Past, Present and Future of Partial Extraction Therapies

Summary of the PhD thesis

by

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1. INTRODUCTION

Tooth loss has always been a challenge in dentistry due to the physiological alterations that occurs to the bone structure following extraction. When replacing missing teeth with implant-supported restorations, the timing of implant placement is crucial to maintain adequate tissue volume and aesthetic results. Since most post-extraction dimensional changes take place between 3-6 months, delayed protocols for implant placement result in bucco-palatal collapse of the alveolar bone as well as gingival recession.

Immediate implant placement has been a mainstay of treatment for many years and has shown excellent long and medium-term survival, comparable with delayed implant placement approaches. However, despite the advantages of one single surgical procedure, shorter treatment duration and higher patient acceptance, immediate implant placement per se does not counteract the natural bone remodelling process, hence it cannot not prevent the collapse of the buccal bone. The collapse of the buccal plate, then, brings about secondary problems, including gingival recession, collapse of the bucco-palatal ridge, and collapse of the papilla.

Current concepts for the preservation of the buccal plate include socket grafting, augmentation of the buccal wall, immediate implant placement, and partial extraction therapies. The present thesis deals with partial extraction therapies: root submergence, the socket shield and the pontic-shield.

II. PROBLEM, HYPOTHESIS AND OBJECTIVES

Statement of the problem

The buccal bone wall is mainly composed of bundle bone, being a tooth-dependent structure. Following tooth loss, the buccal bone collapses, leading to irreversible horizontal and vertical alveolar bone loss, which usually results in functional and aesthetic complications, including decreased ridge volume, collapse on the interdental papilla and gingival recession. Current available treatment options are not able to prevent alveolar ridge collapse nor recreate the volume of bone lost.

Hypothesis

The preservation of a natural tooth root or part thereof provides an effective and predictable approach to circumvent post-extraction dimensional changes that result in the resorption of the alveolar bone at immediate implant sites and pontic sites, due to the maintenance of vital bundle bone and periodontal ligament apparatus in the facial aspect of the tooth.

Objectives

The overall objective of the seven studies covered by this thesis was to provide proof of concept for PETs in terms of clinical application and long-term results, including implant survival, reproducibility, efficacy and safety of this approach through case series, case reports and technique reports.

III. RESULTS

III.1. Case Series

III.1.1. Case series #1[1]

In the first case series, the aim was to to evaluate the survival of immediate implants placed in conjunction with the socket shield technique in 128 patients, who were followed up for 1-4 years.

From the 128 implants, 123 (96.1%) survived.

In total, 25 (19.5%) sites presented complications (internal or external exposition, infection, failure, migration). From those, five implants failed during initial osseointegration and had to be removed and replaced in two cases. In these five early failures, three shields were still intact.

The use the patient's own dental structures with the socket-shield technique was found to be effective in terms of implant survival after up to 4 years follow-up. The implant survival and complication rates observed were comparable to conventional immediate and delayed placement.

[1] Gluckman H, Du Toit J, Salama M. The pontic-shield: partial extraction therapy for ridge preservation and pontic site development. Int J Periodontics Restorative Dent. 2016 May-Jun;36(3):417-23.

III.1.2. Case series #2[2]

In the second case series, a modification of the socket-shield technique (the pontic-shield) was examined in 10 systematically healthy patients. The extraction sockets were filled with an augmentation material (xenograft) and sites were left to heal for at least three months, after which an interim fixed partial denture (FPD) was fabricated with moderate pressure at the pontic areas over the following 3 months. The final restorations were placed after the sockets had fully healed with no evidence of shield exposure. Patients were followed-up after 12 and 18 months.

Through subjective observation of the occlusal and facial aspects of the pontic sites, ridge preservation was achieved in all 14 cases after 12- and 18-months recall. Complication was observed in one patient, where 3 pontic-shields were exposed due to the lack of adequate soft tissue closure during surgery.

It was concluded that the pontic-shield can be a suitable approach for the preservation of the alveolar ridge at pontic sites.

[2] Gluckman H, Du Toit J, Salama M. The pontic-shield: partial extraction therapy for ridge preservation and pontic site development. Int J Periodontics Restorative Dent. 2016 May-Jun;36(3):417-23.

III.2. Case Reports

III.2.1. Case Report #1[3]

During a routine periodontal check-up, a systemically healthy female patient, 45 years of age, had a history of immediate implant placement and reported discomfort around the implant crown, located at the left side, at maxillary first premolar. The dental history included loss of the left maxillary premolar two years earlier, immediate implant placement, submerged healing, implant exposure and cementation of the definitive crown. Upon clinical examination, a deep pocket was present in the mid buccal aspect of the implant, with bleeding on probing. On a periapical radiograph, a foreign object was noticed in the mesial aspect of the implant and diagnosed as a root fragment. The implant and the adhered root fragment were removed and prepared for histological analysis. The socket received an allograft combined with recombinant human platelet-derived growth factor-BB, which was covered with a titanium-reinforced membrane and a collagen membrane before flap closure. Three months later, another implant was placed and later restored.

Histological findings: The fragment was confirmed as being part of a dental root, with dentinal tubules and outer

[3] Schwimer C, Pette GA, Gluckman H, Salama M, Du Toit J. Human Histologic Evidence of New Bone Formation and Osseointegration Between Root Dentin (Unplanned Socket-Shield) and Dental Implant: Case Report. Int J Oral Maxillofac Implants. 2018 Jan/Feb;33(1): e19-e23.

cement. The tissue observed between the implant threads was vital bone with osteