteophytes on anterior margins are seen. Distorted facet surfaces.	spondylosis deformans
				TV11 - TV12	Fusion of the two vertebrae. Bodies and right facet joints are involved, fusion line is irregular, proliferative bony lesions are seen. Vertebral body of TV11 is slightly collapsed (V-shape).The upper plate of it presents irregular shaped elongated depressions together with cavities inside. Slight osteophytes on both bodies.	post-traumatic (osteoporotic fracture?)	CV3 - TV1, TV12 - LV5 TV1 - TV12 sacrum - 2 ossa coxae TV11 - TV12	Distorted costal foveae. No fusion, only multiple subchondral erosions are seen. slight ossification of the ligamentum flavum	degenerative osteoarthritis degenerative osteoarthritis sacroileitis (related to SPA?) OLF (SPA?)
				LV1 - LV5	Bamboo-spine-like appearance. Vertebral bodies are fused by syndesmophytes: LV1 - LV2: bilateral, LV2 -LVL3: right and anterior side, LV3 - LV4: no fusion, left side osteophytes are present, LV4 - LV5: left and anterior side. The left zygapophyseal joint of LV3 -LV4 is fused (bumpy fusion line).	SPA (?) or degenerative origin (?)	TV10 - TV12 LV3 - LV5 2 ossa coxae, 2 calcanei 2 parietals right maxilla	Slight ossification of the supraspinous ligament. Chondrocalcinosis on the lower plate of the LV3 and upper plate of LV4 and LV5. Strengthened entheses. Extensive oval shaped depressions are present. New cancellous bony appositions in the right sinus.	OSSL (SPA?) chondrocalcinosis enthesopathy senile biparietal osteoporosis. Sinusitis (infection)
2	85	Maturus	M	S5 - VCc1	Complete fusion of the two segments.	sacralisation	ribs	Rough ventral surfaces of the ribs.	non-active periostitis (TB)
				corpus sterni - processus xiphoideus	Complete fusion of the two segments.	unknown (developmental?)	ribs, sternum	Slight distortion of joint surfaces of the rib heads and the clavicular incisures.	degenerative osteoarthritis
				3 right ribs (7th - 9th)	Bony bridge developed among the 3 ribs (2-3 cm far from the costal head) on the ventral surface. Its surface is rough,the same roughness is visible on the ventral surface of the ribs.	TB (DNA +)	2 tibiae, 2 fibulae sternum	Strenghtened entheses. Ossification of the anterior costosternal igaments (radial appearance).	enthesopathy OACSL (unknown)

3	90	Senium	M	LV1-LV5	Ossification of the vertebrae by syndesmophytes (but they are a bit OALL-like..). Bodies: LV1 - LV4: bilateral fusion, LV4 - LV5: left and anterior side. Zygapophyseal fusions: LV1 - LV2: left side (partial, gap is visible), LV2 - LV4: bilateral zygapophyseal fusion (gap is partially visible), LV4- LV5: left side (gap is visible; joint capsule ossification),	SPA	TV1 - TV11 LV3-LV5 TV4 - TV7 LV2 - LV4 CV3-CV7, TV4 - LV1 CV1-CV7, TV2 - TV6 2 calcanei, 2 femoral diaphyses	Slight ossification of the ligamentum flavum. Very strong ossification of the ligamentum flavum. Moderated-strong ossification of the supraspinous ligament. Strong ossification of the interspinous ligament. Small - moderated osteophytes on vertebral margins. Distortion of the facet surfaces (rim formations, flattening, lytic alterations). Strenghtened entheses.	OLF (SPA?) OLF (SPA?) OSSL (SPA?) OISL (SPA?) spondylosis deformans degenerative osteoarthritis enthesopathy
4	104	Adultus	F	TV3 - TV4	Vertebral fusion at all posterior elements and at the posterior part of the vertebral bodies. Fusion lines are not visible, fusion areas are smooth.	synostosis vertebralis (deelopmental)	TV3 LV5 5 left, 3 right ribs 2 femora, 2 tibiae 2 orbita	Vertebral body's upper plate is not horizontal, this alteration resulted in righ side curvature of the spine. The shape of the right lateal part of the vertebrae has changed, new articular surface is seen. Remodeled surface on the visceral surfae, close to the sternal end. Remodeled surface in the shafts. Pitting on both orbital roofs are present.	scoliosis sacralisation (partial, incomplete) periostitis (TB?) periostitis cribra orbitalia (porotic stage)

5	132	Senium	F	right radius, all carpals and 2nd, 3rd, 4th metacarpals	Bones are fusioned with osseous bridges. Dorsal side: fusions seems to be the result of non-ligamentous ossification but fusion between the small joint surfaces. Pitting is seen on both carpals and the three metacarpal. Palmar side:smooth surfaced bony bridges form an almost complete, flat, osseous mass (ligament ossification). Palmar margin of the radial distal end fused to the scaphoid. It can be the result of the same process (ligament ossification).	non-specific infection (?) palmar ligament ossifications or post-traumatic origin (?)	right radius right radius right MC1, MC1 - carpals right ulna , radius 2 patellae 2 ossa coxae	Carpal joint surface presents new bony appositions of irregular structure. Distorted ulnar incisure with eburnation. Proliferative and destructive lesions on joint surfaces. Strengthened entheses. Distorsion of the acetabular surface.	osteoarthritis degenerative osteoarthritis degenerative osteoarthritis enthesopathy degenerative osteoarthritis
6	142	Adultus	F	S5 - CcV1	Complete fusion of the two segments.	sacralisation	sacrum	Opened posterior arches (S1 - S5).	sacrum bifidum (compllete)
7	153	Senium	F	right tibia - fibula - talus	Both tibia and fibula are thicker than normal, rough surface can be seen. Shinbone, fibula and talus are fused, tibio-fibular, tibio-talar and fibulo-talar ankyloses developed. Talus is fixed in plantar flexion (≈ 15-20 degrees). Ankylosis partly seems to be the result of ossification of soft tissue compartments (joint capsule, ligaments).	non-specific infection - pyogenic osteomyelitis and spetic arthritis	right tibia, fibula right talus calcaneus right os coxae , femur right ossa coxae 2 humeri vertebrae ribs 2 maxillae	Thickened tibia (in almost all of its length), and new bone-formation (roughness and remodeled surfaces) at shafts are seen. Distortion of the inferior and anterior talar and superior calcaneal surfaces. Distortion of articular surface (overuse of the opposite side extremity). Lyic lesions on the auricular surfaces are present. Distortion of the articular surface of the humeral heads. Slight - moderate osteophytes at vertebral bodies. Rough visceral surfaces are seen. Remodeled new bony appositions are present in the sinuses.	periostitis degenerative osteoarthritis degenerative osteoarthritis sacroileitis degenerative osteoarthritis spondylosis deformans periostitis sinusitis (infection)

8	159	Senium	M	TV7 - TV8	Vertebral fusion as a result of right side ossification of the anterior longitudinal ligament. Intervertebral gaps are not narrow, small facet joints are not involved.	DISH	TV3-TV6, TV8 lower, TV9 - TV11 upper and lower, TV12 lower margins	Right side ossification of the anterior longitudinal ligament with no fusion.	OALL (DISH)
				LV5 - S1	Fusion of the two segments by zygapophyseal joint capsule ossification, by the ossification of the ligamentum flavum by the ossification of the supraspinous ligament and by the interspinous ligament. Left zygapophyseal joint space is disappeared, but the right one is partly recognizable.	DISH	TV3 - TV9	Slight-moderate ossification of the supraspinous ligament.	OSSL (DISH)
							TV8 - TV11	Slight ossification of the ligamentum flavum.	OLF (DISH)
							LV3-LV4	Left side osteophytes.	OALL (DISH)
							LV5	Ossification of the iliolumbar ligament at the VL5's right transverse process.	OILL (DISH)
							LV5	Depressions on the upper plate.	Schmorl's node
							2 patellae, calcanei, tibiae	Strenghtened entheses.	enthesopathy
							sternum	Bilateral ossification of the frist rib's cartilage.	ossification (DISH or ageing?)
							sternum	strongly distorted clavicular incisures (flattening, macroporosity, rim formations).	degenerative osteoarthritis
							TV10 - TV12	Distortion of costal fovae.	degenerative osteoarthritis
							2 tibiae, right fibula	Striation on the long bones' midshafts.	periostitis
9	165			corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	sacralisation	-	-	-
10	166	Adultus	F	LV5 - S1	Fusion of the two segments. Posterior parts of the vertebral bodies and lateral transverse processes are involved, the rest of the bodies and zygapophyseal joints are not affected.	sacralisation	LV5	Distortion of the upper facet surfaces.	degenerative arthritis
							S1 - LV5	Ligament ossifiaction between the right anterolateral corner of the vertebral bodies.	OALL (?)
							3 right, 2 left ribs	Knobby, remodeled visceral surface iof the neck, rough texture on the visceral surface are seen.	periostitis
							2 femora, 2 tibiae	Remodeled surfaces of the shafts are present	periostitis

11	173	Maturus	M	TV5 - TV7, TV10 - TV11	Ankylosis caused by the ossifiaction of the right side anterior longitudinal ligament. Intervertebral gaps are not narrow, small facet joints are not involved in the fusion (only strong osteoarthritis is seen).	DISH	TV4 lower, TV7 lower, TV8-TV9 upper-lower margins	Ossifiaction of the right side anterior longitudinal ligament with no fusion.	OALL (DISH)
							TV12 - LV5 upper-lower margins	Slight bilateral ossifiaction of the anterior longitudinal ligament with no fusion.	OALL (DISH)
							TV2 - TV7	Slight ossification of the supraspinous ligament.	OSSL (DISH)
							2 patellae, 2 clavicles 2 calcanei, 2 ilii	Strenghtened entheses.	enthesopathy
							sternum	Bilateral ossification of first rib cartilage in the manubrium sterni.	ossification (DISH or ageing?
							sternum	Ossification of the anterior sternocostal ligaments (radial appearance).	OASCL (DISH?)
							right femur	Posterior side bony projection on the mid-shaft (laterally from linea aspera).	myositis ossificans
							CV-e, TV-e, LV-e	Moderate osteophytes at vertebral bodies are seen.	spondylosis deformans
							CV2 - CV7	Strong distortionand eburnation on the facet joint surfaces.	degenerative osteoarthritis
							TV-e, LV-e 2 clavicles	Slight distortion of facet surfaces and costal foveae, lytic lesions at both ends of the clavicles are present.	degenerative osteoarthritis Schmorl-nodes
							TV3 - LV4	depressions on the vertebral plates.	Schmorl-nodes
							LV5	Separated vertebral arch. Rupture line is: left side: inferiorly from upper facet, right side: between the lower facet and spinous process).	spondylolysis
							thoracic spine	As a result of right side OALL, left side lateral curvature developed.	scolisosis

12	174	Adultus	F	S5 - CcV1 corpus sterni - processus xyphoideus	Complete fusion of the two segments. Complete fusion of the two elements.	sacralisation unknown (developmental?)	sternum sternum	Round-shape opening in the distal corpus sterni. Irregular lytic surface structure is seen on the posterior side of the sternal manubrium.	fenestratio sterni (anatomic variation) infection
13	175	Maturus	F	S5 - CcV1 corpus sterni - manubrium sterni	Complete fusion of the two segments. Complete fusion of the two elements, no fusion line is visible.	sacralisation unknown - developmental (?)	9 right, 2 left ribs skull	Porous new bone apposition on the visceral surfaces close to the sternal ends. Endocranial changes (SES) are present.	periotitis infection
14	179	Maturus	M	LV5 - S1 manubrium sterni - corpus sterni	Complete fusion of the two segments at all elements. Complete fusion of the two segments. The fusion line is partly visible, bumpy area on the anterior surface is present (it is probably caused by some ligament ossification).	sacralisation unknown (ageing?)	sternum sternum	Periostael reaction (porous spongious apposition) on the ventral side of the corpus sterni Slight ossification of the anterior costosternal ligaments (radial phenomenon).	periostitis OACSL
15	195	Senium	F	TV11 - TV12 LV5 - S1	Vertebral fusion of the anterior and central part of the vertebral bodies. Smooth, thin line is visible at the anterior margins, no other alteration is found. Fusion of the two segments that affects the lateral and posterior part of the bodies. Posterior arches, zygapophyseal joints and anterior parts of the bodies are not involved.	synostosis vertebralis (developmental) sacralisation	2 ossa coxae left ulna left fibula 2 talocrural joints patella, calcaneus	shallow and distorted acetebulum small thickening at mid-shaft new bony appositions on shafts distorted articular surfaces strong entheses	slight coxal dysplasia healed fracture periostitis (mild) degenerative osteoarthritis enthesopathy
16	196	Senium	F	S5 - CcV1 corpus sterni - manubrium sterni - processus xyphoideus	Complete fusion of the two segments. Complete fusion of the three parts of the sternum.	sacralisation developmental	-	-	-
17	202	Maturus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	-	-	-

18	204	Maturus	M	S5 - CcV1 manubrium sterni - corpus sterni - processus xyphoideus	Complete fusion of the two segments. Complete fusion of the three parts of the sternum.	sacralisation developmental (?)	-	-	-
19	205	Maturus	F	corpus sterni - manubrium sterni	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
20	208	Senium	M	LV5 - S1	Strong bilateral bony bridges are present between the two vertebrae. Smooth surface (OALL ?) and lytic lesions in the anterior part can be seen at the border of two segments. Fusion of vertebral bodies along the whole intervertebral space is present. Zygapophyseal joints are involved too, irregular fusion line is visible. Fusion of the right lateral elements is also seen as a result of the lateral ligament ossification between LV5's costal process and S1 wing.	TB	sacrum LV3- LV5 TV1 - TV3 right tibia, fibula left fibula left tibia 2 humeri 2 ossa coxae, 2 tibiae 3 ribs right tibia, 2 tali, 2 calcanei	Lytic lesion on the ventral side of sacrum (S1-S2), signs of cold abscess are seen. Strong bony outgrows (paravertebral bony mass) on the left side of the vertebral bodies, osteophytes (?). Mild and moderate bony outgrows (osteophytes) at the vertebral bodies' margins. Strong thickening of the shafts are seen. Bony ends are dislocated, small pitting is found around the healing area. No cloacal openings. Strong thickening at the distal 1/3 of the fibular shaft. Missing medial malleolus, macroporosity on the new surface. Distortion of articular surfaces at the articulatio cubiti, acetabuli and at talocrural joints. Thickening of mid-parts of ribs. Strengthened entheses.	TB TB (?) spondylosis deformans healed dislocated fracture healed fracture non-united fracture degenerative osteoarthritis healed fracture enthesopathy
21	209	Adultus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	-	-	-
22	218	Adultus	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-

23	241	Maturus	F	corpus sterni - processus xyphoideus	Complete fusion of the two elements.	developmental (?)	sternum	Slight ossification of the anterior costosternal ligaments.	OACSL
24	244	adult	M	S5 - CcV1 corpus sterni - processus xyphoideus	Complete fusion of the two segments. Complete fusion of the two elements.	sacralisation unknown (ageing?)	sternum sternum LV2 - VL3 LV2 LV-e, S1 2 first ribs left femur left femur	Slight distortion of the clavicular incisures. Strong ossification of the anterior costosternal ligaments (radial bony appositions); at the level of the first rib a horizontal bilateral ossification crossing the entire manubrium is seen. Ossification of the supraspinal ligaments. Small overhanging osification of the facet capsulary ligament at the left inferior zygapophyseal surface. Slight osteophytes on the anterior margin of the vertebral bodies. Pitting and distortion of the rib heads. Extensive ossification on the anterior side of the femur. It emerges upwards from the intertrochanteric line. Shortened femoral neck.	degenerative osteoarthritis OACSL OSSL OFCL spondylosis deformans degenerative osteoarthritis ossification of the iliofemoral ligament (OIFL) developmental defect
25	258	Senium	F	corpus sterni - manubrium sterni	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
26	265	Maturus	M	S5 - CcV1	Complete fusion of the two segments	sacralisation	LV4 (or LV5?) ribs	Separated posterior arch. Porous new bony appositions on the visceral side of the ribs.	spondylolysis periostitis (TB?)
27	267	Adultus	F	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	2 calcanei 2 humeri	Strengthened entheses. Distorted heads.	enthesopathy degenerative osteoarthritis

28	271	Maturus	M	S5 - CcV1 corpus sterni - processus xyphoideus	Complete fusion of the two segments. Complete fusion of the two elements.	sacralisation unknown (developmental?)	LV5 LV5 sternum	saggital V-shaped 'depression' on the upper plate of the vertebral body. Invomplete fusion at the right zygapophyseal joint. Slight ossification of the anterior costosternal ligaments (radial phenomenon).	butterfly vertebra (?) lumbalisation OACSL
29	273	Senium	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	LV-e	moderate osteophytosis	spondylosis deformans
30	277	Senium	M	S5 - CcV1 corpus sterni - processus xyphoideus	Complete fusion of the two segments. Complete fusion of the two elements.	sacralisation unknown (developmental?)	sternum sternum sternum S1 S1 S1	Round-shape perforation of the corpus sterni. Slight ossification of the anterior costostrernal ligaments. Distortion of the clavicular incisures (stronger on the right side). Porosity on the vertebral plate and slight eosteophytosis on the lateral parts of the body. Distortion of the upper facet surfaces. Opened posterior arch.	fenestratio sterni (anatomic variation) OACSL degenerative osteoarthritis spondylosis deformans degenerative osteoarthritis sacrum bifidum (partial)
31	282	Maturus	M	VL4 - VL5	Complete fusion of the two vertebral bodies by syndesmophyte-like connections. Left zygapophyseal joint is involved, while the right one presents only partial fusion.Irregular bony area is seen around them.	SPA (?)	LV4 - LV5 TV8 - TV10 TV11 CV2 - LV4 right humerus, ulna, radius	Ossification of the interspinous ligament. Slight ossification of the right anterior longitudinal ligament. Ossification of the ligamentum flavum. Slight - moderated osteophytes on the vertebral bodies. Very strong distortion of the bony elements of the elbow; both erosive and hypertrophic alterations are seen. Moderate degeneative changes (erosive forms) are present in the proximal humerus and distal ulna and radius.	OISL OALL OLF spondylosis deformans degenerative osteoarthritis

32	287	Senium	M	S5 - VCc1 manubrium sterni - corpus sterni - processus xyphoideus	Partial fusion of the two segments by bilateral sacrococcygeal ligament ossification. Complete fusion of the three elements	unknown developmental (?)	sacrum vertebrae 1st ribs right rib left clavicle sternum 2 clavicles, 2 humeri, 2 ulnae, 2 radii, 2 femori, 2 fibulae right os coxae right os coxae left fibula left fibula TV-e	Partially opened vertebral arch. Moderate osteophytes at the vertebral bodies. ossification of the costosternal cartilage. Bifurcation of a right side rib. Moderated thickening (callus) at the mid-shaft, slight angulation is seen. Slight ossification of the anterior costosternal ligaments . Bilateral distortion of the articular surfaces of the shoulder, the sterno-clavicurar trhe elbow , the hip and the knee joints. Periarticular ligament ossification at the anterior angle of the auricular surface. No fusion, no auricular surface distortion are seen. Distortion of the acetabular region, new bony rim is present. Ossification of a muscle insertion on the lateral side close to the fibular head. Thickening as a result of a callus formation at the mid-shaft of the fibula. Slight osteophytosis on the margins of the vertebral bodies.	sacrum bifidum (partial) spondylosis deformans ossification of the costosternal cartilage bifurcated rib (developmental defect) healed fracture OASCL degenerative osteoarthritis OASIL ossification (trauma or DISH?) enthesopathy healed fracture spondylosis deformans
33	316	Maturus	M	corpus sterni - proceccus xyphoideus	Fusion of the two elements	developmental (?)			
34	326	Adultus	M	S5 - CcV1 manubrium sterni - corpus sterni	Complete fusion of the two segments. Complete fusion of the two elements.	sacralisation developmental (?)	sternum	Not united 1st and 2nd segments of the sternum.	developmental defect - segmentation shifting
35	327	Maturus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	VL4 - VL5	Slight marginal osteophytes.	spondylosis deformans

36	328	Maturus	M	LV5 - S1	Complete fusion of the two segments, all parts are involved.	sacralisation	2 orbital roof	Pitting on the roof.	cribra orbitalia
37	329	Maturus	F	S5 - CcV1 corpus sterni - processus xyphoideus	Complete fusion of the two segments. Complete fusion of the two parts of the sternum.	sacrralisation developmental (?)	VT-e, VL-e	Slight - moderate osteophytes are present.	spondylosis deformans
38	330	Maturus	M	VL5 - S1	Fusion of the two vertebral segments, lateral parts, posterior elements and the right and posterior parts are involved.	sacralisation	sternum TV-e S1 - S1 LV5	Slight ossification of the anterior costosternal ligament. slight ossification of the ligament flavum. Strong ossification of the supraspinous ligament. The uper plate of the vertebra is not horizontal, it may result in lateral (left direction) curvature of the spine.	OACSL OLF OSSL scoliosis
39	331	Maturus	M	right tibia - fibula	The right proximal tibiofibular joint is ankylosed. The fusion line is irregular, the surrounding area of the articulation is puffed, and new bone formation is recognizable. The fibula's proximal end is slightly curved. The tibial condyles are extremely distorted, both eburnation on the lateral plate and big osteophytes are present in and around the tibial condyles. The lateral condyle's plateau is not horizontal, its lateral part is depressed, and a skew joint surface formed. The tibial deformity may be a consequence of an oblique fracture of the proximal tibia's lateral condyle. The event may also involved the proximal fibula, but the degenerative joint disease developed after the fracture may also take part in the development of the fusion. The traumatic event resulted in a severe genu valgum deformity.	posttraumatic - degenerative	right tibia right tibia, femur, patella bones of the upper and lower limbs and girdles right tibia , fibula vertebrae vertebrae 3 ribs	The tibial plateau is nothorizontal, this phenomenon may be explained ba some fracture involving the proximal tibia. Very strong distortion of the knee joint, large lipping and eburnation are seen on the joint surfaces. Slight-moderate distortion of almost all of the joints. Strenghtened entheses Slight-moderate osteophytes are present. Slight-moderate distortion of the facet joint surfaces is seen. Callus formation is seen in the mid-shafts. Two of these ribs are fused at the level of callus formations.	healed fracture degenerative osteoarthritis degenerative osteoarthritis enthesopathy spondylosis deformans degenerative osteoarthritis healed fracture

				CV5 - CV6 (?) S5 - CcV1	Fusion of the two segments, all elements are involved. The anterior side of the bodies are characterized with perpendicular direction ossification of ligaments. Zygapophyseal fusion areas are bumpy, irregular fusion line is visible. Fusion of the two segments as a result of the ossification of the anterior sacrococcygeal ligaments.	degenerative origin (?) unknown (posttraumatic origin?)			
40	332	Maturus	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
41	339	Adultus	M	VL5 - S1	Fusion of the two segments. Lateral parts of the vertebral bodies and lateral transverse processes are involved, the rest of the bodies and zygapophyseal joints are not affected.	sacralisation	-	-	-
42	341	Senium	M	S5 - CcV1 corpus sterni - processus xyphoideus	Complete fusion of the two elements. Complete fusion of the two elements.	sacralisatio unknown (developmental?)	CV7 CV6 - CV7 CV4 (?)	Strong ossification of the posterior longitudinal ligament. Strong distortion and macroporosity of the vertebral plates. Strong distortion and macroporosity of the right upper facet joint surface	OPLL spondylosis deformans degenerative osteoarthritis

43	352	Mat-Sen	F	TV9 - TV10	Fusion at the right, posterior and central parts of the vertebral bodies. Posterior elements (arches, zygapophyseal joints) are not involved.The body of the TV9 is collapsed, vslight wedge-shaped form developed. Small cloacal opening-like channels are recognizable on the right and left antero-lateral part of the lower margin. The upper plate of VT10 is depressed.	compression fracture, non-specific pyogen infection	TV7 - TV11 TV6 - TV11 TV8 - TV12 LV6 LV6 - S1 2 calcanei 2 ossa coxae 2 humeri, 2 femora, 2 tibiae, 2 ossa coxae	Slight ossification of the supraspinous ligament. Slight osteophytes (strong on the collapsed TV9's lower plate) on the vertebral margins. Granular depressions on the vertebral plates. Extra-numerous lumbar vertebra. The right transverse process became similar to the lateral element of S1. Fusion is not found. Strengthened entheses. Slightly oval shaped aceabuli SLightly distorted articular surfaces are present	OSSL spondylosis deformans Schmorl - nodes extranumerous vertebra (developmental defect) sacralisation (partial, incomplete) Enthesopathy hip dysplasia (developmental) degenerative osteoarthritis
44	356	Maturus	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	TV-e LV5 LV-e	Slight ossification f the ligamentum flavum. Moderate ossification of the right iliolumbar ligament. Distorted facet joint surfaces.	OLF OILL degenerative osteoarthritis
45	357	Maturus	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	-	.-	-

46	368	F	F	TV4 - TV5	Fusion of the two segments at the right facet joint. Bodies and other parts of the vertebrae are not involved. Fusion line is bumpy, fusion area is characterized with irregular structure.	degenerative origin	TV-e, LV-e TV4 CV-e, TV-e, LV-e right femur, tibia 2 humeri	slight-mderate osteophytes on the margins of the vertebral bodies. Right upper facet is distorted (macroporosity is also present). Light, porotic vertebrae are present. Strong distortion (lipping) of the proximal tibial and the distal femoral joint surfaces. Slight rim formations of the humeral heads.	spondylosis deformans degenerative osteoarthritis osteoporosis degenerative osteoarthritis degenerative osteoarthritis
47	370	Adultus	F	CV2 - CV3	Vertebral fusion at vertebral bodies and at vertebral arches. Smooth line is recognizable at fusion lines, no signs of degenerative processes, fracture or infection are seen.	synostosis vertebralis (developmental)	os coxae left ulna left fibula 2 tibiae, 2 femora vertebrae VT-e spine	Shallow acetabular region Small thickening at the midshaft Small thickening at the shaft Porous new bone-formation in the shafts. Vertebral bodies are very light and porotic. Lytic lesions on the upper or lower plates of the vertebral bodies are present. Abnormal curvature of the spine via left.	dysplasia coxae healed fracture healed fracture periostitis osteoporosis Schmorl-nodes scoliosis
48	387	Senium	M	LV5 - S1 corpus sterni - processus xyphoideus	Complete fusion of the two segments. Complete fusion f the two parts of the sternum.	sacralisation developmental (?)	-	-	-
49	392	Adultus	F	S5 - VCc1	Complete fusion of the two segments	sacralisation	S3 - VCc1	Spongy-like appositions on the ventral surface of S3-S5 and the first coccygeal segment. VCc1 presents porosity too.	periostitis (TB?)
50	395	Senium	M	corpus sterni - processus xyphoideus	Complete fusion of the two elements	developmental (?)	-	-	-
51	415	Ad-Mat	M	manubrium sterni - corpus sterni	Complete fusion of the two elements.	developmental (?)	2 ossa coxae	slightly elongated acetabuli	dysplasia (developmental)

52	417	Maturus	F	corpus sterni - processus xyphoideus	Complete fusion of the two elements.	developmental (?)	-	-	-
53	450	Maturus	F	VL5 - S1	Partial fusion of the two segments at the left lateral processes. Bodies, posterior elements and right side lateral elements are not involved.	sacralisation	-	-	-
54	452	Senium	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	sternum	Slight ossification of the anterior costosternal ligaments.	OACSL
55	456	Adultus	F	S5 - CcV1	Complete fusion of the two segments.	sacralisation	-	-	-
56	464	Senium	M	CV6 - CV7 LV5 - S1 S5 - VCc1	Complete fusion of the two vertebrae, both bodies and posterior elements are affected. Area between spinous processes are not involved. Anterior surfaces of the two bodies present irregular remodeled surface. Fusion areas are not smooth, but not as bumpy as it's seen in other degenerative cases. Fusion of the two vertebrae by right side ligament ossification (OALL); the posterolateral corners of the bodies are also involved in the fusion. Zygapophyseal gaps are not affected, but roughness around them is visible. Bodies are fused at the interior and posterior parts of the vertebral plates. Cloaca-like round shaped opening on the anterior side of the S1. Complete fusion of the two segments.	degenerative or developmental origin DISH sacralisation	TV9 - TV11 TV-e, LV-e CV-e, TV-e, LV-e LV5 2 ossa coxae TV3 - LV1 TV3 - LV2 S1 sacrum sternum	Very slight right side ossification of the anterior longitudinal ligament. Slight osteophytes on the vertebral plates' margins. Slight distortion (macroporosity) of the facet joint and foveal surfaces. Bilateral ossification of the iliolumbar ligament with no fusion. Early stage ossification of the sacroiliac ligaments. Ossification of the supraspinois ligament. Ossification of the ligamentum flavum. Opening (cloaca?) on the left side of the vertebral body, reactive new bone formation is seen around it. Possible signs of cold abscess on the ventral surface (S1-S2). Ossification of the anterior costosternal ligaments (radial phenomenon).	OALL spondylosis deformans degenerative osteoarthritis OILL (DISH?) OSIL (DISH?) OSSL (DISH?) OLF (DISH?) infection infection (TB?) OACSL (DISH?)

							lower V-e	Ossification of ligamentum flavum.	OLF (DISH?)
							2 MT5, 2 naviculars, 2 distal fibulae	Ligament ossification.	ligament ossification (DISH?)
							2 calcanei, 2 patellae	Strengthened entheses.	enthesopathy
							2 ulnae, 2 radii, 2 clavicles, 2 scapulae, 2 humeri, sternum, 2 ossa coxae	Distorted joint surfaces are present.	degenerative osteoarthritis
							LV-e	Asymmetric vertebral bodies, this phenomenon is reulted in slight lateral curvature of the spine.	scoliosis
							rib fragments	Thickening (callus) in the mid-shafts are seen.	healed fracture
57	465	Adultus	M	LV5 - S1	Fusion of the two segments. Lateral parts of the vertebral bodies and lateral transverse processes are involved, the rest of the bodies and zygapophyseal joints are not affected.	sacralisation	sternum	Unilateral, right side ossification of the first costosternal joint cartilage.	unknown (degenerative?)
				corpus sterni - manubrium sterni	Complete fusion of the two elements, no fusion line is visible.	developmental			
58	468	Maturus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	-	-	-
59	470	Adultus	F	VL5 - S1	Fusion of the two segments, lateral parts are completely, the right facet joint is partly involved. Other elements are not fused.	sacralisation	-	-	-
60	478	Mat-Sen	F	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
61	480	Adultus	F	corpus sterni - manubrium sterni	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
62	481	Adultus	F	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)		-	-
63	482	Ad-Mat.	M	S5 - CcV1	Partial fusion of the two segments.	sacralisation	VT4 - VL1	Slight ossification of the ligamentum flavum.	OLF

25. Bátmonostor - Pusztafalu (Árpád age - early modern times,12-18th c. AD, 3782 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	7B	Juvenis	M	CV5 - CV7	Complete fusion of the three vertebrae, all parts are involved. Smooth fusion areas, hardly recognizale fusion lines are present.	synostosis vertebralis - developmental defect	no CO, CC, HV, rib PO	-	-
2	16	Maturus	F	right femur - tibia	Both the femorotibial and the femoropatellar joints are fused. The femur and the tibia ankylosed in hyperextension of about 25 degrees. The tibia is rotated to the lateral direction; the knee is fixed in moderate valgus position. The femorotibial joint presents complete ankylosis, while the original joint gap is not recognizable, the intercondylar fossa is remained intact on the posterior side of the knee joint. Cloaca-like opening is seen on the anterior side, the round-shape hole (about 0.7 mm in its diameter) is found at the level of the original joint gap. The knee cap is fused to the femur, but the position has changed, it dislocated to the upper border of the patellar surface. Remodeled bony surfaces in the right tibial and fibular diaphyses refer to some periosteal reaction; as a result of the process thickening of the tibia can be found.	non-specific or tuberculous arthritis	left femur and tibia skull frontal no CO, CC, HV, rib PO	Distortion of articular surface (overuse of the leg) Pitting on the cranial vault multiple granular impressions on the endocranial side	degenerative osteoarthritis cribra cranii (porotic stage) infection (?)

3	46	Senium	M	TV3 - TV12 S5 - CcV1	Extensive ossification of the right side anterior longitudinal ligament. No fusion, but facing ossifiactions: TV3 - TV4, TV8 - TV9 fusion: TV4 - TV8, TV9-TV12. Vertebral bodies and facet joints are intact, chondrocalcinosis is not seen. Complete fusion of the two segments.	DISH sacralisation	TV10 - TV12 TV7 - TV12 CV-e, TV1 - TV2, LV-e, S1 TV3 - TV7 2 1st ribs TV7 - TV12 2 ossa coxae, 2 calcanei, 2 tibiae, 2 radii, 2 clavicles, 2 MT5 2 ulnae, 2 scapulae, 2 femora, 2 tibiae, 2 ossa coxae, sternum, 2 clavicles	Slight ossification of the left side anterior longitudinal ligament with no fusion. Ossification of the suprasspinous ligament. Slight-moderate bilateral osteophytes are present on the margins of the vertebral bodies Slight distortion of the zygapophyseal joints. Ossification of the cartilage of the two 1st ribs. Moderate ossification of the ligamentum flavum. Strenghtened entheses. New bone formations on the rims of joints.	OALL (DISH) OSSL (DISH) spondylosis deformans degenerative osteoarthritis cartilage ossification OLF (DISH) enthesopathy degenerative osteoarhritis
4	48	Maturus	M	manubrium sterni - corpus sterni - processus xyphoideus (?) VL5 - S1 S5 - CcV1	Complete fusion of the two parts of the sternum Complete, bilateral fusion of the two segments, all part of the vertebrae are involved. Complete fusion of the two segments	developmental (?) sacralisation sacralisation	VT-e, VL-e 2 ribs 2 ossa coxae, sacrum 2 ossa coxae, sternum sternum sternum	Small osteophytes are present. Slight callus formation in the mid-shafts is seen. Slight lipping is seen on the four auricular surfaces. Auricular surfaces are intact. slight distortion of the acetabuli and the clavicular incisures. Ossification of the anterior costosternal ligaments (radial appearance). Ossifiaction of the cartilage of the 1st ribs.	spondylosis deformans healed fracture sacroileitis degenerative osteoarthritis OACSL (ageing?) cartilage ossification (ageing?)

5	63	Senium	F	TV9 - TV10	Vertebral fusion that involves only the ertebral bodies. The fusion area is smooth, no irregualr fusion line is visible. Both of the vertebral bodies are slightly V-shaped, it results in slight kyphosis of the spine.	synostosis vertebralis - developmental	TV9 - TV10	Slightly V-shaped vertebral bodies	kyphosis
6	120	Adultus-Maturus	M	left tibia - fibula	Functional ankylosis developed in the distal tibiofibular joints as a result of tibial fracture. Distal tibio-fibular joint is intact, no signs of arthritis can be seen on the joint surfaces.	post-traumatic functional ankylosis (fracture)	left tibia left tibia	Moderate callus formation and dislocation are seen in the distal tibia. Swollen tibial metaphyses, porous periosteal appositions and small cloaca-like opening are present on the tibial diaphysis.	healed fracture perostitis - osteomyelitis

7	129	Maturus	F	left radius - all carpals - 2nd and 3rd metacarpals	Bony ends fused in 16 cases the entire wrist and all of the mediocarpal joints became fixed, two carpometacarpal articulations (2nd-3th CMC joints) and one intermetacarpal joints are also involved. Smooth bony surfaces interrupted with some irregular shape cavities on both the volar and the dorsal sides are recognizable. The symptoms are in association with ligament ossification, anterior and posterior ligaments of the wrist and the carpus are involved. Second and third carpometacarpal and the first intermetacarpal joints are also fused, these ankyloses fixed the metacarpals in extended position. Post mortal fractures of this area exposed the interior structure of the distal line carpals, and the present less dense trabecular system may be in association with the lack of the use of the joints. However we can state that the rest of the articulations were used after the development of the ankylosis. Strong distortion characterized with flattening and newly formed rims of the joint surfaces of the distal radioulnar and the not ankylosed carpometacarpal joints are present.	infectious arthritis - posttraumatic event (?)	- -	- -	-
8	220	Senium	M	CV3 - CV4	Bony fusion is found in the two vertebrae. The left zygapophyseal joint and the left side of the posterior arch are involved, where slightly bumpy fusion line is seen. Right facet joint and the vertebral bodies are not involved.	degenerative origin	vertebrae CV-e CV2	Moderate osteophytes in the vertebral bodies are seen. Flattening and lipping of the left side facet joint surfaces. Conoid shape dens axis.	spondylosis deformans degenerative osteoarthritis degenerative osteoarthritis - developmental defect (?)
9	223	Senium	M	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-

10	235	Maturus	F	L5 - S1	Completefusion of the two segments.	sacralisation	LV4 - LV5 LV-e LV-e sacrum, LV5	Right side ligament ossification (anterior longitudinal ligament). Slight osteophytes are present on the margins of the vertebral bodies. Moderate distortion of the zygapophyseal joint surfaces. Slight lipping on the anterior margin of the right auricular surface.	OALL (DISH?) spondylosis deformans degenerative osteoarthritis sacroileitis
11	256	adult	U	corpus sterni - processus xyphoideus	Complete fusion of the the parts of the sternum.	developmental (?)	sternum	Moderate ossification of the anterior costosternal ligaments.	OACSL
12	337	Maturus	F	CV5 - CV6	Fusion of the 2 vertebrae, the left zygapophyseal joint, the left side of the posterior arch and the left and posterior parts of the vertebral bodies are involved. The fusion area is slightly bumpy, undulating, the original spaces are not recognizable.	degenerative origin (based on developmental defect)	CV6 cervical spine	Opened posterior arch. As a result of the vertebral fusion slight left side curvature of the spine is present.	spina bifida scoliosis
13	351	Maturus	M	corpus sterni - processus xyphoideus	Complete fusion f the two parts of the sternum.	developmental (?)	-	-	-
14	373	Maturus	M	TV5 - TV6 (?)	Fusion of the 2 vertebrae, both the facet joints and the bodies are involved. The fusion line between the bodies is irregular, moderate bumpy apearance is seen. In the facet joints a less irregular fusion line is seen. New bony apposition is found on the anterior side of the vertebral bodies.	degenerative origin	2 1st ribs TV4, TV6 - TV10 TV-e	Ossification of the cartilages. Ossifiacation of the right anterior longitudinal ligament with no fusion. Slight distortion of the foveae onf the lateral processes.	ageing or DISH (?) OALL (DISH) degenerative osteoarthritis
15	374	Adultus	F	VL5 - S1	Partial fusion of the lateral parts of the segments, other elements are not involved.	sacralisation	-	-	-
16	390	Senium	M	left femur - tibia	Ankylosis of the left knee; the joint is fixed in extension position. The femorotibial articulation is partly recognizable, while the complete fusion is found at the medial condyles; incomplete ankylosis is present at the lateral condyles. A drainage cloaca with around 0.8 mm in its diameter is seen in the intercondylar fossa. The tibia is dislocated into the posterior direction, the tibial plateau seems to be flattened.	post-traumatic septic arthritis (?)	2 calcanei, right femur left tibia - femur 3 LV-e, S1 rib	Strenghtened entheses (stronger in right bone). Slight periosteal apposition is found on both the femoral and the tibial shafts, undulating surfaces are seen. Moderate osteophytes are present in vertebral bodies. Small thickness in the shaft is seen.	enthesopathy periostitis spondylosis deformans healed fracture

17	465	Senium	M	left femur - tibia - fibula	The knee joint is fixed in a lateral rotation and angulation of about 35 degrees that does not correspond to normal physiological flexion. The fusion of the medial condyles is complete, whereas the lateral condyle is attached to the tibial lateral plate by a bony bridge. The femoropatellar and proximal tibiofibular articulations are also fused. At the level of the original joint gap, an irregular osseous belt emerges whose surface is characterized with new, rough-surfaced bony elements. Spicules of new periosteal bone formations can be recognized on the medial side of the proximal metaphysis adjacent to the tibial tuberosity. The fibula also shows signs of irregular periosteal bone apposition at the proximal end and along the diaphysis. On the anterior aspect of the tibial diaphysis and at the medial side of femoral shaft, a circumscribed swelling up to 15 mm in height can be seen, where the distinction between the original cortical and the newly formed bone can easily be recognized. The linea aspera and linea musculi solei appear pronounced and are easily recognizable.	TB arthritis	2 orbits, skull vault	Pitting of the orbital roofs and the calvarium is seen.	cribra orbitalia et cranii
18	469	Maturus	M	LV5 - S1	Fusion of the two segments. The lateral parts are fused, bodies and posterior parts are not involved.	sacralisation	sacrum	Opened posterior arches (S1 - S5).	sacrum bifidum (complete)
19	472	Senium	M	manubrium sterni - corpus sterni TV12 - right rib	Complete fusion ofthe two parts of the sternum. Fusion of the rib head and the fovea of the vertebral body.	developmental (?) unknown	sternum sternum TV-e, LV-e	Ossification of the anterior costosternal ligaments. Ossification of the first rib's cartilage on the left side (no fusion). Slight distortion of the facet joint surfaces.	OACSL (unknown etiology) unknown (ageing?) degenerative osteoarthritis

20	544	Adultus	M	LV5 - S1	Fusion of the two segments. The lateral parts are fused, bodies and posterior parts are not involved.	sacralisation	sacrum	Opened posterior arches (S1 - S5).	sacrum bifidum (complete)
21	545	Senium	F	TV6- TV8, TV9 - TV10	Vertebral fusion of 2 + 3 vertebrae. Only the anterior parts of the vertebral bodies are involved, where very small osteophytes seems to became fused.	degenerative origin (?)	TV6, TV8, TV9 TV-e TV67 - TV10	Slight osteophytes are present on the anterior margins of the vertebral bodies. Slight distortion of the facet joint surfaces. Moderate ossification of the supraspinous ligament.	spondylosis deformans degenerative osteoarthritis OSSL
22	707	Senium	F	LV5 - S1	Fusion of the two segments. Only the right lateral part and the right anterior side of the vertebral bodies are fused.	sacralisation	LV5	The upper plate of the LV5 is not horizontal, but turned to the left direction.	scoliosis
23	726	Senium	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	right tibia, fibula	Thickened and rough surfaced tibial and fibular diaphyses are seen. On the surface of the bones are remodeled structure is found.	periostitis
24	767	Senium -	F	corpus sterni and processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
25	827	Maturus	F	TV8 - TV9	Collapsed and fusioned vertebral bodies are seen. The vertebral body of TV8 is almost completely disappeared (V-shape), irregular shaped lesions are present on the remain of the body.	TB - Pott's disease	spine TV-e TV7, TV9 - TV10 sternum no HV, ECL, CO, CC, rib PO	Angulation of the spine is seen as a result of the collapse of the TV8. Slight - moderate distortion of the facet joint surfaces and the foveae on the lateral side of the vertebral bodies. Slight-moderate osteophytes of thwe vertebral bodies are found. Foramen is present in the distal part of the sternum	kyphosis degenerative osteoarthritis spondylosis deformans fenestratio sterni - anatomical variation
26	845	Maturus	M	LV5 - S1	Fusion of the segments, the lateral parts and the right anterior part of the vertebral bodies are involved.	sacralisation	TV-e, LV-e right ulna, radius	Moderate osteophyteson thetvertebral bodies' margins Distorted distal joint surfaces, slight new bony appositions of porous appearance are found on them.	spondylosis deformans arthtritis (infectious?)

27	859	Infantia I	U	CV2 - CV3	Complete fusion of the two segments, the left side of the posterior arches are fused. Smooth fusion area is seen, the fusion line is not recognizable.	synostosis vertebralis - develpmental alteration	-	-	-
28	925	Senium	M	TV9- TV10	Complete fusion of tall vertebral parts of the two segments. The fusion lines are not vishible, the area sof the fusions are smoot surfaced.	synostosis vertebralis - developmental alteration	skull 2 calcanei	Deformed occipital region is seen. Strenghtened entheses.	bathrocephaly enthesopathy
29	937	Infantia I	U	CV? - CV?	Fusion of the posterior arches of the two segment, the zygapophyseal joints are not involved. Bodies are missing. The fusion line is not visible, smooth area is found.	synostosis vertebralis - decelopmental alteration	-	-	-
30	948	Senium	M	sacrum - left os coxae corpus sterni and processus xyphoideus	Complete ossification of sacro-iliac joint, slight ossification of the sacroiliac ligament is seen. The anterior part of the joint is not fused. complete ossification	unknown deelopmental (?)	left tibia sternum	Strenghtened enthesis (tibial tuberosity). Roundish opening is on the sternal body.	enthesopathy fenestratios sterni - anatomical variation

31	993	Senium	M	right femur - tibia - patella	The right knee joint is completely ankylosed and destroyed. The femur and the tibia are fused, and flexed 85 degrees. The patella is dislocated to the upper border of the lateral femoral condyle and fused to its lateral surface. Osseous fusion occurred between the posterior aspects of the tibial and femoral condyles. The medial condyles are fused along their entire width; the lateral condyles are joined by a narrow bony connection. As a consequence of post-mortem taphonomic processes, the internal structure of the lateral condyle of the femur is exposed, and three small (6-7 mm in diameter) lytic lesions are recognizable in the trabecular bone. A bony projection that is 55 mm in length and 35 mm in width projects anteriorly from the ankylotic joint . The surface of this wedged outgrowth is rough and covered with dense trabeculae. Typical cortical structure is not found in this area. Above the medial femoral condyle a new smooth-surfaced bone formation is found near the medial epicondyle. Slight periosteal reactions are also visible.	TB-arthritis (?)	LV-e 2 calcanei right femur, tibia right ibia 2 femora 2 orbits skull	Slight osteophytes of the vertebral bodies are present. Strenghtened entheses. Lamellar and spongy new bone formations cover the femoral shaft, the anterior side of the tibial diaphysis shows only slight spongy new bone appositions. The position of the bone suggests that the tibia slipped in the posterior direction. Distortion of femoral heads is found. Bilateral pitting on the orbital roofs. Deep granular endocranial depressions on the frontal bone are present.	spondylosis deformans enthesopathy periostitis (sub)luxation degenerative osteoarthritis cribra orbitalia (porotic stage endocranial chane - infection
				manubrium sterni and corpus sterni	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
32	1107	Senium	M	manubrium and corpus sterni	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
33	1137	Senium	M	VL5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-
34	1217	Adultus	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
35	1233A	Ad-Mat	F	LV5 - S1	Complete fusion of the two segments.	sacralisation	LV5	Slight osteophyte is present on the upper anterior margin of the vertebral body.	spondylosis deformans
36	1261	Senium	M	CV2 - CV3	Vertebral fusion, the right zygapophyseal joint is involved. The fusion line is irregular, the area is bumpy.	degenerative origin	right clavicle 2 patellae	Thickening and dislocation at the acromial end. Strenghtened entheses.	healed fracture enthesopathy

37	1305A	Senium	M	TV2- TV5	Complete vertebral fusion, all vertebral parts are involved.The fusion lines are not recognizable, smooth fusion areas are present.	synosotosis vertebralis - evelopmental	TV4	Only the right side of the vertebra is present, a triangular shape part of the vertebra is between the two neighbouring vertebra. The majority of the body and the whole right side is missing.	Developmental defect
38	1346	Maturus	F	CV5 - CV6	The vertebral bodies are fused, other elements are intact. The fusion line is straight, smooth fusion area is seen.	synosotosis vertebralis - developmental	CV4 - CV5 mandible	Slight osteophytes on the anterior margins of the bodies are present. Strong atrophy of left ramus mandibulae.	spondylosis deformans developmental defect
39	1381	adult	U	left tibia - fibula	Functional ankylosis developed in the distal tibiofibular joints as a result of tibial and fibular fractures. Distal tibio-fibular joint is intact, no signs of arthritis can be seen on the joint surfaces.	posttraumatic (fracture)	-	-	-
40	1409	Senium	F	CV7- TV2 TV3 - TV4 TV5 - TV6	Complete fusions are present, all parts of the vertebrae are present. Collapse is resulted in V-shaped vertebral bodies. Complete fusion of the vertebral bodies, but no collapse. The original height of the vertebral bodies are seen. Complete fusions are present, all parts of the vertebrae are present. Collapse is resulted in V-shaped vertebral bodies.	TB - Pott's disease TB TB - Pott's disease	thosracic spine TV-e	Angulation formed as a result of the collapse and fusion of the vertebrae. Irregular surface (remodeled anterior vertebral bodies) is seen.	kyphosis periostitis
41	1451	Senium	F	left radius - ulna	The distal radioulnar joint is ankylosed. The fusion developed as a result of two different processes. The first fusion appeared in the joint itself, while in the second case the ossification of the dorsal radioulnar ligament is seen. The distal ulna is distorted; the presence of this phenomenon is associated with a healed ulnar fracture. On the basis of the characteristics found in the forearm the ankylosis developed after a traumatic event.	posttraumatic (fracture)	left ulna left radius left ulna	Dislocation of the distal ulna. Green discoloration is seen on the distal radius. Distortion of the proximal end.	healed fracture traits of bronze jewellery Degenerative osteoarthritis

42	1735	Maturus	M	LV4 - LV5	Fusion of the two segments. Bodies are fused by smooth surfaced syndesmophyte-like bridges. Right zygapophyseal fusion is present, irregular new bone formation is seen around the joint.	SPA (?)	LV4 - LV5	Strong distortion of the right facet joint surfaces.	osteoarthritis
43	1793	Maturus	M	right os coxae - sacrum S5 - CcV1	Sacroiliac fusion is developed by the ossification of the right sacroiliac ligament. Sacroiliac joints are intact. Complete fusion of the two segments.	DISH sacralisation	3 TV? LV1 2 patellae, 2 calcanei, 2 ulnae, 2 ossa coxae, 2 fibulae LV2 - LV5, CV-e 2 ulna, 2 femora, 2 ossa coxae	Ossification of the right side anterior longitudinal ligament with no fusion. Disc spaces and facet joint gaps are preserved. Ossification on the ight costal process. Strenghtened entheses. Large osteophytes on the lumbar vertebral bodies' margins. Macroporosity of the cervical vertebrae's endplates. Distorted femoral head and ulnar olecranon are present.	OALL (DISH) ossification (DISH?) enthesopathy spondylosis deformans degenerative osteoarthritis
44	1833A	Maturus	F	manubrium sterni - corpus sterni	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
45	1845	Maturus	U	2 ribs	Osseous fusion of the 2 bones in the midshafts.	developmental alteration - synostosis costarum	-	-	-

46	1920	Maturus	M	right femur - hip (acetabulum)	The right hip is fixed in a flexion of about 90 degrees. The original shape of the femoral neck is not recognizable, newly built extensive thickening covers both the neck of the femur and the acetabular region. Signs of fracture are not visible, only post-mortem fracture is found in the proximal femoral diaphysis. While the surface of the femoral shaft presents no pathological lesions, the neck and the innominate bone is rough, both pitting and spiculous new bone formations are present. Cloacal openings on the hip bone are also seen, small teardrop-shape and roundish openings are recognizable on both the lateral and medial side, their diameter is less than 0.5 cm. On the medial side smooth surfaced shallow depressions with ‘flowing’ appearance are seen. Concerning other pathological lesions in the skeletal remains, cloaca on the left side hip bone and severe osteoarthritis with overhanging bony lips of the same side femoral head is found.	septic arthritis	left femur left os coxae	The head of femur presents severe degenerative distortion (lipping), femoral neck is very short (2 cm) Round-shape cloacal opening is seen on both the medial and lateral sides of the bone.	degenerative osteoarthritis osteomyelitis, septic osteoarthritis
47	1974	Maturus	M	VT8 - VT9	Bilateral fusion of the posterior arches of the vertebrae (bodies are missing). Bodies are missing because the right and left pedicles are atrophied and only spike-like remnants are present. Although only two vertbrae are fused, but slight curvature of the thoracic spine is recognizable.	TB (kyphosis)	TV7 - TV8, TV9 - TV10 TV7 2 left ribs	Severe distotion of the facet joints and the foveae of the lateral processes. Irregular shaped lytic lesions are present, these almost comletely destroyed the inferior part of the verebral body (only the anterior and lateral (both sides) parts are involved) Irregular shaped cavities are present in the head of the ribs.	arthritis (TB?) TB TB
48	2006	Senium	M	TV12 - LV1	Complete fusion of the two segments. One of the vertebral bodies presents collapse of its body (V-shaped vertebral body), but a syndesmophyte-like osseous belt covers the fusion area. Right facet joints is involved, bumpy area is seen around it.	posttraumatic (fracture)	TV-e, LV-e LV5	Very light, porotic vertebrae are present. Osteophytes and lytic lesions on the lower endplate are found.	osteoporosis spondylosis deformans

49	2022	Maturus	M	S5 - CcV1	Complete fusion of the two segments.	sacralisation	sacrum	Opened posterior arches (S1 - S5).	sacrum bifidum (complete)
50	2082	Adultus	M	LV5 - S1	Fusion of the segments, the lateral parts are involved.	sacralisation	VL5, S1-S2	Opened posterior arches are seen.	spina bifida sacrum bifidum
51	2083	Senium	M	TV10 - TV11 LV4 - LV5	Fusion of the vertebral bodies, irregular and bumpy fusion line is seen. Facet joints are not involved. Fusion of the vertebral bodies, facet joints and posterior arches. Irregular and bumpy fusion lines are seen. The height of the vertebral bodiesare decreased.	degenerative origin degenerative and posttraumatic (compression fracture?) origin	TV10 - LV5 LV3 - S1	Slight - moderate osteophytes are found. Distorted facet joints are present.	spondylosis deformans degenerative osteoarthritis
52	2100	Ad-Mat	F	LV5 - S1	Fusion of the two segments, lateral parts are involved.	sacralisation	VL5, S1-S5	Opened posterior arches are seen.	spina bifida sacrum bifidum (complete)
53	2114	Mat-Sen	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
54	2125	Maturus	F	manubrium sterni - corpus sterni - processus xyphoideus	Complete fusion of the three parts of the sternum.	developmental (?)	-	-	-
55	2126	Senium	M	left os coxae - sacrum corpus sterni - processus xyphoideus	left sacro-iliac joint is ankylosed by the ossification of the left sacroiliac ligament. Joint space is preserved, auricular surfaces are intact. Complete fusion ofthe two parts of the sternum.	DISH (?) developmental (?)	2 femora, right humerus, right fibula, 2 patellae, 2 ossa coxae sternum right ulna 2 femora, 2 ulnae, 2 humeri, 2 ossa coxae right tibia, fibula	Strenghtened entheses Ossification of the anterior costosternal ligaments. healed non-dislocated fracture close to distal end. Distorted joint surfaces. Severe hypertrophic changes in the distal shaft.	enthesopathy OACSL (DISH?) healed fracture degenerative osteoarthritis periostitis
56	2136B	Maturus	M	right tibia and fibula	Functional fusion is developed in the in the distal tibiofibular joints as a result of tibial and fibular fractures, the fractures healed with severe dislocation.	posttraumatic (fracture)	right tibia	The presence of some infection is suggested by the presence of swollen tibial metaphyses, porous periosteal appositions on the long bone, small cloaca-like openings are also present on the tibiae.	periostitis , osteomyelitis

57	2153	Mat-Sen	M	CV2 - CV4	Ankyloses developed as a result of the ilateral zygapophyseal fusions (bumpy irregular surface). The posterior and lateral parts of the vertebral bodies show the same type ankyloses.	degenerative origin	CV-e , TV-e, LV-e right clavicle, CV-e	Moderate - strong osteophytes of the vertebral bodies are seen. Pitting, distortion on the joint surfaces.	spondylosis deformans degenerative osteoarthritis
58	2211	Ad-Mat	M	TV11 - TV12 LV5 - S1	Fusion of the two vertebrae. Bodies are completely fused, slightly bumpy fusion line is visible. Right facet joint is partly fused, the left one is intact. Fusion of the left lateral parts, other elemenst are not involved.	degenerative origin sacralisation	TV-e, LV-e left os coxae	Strong macroporosity is present on the vertebral endplates. Extremely distorted acetabulum with large new rim formations. Some spiculous new bony apposition is also seen, this may be in association with some infectious process.	spondylosis deformans degenerative osteoarthritis(infection?)
59	2264	Ad-Mat	F	corpus sterni - manubrium sterni	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
60	2336	Maturus	M	LV5 - S1	Partial fusion of the two segments, only the right lateral parts are involved.	sacralisation	-	-	-
61	2342B	Maturus	M	TV12 - LV1	Collapsed (V-shaped) and fusioned vertebral bodies, both zygapophyseal joints are involved. Irregular surface can be seen around the fusion lines/areas.	TB (?) Pott's disease	sacrum LV5 CV-e, TV-e, LV-e right tibia LV-e, TV-e	Large cavity at the level of the left side 2nd sacral foramen. Partly separated posterior arch arch, fracture on the right side of the arch is seen. Moderatestrong osteophytes in the vertebral bodies. Multiple fracture of the bone: - dislocated fracture of the bone's shaft, close to the distal end; - Rupture crossing the distel joint surface and the fibular incisure. Distorted facet joint surfaces.	infection (TB?) non-union fracture spondylosis deformans healed fracture degenerative osteoarthritis
62	2344A	Adultus	M	right 2nd - 5th metacarpals - carpals	Complete carpal and carpometacarpal ankyloses are present, the original joint gaps are not recognizable. Roughness on both the dorsal and volar sides is found, beside rough bony surfaces, porosity of the carpals and the proximal ends of the metacarpals are recognizable. Cloacal openings are not seen.	septic arthritis	right wrist	Distortion of the radioscaphoid, radiolunate and ulnolunate joint surfaces is present; roughness, microporosity and small irregular shaped lytic lesions are seen on these surfaces.	arthritis - degenerative - infectious (?)

63	2346A	Maturus	M	VL3 - VL4	Bony fusion of the vertebral bodies, zygapophyseal joints are not involved. The lower body is slipped to anterior direction, and the fusion fixed the bodies in this position. Irregular fusion lin is visible.	posttraumatic and degenerative origin	LV3 - LV4 LV1 - LV5	Zygapophyseal joints present strong distortion, erosive and proliferative areas are found. Slight osteophytes are seen on the margins of the bodies.	degenerative osteoarthritis spondylosis deformans
64	2369	Maturus	M	right 1st metatarsal - 1st proximal phalanx	The right first metatarsophalangeal joint is ankylosed, the fusion resulted in a slight varus deformity. The fusion involved partly the articulation; the joint gap is recognizable on both the dorsal and volar sides. While on the dorsal side only an irregular line is visible at the level of the joint gap, newly formed bony projection of irregular structure is also found on the volar side of the fused articulation. Signs of previous fracture or infection are not present in this specimen.	degenerative origin and infectious arthritis (?)	-	-	-
65	2395A	adult	U	corpus sterni - manubrium sterni - processus xyphoideus	Complete fusion of the three parts of the sternum.	developmental (?)	-	-	-
66	2405	Mat-Sen	M	LV2 - LV3	Fusion of the anterior and lateral parts of the vertebral bodies. 'Flowing' syndesmophyte-like ossification connects the two vertebrae. The body of LV3 is collapsed, 0,5 cm wide rupture crosses the the lower plate. The shape of the body seems to be biconcave. Zygapophyseal joint are missing.	posttraumatic origin (fracture)	TV-e, LV-e TV12 - LV5 TV7 - TV11 TV7	Moderate distortion of the facet joint surfaces. Strong osteophytes are present on the margins of the vertebral bodies. Right side ossification of the anterior longitudinal ligament. Ossification of the right side costovertebral joint capsular ligament	degenerative osteoarthritis spondylosis deformans OALL (traumatic origin?) OCL (traumatic origin?)
67	2462	Maturus	M	right tibia - fibula	Functional ankyloses are developed in the distal tibiofibular joints as a result of tibial fractureThe tibial fracture healed with moderate dislocation.	functional ankylosis - posttraumatic (fracture)	right tibia 2 calcanei	Healed dislocated fracture in the distal tibia. Strenghtened entheses (Achilles-tendons).	healed fracture enthesopathy
68	2477	Senium	M	manubrium sterni - corpus sterni - processus xyphoideus	Complete fusion of the three parts of the sternum.	developmental (?)	-	-	-

69	2504	Senium	M	TV2 - TV3 TV4 - TV6	The right lateral part of the bodies are fused, facet joints are not involved. The posterior margins of the bodies (TV4 - TV6), the left lateral parts of the bodies (TV4 - TV5) and the left zygapophyseal joint /TV4 - TV5) are ankylosed. Around the latter two fusions new iregular bony formations developed, the posterior element fusion presents a smooth surfaced appearance.	synostosis vertebralis developmental (?) developmental defect and degenerative origin	TV5 upper thoracic spine TV-e	The left side of the vertebral body is collapsed, a lateral direction V-shape body is present. Severe curvature (cca 90 degrees) of the spine (left side). Distorted zygapophyseal joint surfaces and distorted fovae are seen.	developmental alteration scoliosis degenerative osteoarthritis
70	2518	Maturus	M	corpus sterni - processus xyphoideus	Complete fusion of the two parts of the sternum.	developmental (?)	-	-	-
71	2527A	Adultus	M	left tibia - fibula	osseous bridge close to knee joint	trauma - fracture ?	right tibia	new lamellar bone	periostitis
72	2528	Adultus	M	LV5 - S1	Fusion of the lateral parts of the segments. No other elements are involved.	sacralisation	-	-	-
73	2635	Senium	M	LV5 - S1	Fusion of the lateral parts and the zygapophyseal joints of the two segments.	sacralisation	LV5 sacrum	Opened posterior arch. Opened posterior arches (S1, S2, S4).	spina bifida sacrum bifium (partial)
74	2645	Senium	M	manubrium sterni - corpus sterni	oOsseous fusion of the the parts of the sternum.	developmental (?)	sternum	Ossification of the anterior costosternal ligaments.	OACSL (ageing?)
75	B/IX (stray find)	adult	U	LV5 - S1	Fusion of the two segments, lateral parts are involved.	sacralisation	-	-	-

76	B/XVI - 149 (stray find)	adult	U	2nd - 4th metacarpals - carpals LV5 - S1	Ankyloses developed among the all carpals and in four carpometacarpal joint. The 3rd and 4th metacarpals are lost post mortally, but the area of the ankyloses are seen. The position of the 2nd metacarpal has changed; it is rotated to the lateral direction along its longitudinal axis. Joint spaces are partly recognizable; in some cases newly formed cancellous trabecular system is visible between the affected carpals. No signs of a previous fracture can be seen in the specimen, the porosity together with some small lytic areas on the carpals surfaces may refer to the presence of some infection. Fusion of the two segments, the right lateral part, the body and the zygapophyseal joints are involved.	septic arthritis and traumatic origin (?) sacralisation	-	-	-
77	B/ RBX	adult	U	cmanubrium sterni - corpus sterni - processus xyphoideus	Complete fusion of the three parts of the sternum.	developmental (?)	-	-	-

26. Nyárlőrinc - Hangár út (Árpád age - early modern times, 12-16th c. AD, 483 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	24	Maturus	M	TV7 - TV8 , TV9 - Tv10	Right side anterior longitudinal ligament ossification, intervertebral gaps are not narrow, small facet joints are not involved. Complete fusion of the segments.	DISH	TV4 - TV6	Right OALL with no fusion.	OALL (DISH)
							TV8 lower - TV9 upper margin	Right OALL with no fusion.	OALL (DISH)
				LV5 - S1		sacralisation	TV10 lower, TV11 - LV2 upper-lower margins	Bilateral OALL with no fusion.	OALL (DISH)
							LV3 lower - LV4 upper margins	Osteophytes are present.	spondylosis deformans periostitis
							LV4 lower, LV5 upper margins	Left OALL with no fusion is present.	(OALL) DISH
							TV-e, LV-e	Distorted small facets .	degenerative osteoarthritis
							sacrum	Distorted auricular surfaces.	degenerative osteoarthritis
							tibia	New bony apposition is found.	periostitis
							fibula	New bony apposition and signs of inflammation are present.	periostitis and osteomyelitis
							TV3 - TV9	Ossification of the supraspinous ligament.	OSLL (DISH?)
2	82	Adultus	F	TV10 - LV5	Fusion of 8 segments at all vertebral elements. Body height is fairly remained at LV4 - LV5, but the rest of the vertebral bodies are collapsed (V-shape) or disappeared. Massive paravertebral mass developed at the level of TV12 - LV2.	TB - Pott's disease (DNA +)	TV9	The body of VTV9 is destroyed, the remnants present a big loss of height (V-shaped body), and irregular surfaces both on endplates and sides of vertebral bodies.	TB (Pott's disease)
							sacrum	S1 presents open posterior arch.	sacrum bifidum
							sacrum	The sacrum's shape is distorted, its base is turned backward resulted in S-shape from side view and in distortion of auricular surfaces.	developmental disease
							No ECL, CO, CC, HV, rib PO, LEH		

3	218	Maturus	M	corpus sterni-processus xyphoideus	fusion of the two segments	unknown (developmental?)	sacrum, os coxae right femur right os coxae - acetabulum calcaneus ulna LV-e TV12 - LV1, LV3 - LV4 CV3 2 left ribs right MT1	lytic lesions on sacro-iliac joint surface Severe distortion of the femoral head with some signs of infection (both lytic and proliferative lesions on the head and neck). Moderate distortion of the articular surface with proliferative and lytic lesions around it. Strenghtened entheses. Depressions on the upper or lower surface of the vertebral body. Strong osteophytesare present. Flattening and pitting of the right upper facet. Callus formation in the shafts. Bony appositions on distal head	sacroileitis infectious osteoarthritis infectious osteoarthritis enthesopathy Schmorl-nodes spondylosis deformans spondylarthritis healed fracture degenerative osteoarthritis
4	222	Maturus	F	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-
5	389	Adultus	F	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-

6	460	adult	M	CV2 - CV3 LV6 - S1	Bony fusion (rough surface) around the right zygapophyseal joint (rough surface and fusion line), no other elements are involved. Fusion of the bodies and lateral (both side) elements (posterior arches and facet gaps are not involved).	degenerative fusion sacralisation	CV1 - Cv3, CV5 - CV7 (CV4 is missing) CV3, CV5 - CV7, TV1 - LV5 rib right radius right humerus radius ulna TV1 - TV12 TV3 - TV6 LV6	Distorted facets (pitting, eburnation). Distorted endplates with slight osteophytes. Small thickening in the mid-shaft. Callus formation and dislocation in the distal epiphysis. Strong new bony apposition and eburnation in the elbow and ankle joint. Distorted shape is seen. Ossification of the supraspinous ligament. Extra-numerous vertebra.	degenerative osteoarthritis spondylosis deformans periostitis healed fracture degeneratie osteoarthritis (posttraumatic) degenerative osteoarthritis OSSL (traumatic origin?) developmental defect
7	473	Juvenis	U	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-
8	503	adult	M	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-
9	505	adult	M	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-
10	535	adult	F	LV5 - S1	Complete fusion of the two segments.	sacralisation	-	-	-

27. Óföldeák (Árpád age - early modern times, 12-18th c. AD, 419 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	16	Maturus	F	LV5 - S1	Complete fusion of the two segments is present.	complete sacralisation	-	-	-
2	88	Maturus	F	LV5 - S1	Complete fusion of the two segments is present.	complete sacralisation	-	-	-
3	90	Senium	M	LV5 - S1	Complete fusion of the two segments is present.	complete sacralisation	-	-	-

4	93A	adult	U	CV3 - CV4	Ankylosis is developed in the left facet joint with irregular/rough surfaces	degenerative origin	VC2 left femur - tibia right calcaneus, left tibia VL-e VT-e	Eburnation of lower facet joint surface is present. Strongly distorted articular surfaces. Strengthened entheses. Small osteophytes are present. Ossification of the ligamentum flavum.	degenerative osteoarthritis degenerative osteoarthritis enthesopathy spondylosis deformans OLF
5	313	Maturus	F	LV5 - S1	Complete fusion of the two segments is present.	complete sacralisation	-	-	-
6	314	Maturus	M	LV5 - S1	Complete fusion of the two segments is present.	complete sacralisation	-	-	-
7	stray find	Senium	U	TV10 - TV11	Complete bony fusion (both anterior and posterior parts) is present. Cloacal openings on bodies: - TV10 - right and posterior side; - TV11 - left side rough body surfaces.		TV10 -TV11 LV5 right femur, os coxae right os coxae	Small osteophyte on the TV10's upper margin. Moderate osteophytes are developed on the upper antero-lateral margin Distorted articular surfaces are seen, new rim formations on the femoral head and in the acetabulum are found. Ossification of sacroiliac ligament.	spondylosis deformans spondylosis deformans degenerative osteoarthritis OSIL
8	stray find	Adultus	F	LV5 - S1	Complete fusion of the two segments is present.	complete sacralisation	-	-	-
9	stray find	Maturus	M	TV5 - TV12	Right side anterior longitudinal ligament ossification. (The fusion continues upwards, but TV4 is missing.)	DISH	TV11 - TV12 TV11 - TV12 TV5 - TV6, TV12 TV5 - TV12 sternum	Left side ossification of the anterior longitudinal ligament. Right side ossification of the anterior longitudinal ligament with no fusion. Costovertebral joint capsule ossification on the right side, gaps are preserved. Foveal distortion (macroporosity, rims). Distorted clavicular incisures.	OALL (DISH) OCL (DISH) degenerative osteoarthritis degenerative osteoarthritis degenerative osteoarthritis

28. Ópusztaszer - Monostor (Árpád age - early modern times, 11-18th c.,1089 individuals)

no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	22	Maturus	M	3 phalanges of the foot (proximal-middle-distal)	The joint gap at the proximal interphalangeal joint fusion is partly recognizable; roughness and porosity of the bony surfaces are found. While the PIP joint is fixed in extension, the fusion of the distal interphalangeal joint resulted in flexion of 90 degrees. Great bony mass is visible laterally along the PIP and DIP joints. The participation of the collateral ligaments in the development of this bony mass is possible, although it cannot be said with certainty.	posttraumatic - infection (?)	right clavicle 2 ossa coxae 2 ossa coxae TV-e, LV-e left zygomatic right femur, tibia, fibula	Distorted acromio-clavicular and acatebular surfaces. Strenghtened entheses. Moderate bony outgrows at vertebral bodies. Dislocated and healed lateral part is recognizable. Striation and pitting in the diaphyses.	degenerative osteoarthritis enthesopathy spondylosis deformans healed cut / fracture periostitis
				LV5 - S1	Fusion of the two segments, lateral parts, bodies and left zygapophyseal joint surfacesare involved.	sacralisation	no CO, CC, ECL, LEH		
2	37	adult	U	LV2 - LV3	Fusion of the vertebral bodies by left side ossificatin of the anterior longitudinal ligament. Intervertebral spaces and facet gaps are not involved.	DISH (?)	LV3 - LV4 LV3 LV3 - LV4 LV3 - LV4	Slight ossification of the supraspinous ligament and the ligamentum flavum. Slight left side ossification of the anterior longitudinal ligament with no fusion. Slight distortion of facet surfaces. Intervertebral space is bigger at the left side, it caused slight angulation of the spine	OSSL, OLF (DISH?) OALL (DISH ?) degenerative osteoarthritis scoliosis (right side)

3	47	Adultus	M	sacrum, left os coxae - art. sacro-iliaca	Unilateral, left side fusion at sacro-iliac joint (no ligament ossification, the joint itself is fused). Fusion line is clearly visible.	unknown (seronegative arthropathy ?)	TV8 - TV9 TV-e, ribs TV-e, LV-e VL1-VL5 left clavicle right rib	Right side ossification of the anterior longitudinal ligamentum with no fusion. Distortion of the foveae. Slight - moderate bony outgrows at vertebral bodies. Remodeled surface on the anterior side of the vertebral bodies. Callus formation on mid-shaft. Callus formation close to the sternal end.	OALL degenerative osteoarthritis spondylosis deformans periostitis (unknown origin..similar to chars found in TB cases) healed fracture healed fracture
4	91	Maturus	M	sacrum, right os coxae	Right side fusion at the sacro-iliac joint by sacroiliac ligament ossification. The superior part of the sacroiliac jointis involved, the auricular surfaces are intact.	unknown (DISH?)	right os coxae right os coxae, 2 tibiae right rib	Distortion of the acetabular rim. Strenghtened entheses (ischiac tuberosity, tibial tuberosity). Lamellar ossification on the ventral side at the costal angle. Rib is flattened at the same area.	degenerative osteoarthritis enthesopathy unknown (post-traumatic ossification?)

5	174	Maturus	M	left tibia - fibula	Fusion at proximal tibio-fibular joint. The medial tibial condyle is in a lower position than the lateral one; this possibly congenital condition may play an important role in the development of degenerative alterations in the proximal tibiofibular joint. Signs of fracture or infection are not recognizable in the skeleton.	degenerative origin	2 tibiae left tibia - femur right tibia - patella 2 clavicles, 2 scapulae, 2 humeri, 2 femori CV-e, TV-e, LV-e CV-e, TV-e, LV-e left tibia 2 left ribs left clavicle no CO, CC, ECL, LEH	Medial condyles is much lower than the lateral ones. Distorted distal femoral and proximal tibialarticular surfaces. Strong distortion and new rim formations on joint surfaces. New bony formations and distortion of the femoral and humeral heads, clavicular ends and glenoid cavities. Slight distortion of facet surfaces and the foveae of the ribs. Moderateosteophytes at vertebral bodiesstrengthened enthesis (tub. tibiae). Callus formation on mid-shafts. large new bony formations at the distal 1/3 of the clavicle (it reaches the scapula (missing)	developmental defect degenerative osteoarthritis (secondary?) degenerative osteoarthritis enthesopathy degenerative osteoarthritis spondylosis deformans healed fractures unknown, no signs of a fracture (traumatic origin?)
6	330	Juvenis	U	TV3 - TV4	Complete fusion of the two vertebrae at posterior elements involving the arches and facets. Fusion line is smooth. Bodies are intact.	synostosis vertebralis - developmental	TV-e	Increased vessel impressions on the lateral sides of the vertebral bodies.	hypervascularization (infection?
7	343	Infantia II	U	2 left ribs	Complete fusion of the two ribs at the head. Smooth fusion line is seen, no signs of previous fracture or infection is found.	synostosis costarum - developmental	TV-e no rib PO	increased vessels on the lateral sides of the vertebral bodies	hypervascularization (infection?
8	369	Maturus	M	LV5 - S1 corpus sterni - manubrium sterni - processus xyphoideus	Complete fusion of the 2 segments, all parts are involved. Fusion of the 3 segments.	sacralisation unknown (developmental?)	LV5 - left os coxae lower TV-e mandibular front teeth no CO, CC, ECL	Assymetric ligament ossification with no fusion at the left sacro-iliac joint. Auricular surfaces are intact. slight distortion of the facet surfaces and the foveae single striation on the labial surfaces of the crowns	unknown degenerative osteoarthritis linear enamel hypoplasia

9	381	Maturus	F	CV2- CV4	Fusion of the three vertebrae. Fusion developed at posterior margins of the bodies, at facet joints (right: CV2-CV4; left: CV3-CV4). Fusion area is bumpy, irregular structure is seen.	degenerative origin	CV1 - CV2 CV4 - TV1 CV1 no CO, CC, ECL, LEH	eburnation on atlanto-axial joint surfaces strong distortion and macroporosity on facet surfaces (both side). Eburnation is present on CV4-CV5 (bilaterally) and on CV6-CV7 (right side) facets. opened foramina transversarium	degenerative osteoarthritis degenerative osteoarthritis anatomic variation
10	387	Adultus	F	CV1 - CV2	Complete fusion of the two vertebrae at all vertebral elements (except for the right arch). Atlanto-axial joint is disappeared, new articular surface developed superiorly that connets to the occipital base. All fusion lines are smooth, no signs of fracture or infection are seen.	synostosis vertebralis - developmental	CV2 LV3 occipital skull - endocranial surface	Partly open spinous process. Separated posterior arch. New condylar surface appears between the two occipital condyles. Branching vessel pattern with no discoloration on the endocranial side of the calvarium.	spina bifida (partial) spondylolysis condylus tertius (anatomic variation) infection
11	392	Infantia II	U	2 ribs	Complete fusion of the two ribs at the head. Smooth fusion line is seen, no signs of previous fracture or infection is found.	synostosis costarum - developmental	left orbit no CC, ECL	porotic lesions of the orbital roof (right one is not examinable)	cribra orbitalia
12	466	Adultus	F	CV2 - CV3	Fusion of the two vertebrae at posterior elements. Right arch is completely, left side of the arch is partly fused. Both facets are partly fused. Fusion line at the right facet joint is a bit irregular, bumpy area is visible.	degenerative origin	LV4 - LV5 S1 TV10 - TV12 no CO, CC, ECL, LEH, rib PO	Separated posterior arches of the two vertebrae (arches are lost). Partially fused posterior elements. Increased vessel imprints on the right side of the bodies.	spondylolysis lumbalisation hypervascularization
13	557	Senium	M	LV5 - S1 LV3 - LV4 TV3 - TV4	Bilateral fusion of the vertebral bodies by syndesmophyte-like connections. Disc spaces are normal, zygapophyseal joints are missing. The right side ossification of the anterior longitudinal ligament resulted in fusion. Disc spaces seem to be normal. Zygapophyseal joints are missing.	DISH (?) DISH	TV4 - TV8, TV10 - TV11 LV3-LV5	Right side ossification of the anterior longitudinal ligament with no fusion. Disc spaces seem to be normal, zygapophyseal joints are missing. Large osteophyte-like projections on the anterior margins of the vertebrae.	DISH Degenerative osteoarthritis or DISH (?)

14	572	Senium	F	CV2 - CV3	Complete fusion of the two vertebrae at all parts of the vertebrae. Smooth fusion line is present, no signs of traumatic event or infection are seen.	synostosis vertebralis - developmental (?)	no CO, CC, ECL, LEH	-	-
15	605A	Maturus	F	TV12 - LV1	Complete fusion vertebral bodies, the fusion line is irregular with wavy surface. TV12's anterior part is collapsed a bit rsulted in slight kyphosis. TV12's anterior surface is irregular with a small bony bridge (0.5 mm wide, 5-6 mm long) on the right side. Posterior elements and facet gaps are intact.	post-traumatic (fracture)	LV1 TV12	New bony bridge with no fusion between spinous processes (at the beginning of them). Distortion of the left side costal fovea of the TV12.	ossification of the anterior part of the interspinous ligament - unknown origin degenerative osteoarthritis
16	631	adult	M	TV12 - LV1	Fusion of the vertebral bodies by bilateral ossification of the anterior longitudinal ligament (left side is more developed); intervetebral spaces and facet joint gaps are not involved.	DISH	TV12's upper plate, from LV1 lower plate to LV4 lower plate TV12 - LV4 TV12 - LV3 TV12 - LV1 TV12 - LV1 LV2 TV12 - LV4	Bilateral ossification of the anterior longitudinal ligament. Moderate osteophytosis on the vertebral bodies' anterior side. Ossification of the supraspinous ligament. Ossification of capsular elements at the right facet joint. Ossification of capsular element at left costo-vertebral joint. Abscess at body's right margin surrounded by new bony formations. Distorted facet surfaces.	OALL (DISH) spondylosis deformans OSSL (DISH?) capsular element ossification (DISH?) capsular element ossification (DISH?) infection (non-specific? degenerative osteoarthritis

17	644	Senium	M	TV8 - TV9, TV11 - TV12	Complete fusion of the 2x2 vertebrae by the ossification of anterior ligament . Facet joints are preserved, slight ligamentum flavum ossification is seen, no other changes are found.	DISH	TV8 - TV9	Chondrocalcinosis developed between vertebral plates.	chondrocalcinosis (DISH ?)
							TV9 - TV11	Right side ossification of the ligamentum flavum with no fusion	OLF (DISH?)
				corpus sterni - manubrium sterni	complete fusion o the 2 segments	unknown (developmental ?)	os coxae - femur	Distorted articular surface of the hip joint	degenerative osteoarthritis
							2 tibiae, 2 femori, 2 ossa coxae, right patella	Strengthened entheses.	enthesopathy
							TV-e, sternum	Distorted vertebral foveae and clavicular incisures of the sternal manubrium.	degenerative osteoarthritis
							sternum	Bilateral ossification/calcification of the first rib cartilage.	cartilage ossification (DISH?)
							sternum	Ossification at costal incisures (anterior sternocostal ligaments).	OASCL (DISH?)
							frontal bone	divided frontal bone	metopic suture (anatomic variaton)
							skull	granular impressions on the endocranial surface of the calvarium	endocranial lesions
							no CO, CC		

18	774	Senium	F	right talus - calcaneus TV4 - TV7	The unilateral ankylosis involved the anterior, the middle and the medial part of the posterior surfaces, while the joint gap at the lateral half of the posterior articular surface is recognizable. The fusion line is irregular and bumpy area is found around it. No signs of infection or fracture are seen, but the distortion of all talar joint surfaces is present. Fusion of the 4 segments at the anterior part of the vertebral bodies. Very slight osteophytes are seen, no ligament ossification are found, but irregular vertebral body margins are present. Intervertebral spaces and facet joints are not involved.	degenerative origin degenerative origin	right talus, calcaneus right calcaneus VC-e, VT-e, VL-e VT-e, VL-e	Distorted joint surfaces of the two bones. Strenghtened enthesis at the insertion of the Achilles tendon. Moderate bony osteophytes at the vertebral bodies. Slightly distorted facet surfaces.	degenerative osteoarthritis enthesopathy spondylosis deformans degenerative osteoarthritis
19	808	Senium	M	CV7 - TV1	Fusion at right posterior element (behind the facet joint). Left zygapophyseal joint is not involved. Vertebral bodies and right side facet joint is missing.	unknown (degenerative origin?)	TV1	Small bony spicule between the two spinous processes, fusion does not appear.	unknown (degnerative origin?)

20	865	Senium	F	sacrum - 2 ossa coxae	Bilateral fusion of the three bones (right side: complete, no ligament ossification; left: fusion in the centre of the auricular surface, peripheral areas are not involved, but macroporosity is seen).	unknown (SPA?)	left os coxa	Strong lytic lesions (signs of fusion in the centre of the surface).	sacroileitis
							TV12	Vertebral body is biconcave, the vertebra is very porotic.	osteoporosis
				LV4 - LV5	Complete fusion of the posterior parts of the vertebral bodies (no original borders are recognizable, anterior parts are missing) and the inferior part of the zygapophyseal joints.	unknown (SPA or degenerative origin?	TV-e, LV-e	Distorted facet joints.	degenerative osteoarthritis
				LV1 - LV2	Complete fusion of the posterior parts of the vertebral bodies (anterior parts are missing), facet joints are not fused.	unknown (SPA or degenerative origin?			
				TV10 - TV11	Fusion of the vertebral bodies (right anterior side and interior part), original body margins are visible on lateral parts. Posterior arches and facets joints are not involved.	unknown (SPA or degenerative origin?			
21	872	Maturus	M	right 2nd metacarpal - trapezoid	Complete bony ankylosis with no sign of fracture. Fusion line is not recognizable. Slight porosity of the MC2's proximal end and the trapezoid.	septic arthritis (?)	right 1st metacarpal - 2nd metacarpal	Strongly distorted proximal ends of the metacarpals.	degenerative osteoarthritis
				right 3rd metacarpal - capitate	Complete bony ankylosis with no sign of fracture. Fusion line is not recognizable. Slight porosity of the MC3's proximal end and the capitate.	septic arthritis (?)			
22	905	subadult(Inf. II or Juv)	U	TV5 - TV6	Complete fusion of the two segments at posterior elements, both facets and spinous processes are involved. Fusion line is smooth, no signs of infection or trauma are found. Bodies are intact.	synostosis vertebralis (developmental)	TV-e	Increased vessels at the laantero-lateral parts of the vertebral bodies.	hypervascularization (infection?)

23	926B	adult	M	3 TV? (mid thoracic spine)	Anterior side ligament ossification, intervertebral gap is not narrow, small facet joints are not involved.	DISH	3 VT? (mid region) right femur, right radius right femur, humerus, ulna, radius, left scapula	Slight ossification of the ligamentum flavum. Strenghtened entheses. Distorted joint surfaces (femoral head, proximal and distal humeral ends, proximal ulnar end, distal radial end, scapular glenoid cavity), new rim-formations.	OLF (DISH?) enthesopathy degenerative osteoarthritis
24	939	Maturus	F	LV5 - S1 LV3 - LV4 2 right ribs manubrium sterni - corpus sterni	complete fusion at bodies and at all posterior elements (height of VL5 is extremely small) Partial fusion of the bodies (lateral and interior parts are involved) and the posterior elements. Vertebral bodies' margins are irregular, small osteophytes are also seen here. Vertbral bodies' anterior surface is irregular, slight new bony appositions are seen. Fusion at the costal neck. Smooth surface, no sign of fracture or infection Complete fusion of the 2 segments (smooth surface, the original joint line is not visible).	sacralisation degenerative origin developmental defect (synostosis costarum) unknown (developmental?)	LV4 - LV5 TV1 - LV5	Strongly distorted facet joints (eburnation on both side). Slight osteophytosis on vertebral bodies.	degenerative osteoarthritis spondylosis deformans
25	R6 (stray find)	adult	U	TV7 - TV10	Fusion of the vertebral bodies by bilateral ossification of the anterior longitudinal ligaments. Facet joints, intervertebral spaces are preserved.	DISH	TV7 - TV10 TV7 - TV10 TV7 - TV9	Costovertebral fovae are distorted. Ossification of the ligamentum flavum. Ossification of the left side costovertbral capsular elements.	degenerative osteoarthritis OLF (DISH?) OCL (DISH)
26	R-58 (stray find)	adult	U	CV6 - CV7	Complete fusion of the vertebral bodies by the bilateral ossification of the anterior longitudinal ligaments Posterior elements (arches, facet joints) are not involved.	unknown (DISH?)	CV-e TV12 - LV1	Distorted vertebral enplates (macroporisity) with slight - moderate osteophytes. Depressions on the facing vertebral plates.	Spondylosis deformans Schmorl-nodes

27	R-IIId (stray find)	adult	U	CV1 - CV2	Fusion of posterior arches and zygapophyseal joints of the two segments. Fusion line is smooth, no signs of fractures or infection are seen.	synostosis vertebralis (developmental)	-	-	-
28	R- UN (stray find)	adult	U	LV5 - S1	Complete fusion of the vertebral bodies. Unilateral ankylosis of the left lateral elements, posterior elements and zygapophyseal joints are not involved.	sacralisation	LV5	Small osteophytes on the lateral margins of the vertebral body.	spondylosis deformans

29. Szeged - Vár (late Middle ages,14-15th c. AD, 641 individuals)									
no. of cases	grave no.	age at death	sex	ankylosis			other lesions		
				localisation	description	diagnosis / aetiology	localisation	description	diagnosis / aetiology
1	148	Senium	M	CV3 - CV4	Fusion of the vertebrae, both side zygapophyseal fusion is found. The lfusion on the left side is rough, bumpy, partial fusion is found on the right side.	degenerative origin	CV-e, TV-e, LV-e right scapula	Moderate bony outgrows at vertebral bodies. Eburnation on the scapular glenoidal surface is seen.	spondylosis deformans degenerative osteoarthritis
2	156	Mat - Sen	M	proximal and middle phalanges of the hand	Ankylosis of one of the proximal interphalangeal joints of the hand is present, the bones are fixed in a severe flexion (about 85 degrees). The joint is partly recognizable, large irregular surface thickening at the fusion area is found. (Sub)luxation of the middle phalanx is seen, this process may be responsible for the development of the ankylosis, but we cannot rule out the role of degenerative alterations, these changes may developed after the traumatic process.	degenerative and posttraumatic origin (?)	left ulna	Healed, non-dislocated fracture resulted in callus-formation in the distal third of the ulna.	fracture (healed, non-disclocated)
3	164	Maturus	M	LV2 - LV3	Fusion of the vertebral bodies (strict line, no signs of inflammation) is seen, small facet joints are not involved.	synostosis vertebralis - developmental (?)	2 clavicles, bones of the hand, sternum V-e V-e 2 patellae, calcanei	Pitting formations - macroporosity at joint surfaces. Slight bony osteophytes in the vertebral bodies. Irregular shape depressions on the vertebral plates. Strenghtened entheses.	degenerative osteoarthritis spondylosis deformans Schmorl's node enthesopathy

4	206	Maturus	M	TV4 - TV5	Anterior and right-side fusion with thin fusion line is seen. The right-side small facet joint and the posterior arch are involved; the left-side facet joint is intact. TV4 is slipped to left side (with 2-3 mm), and the fusion resulted in a very slight scoliosis (via right side).	degenerative origin	TV4 thoracic spine	Non-united fracture is found on the left side of the posterior arch. Slight curvature is is seen via right side.	fracture (healed, non-disclocated) scoliosis
5	209	Adultus	F	corpus sterni and manubrium sterni	Fusion of the two parts of the sternum (no visible line between the segments, no angulation).	developmental (?)	sternum sternum	Spongious lytic lesions on the ventral manubrium surface are present. Sght distortion of the clavicular incisure of the manubrium.	infection (?) degenerative osteoarthritis
6	236	Mat - Sen	M	corpus sterni and manubrium sterni	Fusion of the two parts of the sternum (no visible line between the segments, no angulation).	developmental (?)	sternum	Slight distortion of the clavicular incisure of the manubrium.	degenerative osteoarthritis
7	262	Maturus	F	TV9 - TV10	Porotic vertebral bodies are present. Fusion of the two vertebrae (bilateral small facet joints and body fusion (both side; some small bony bridges at the anterior margin)). Irregular fusion lines are seen. The body of the TV9 is decreased in its height (less than half of the original height is found). Small posterior direction angulation resulted in slight kyphosis.	posttraumatic - compression fracture	TV-e, LV-e	Light, porotic vertebrae are present.	osteoporosis (senile)
8	264	Adultus	M	CV4 - CV5	Fusion of the two vertebrae is present, all vertebral parts are involved. The fusion line is hardly recognizable, smooth aspect is visible. Vertebral corpora are short.	developmental - Klippel-Feil syndrome (?)	left scapula 2 clavicles sternum	Deformed, more curved scapula is seen. More developed curve of the two scapulae are found. Non-united 1st and 2nd sternal segments.	developmental (KF syndrome?) developmental (due to KF syndrome?) developmental
9	290	Maturus	M	TV8 - TV12	Complete bridges developed asa result of the ossification of the right anterior longitudinal ligament (no sacro-iliac and zygapohyseal involvement, intervertebral spaces are not narrow).	DISH	upper and lower limbs TV-e TV-e right humerus TV-e	Strenghtened entheses. Slight ossification of the ligamentum flavum. Calcification of the vertebral disc surfaces are seen. Collateral ligaments of the elbow are ossified/calcified. Distortion of the foveae are seen on the right side.	enthesopathy (DISH?) OLF (DISH?) chondrocalcinosis (DISH ?) ligament ossification (DISH?) degenerative osteoarthritis

10	291	Maturus	M?	right tibia -talus	The right tibia and the talus are fused. The fusion line is not visible, smooth aspect is seen. The tibial shaft is swollen; its surface presents irregular, partly spiculous, partly undulating areas. Oval shaped, slightly protruding areas characterized with porous new bone formation may be associated with a skin ulcer. Two cloacal openings can be seen on the anterior side of the distal tibial shaft, one of them is oval, while the upper one is elongated in its shape.	septic arthritis - postraumatic (?)	right tibia right fibula right talus	At the line of the two cloacae slight linear depression may be the sign of a healed oblique fracture of the distal tibia. Small callus formation on the mid-shaft (no angular alteration) is seen. Slight distortion of the subtalar surfaces is recognizable.	osteomyelitis healed fracture healed fracture degenerative osteoarthritis
11	303	Maturus	M	TV7 - TV8, TV9 - TV10	Complete fusion of the two blocks of the vertebrae is seen caused by the ossification of the right side anterior longitudinal ligament. No sacro-iliac and zygapohyseal involvement is found, intervertebral spaces are preserved.	DISH	TV5 - TV7, TV8 - TV9 LV4 - LV5 2 ossa coxae, 2 femora, ribs, 2 humeri, 2 clavicles TV-e left clavicle 2 ossa coxae	Right-side anterior longitudinal ligament ossification with no complete bony bridges are present. Slight bilateral anterior longitudinal ligament ossification is found. Strenghtened entheses. Foveal distortion on the right side of the vertebrae. Strong angulation close to the acromial end (with strong entheses) is found. Slight distortion of the lunate surfaces are recognizable.	OALL (DISH) OALL (DISH) enthesopathy degenerative osteoarthritis healed fracture degenerative osteoarthritis

12	483	Adultus	F	TV8 - LV3	Fusion of 8 segments. All zygapophyseal joints are involved. Vertebral bodies of TV8 - LV2 are completely, bodies of the LV2 - LV3 are partly ankylosed and destroyed: TV8: carious lesions, no collapse; TV9- LV2: as a result of the anterior collapse of the vertebral bodies kyphotic angulation of 90 degree is formed (Pott's gibbus). LV3: carious lesions are present, no collapse. The vertebrae are characterized by irregular surfaces, the original joint gaps and disc spaces are hardly recognizable.	TB - Pott's disease	thoracolumber border	Irregular shaped amorphous bony mass is formed on the left side of the remnants of the vertebral bodies.	soft tissue calcifictaion (?) - TB
13	486	Senium	M	CV2 - CV4	Complete bony fusion of the three vertebrae.Intrevertebral body fusion between CV3 and CV4, bilateral zygapophyseal fusion at all involved vertebrae are present. Posterior arches are missing. Fusion areas present iregular fusion lines, bumpy areas are found in all articulations.	degenerative origin	2 clavicles, CV1-CV2, CV4 - CV7 CV-e, TV-e, LV-e	Distorted shapes of the joint surfaces with new rim-formations are recognizable. Slight - moderate bony osteophytes of the vertebral bodies are present. Moderate-strong bony osteophytes of the vertebral bodies are present.	degenerative osteoarthritis spondylosis deformans spondylosis deformans
				LV2 - LV3	Bony fusion of the left side of the vertebral bodies by smooth surfaced syndesmophyte-like bony bridges. Disc spaces are preserved, chondrocalcinosis on the vertebral endplates are seen. Zygapophyseal joints are missing.	degenerative origin (?)	2 scapulae, 2 tibiae, 2 femora, 2 fibulae 2 maxillae, 2 parietals	New lamellar and porous bony appositions are seen. in the diaphyses. Increased density of blood vessel impressionsin the sinuses and on the endocranial surfaces are seen.	periostitis infection

14	516	Maturus	M	right 3rd metacarpal - proximal and middle phalanges	The right 3rd metacarpal and the proximal and middle phalanges of the hand are affected in the fusions. The ankylosis resulted in a slight curvature of the middle finger; the bones are fixed in a slight flexion position. The longitudinal axis has changed as well, very slight varus deformity of the phalanges is found. The area of the metacarpophalangeal ankylosis is swollen a bit, smooth surface is present here. In the proximal interphalangeal fusion two different phenomena are recognizable. The palmar side thickening may be the result of the ossification/calcification of the palmar interphalangeal ligament, while the presence of carious bony ends are visible on the dorsal and lateral sides may be suggestive of both degenerative and rheumatoid arthritis. Surfaces of the three bones present both undulating and porotic appearance, these periosteal changes may be associated with some infectious process.	infectious arthritis - degenerative or rheumatic origin (?)	bones of the right leg, 7th - 8th. ribs, 2 clavicles, right humerus, hip joint 2 hallux 2 tibiae TV7 - TV10	Distorted shape of the joint surfaces are seen. Eburnation is found on the distal ends. Lamellar bony apposition at mid-shaft is present. Slight depressions on the vertebral endplates are found.	degenerative osteoarthritis degenerative osteoarthritis periostitis Schmorl's nodes
15	517	Maturus	U	occipital - CV1 CV3 - CV4	Bony fusion of the zygapophyseal joints. Irregular fuion lines are seen, the fusion resulted in slight curvature ofthe cervical spine's axis. Other vertebral/occipital parts are not involved in the ankylosis. Bony fusion of the two vertebrae in the posterior part of the vertebral bodies and in the right small facet joint. Left side posterior elements are missing. Fusion areas are bumpy, irregular winding fusion lines are present.	degenerative origin degenerative origin	2 tibiae, 2 femora, 2 ulnae, 2 radius CV-e, TV-e, LV-e CV2 right orbit 2 parietals skeleton	Porous bony apposition are seen in the mid-shafts. Slight - moderate bony outgrows are found in the vertebral bodies. Distortion of the dental process, lytic lesion on the anterior side also can be seen. The right upper small facet joint surface is distorted. Pitting on orbital roof is recognizable. Granular lytic alterations on the endocranial surface are present. Very light, porotic bones are found.	periostitis spondylosis deformans degenerative osteoarthritis cribra orbitalia (porotic stage, unilateral) endocranial lesions -infection (?) senile osteoporosis

16	528	Mat - Sen	M	TV3 - TV4	Complete fusion of the vertebral bodies is developed, the fusion line is poorly visible (taphonomical reasons). The height of the TV4 is decreased a bit. Concerning the small facet joints, periarticular fusion with no intaarticular involvement is seen on the right side. Left zygapophyseal joint is lost post mortally.	posttraumatic (compression fracture) - degenerative origin (?)	TV-e metatarsals	Small bony osteophytes on the margins of the vertebral bodies are present. Extensive porous new periosteal appositions are present in the midshafts.	spondylosis deformans periostitis
17	561	Maturus	U	LV3 - LV5	Vony fusion of the three vertebral bodies with no angular kyphosis. Verteral bodies: LV3: the original height is recognizable. It is fused to the LV2, two small cloacal openings on the anterior side of the body are present. LV4: destruction/collapse of the inferior part of the body is seen, teardrop-shaped 'cloaca-like' drainage on the anterior and left side of the body is found. LV5: the post mortem destruction of the upper part of the body impedes the reconstruction. Small bony remodeling on the anterior surface is seen . The lower plate is intact. Posterior arches: complete bilateral fusions involving the small facet joints are present.	pyogenic infection (?)	TV-e no rib PO, CO, CC, ECL, HV	Slight distortion of the facet surfaces are present.	degenerative osteoarthritis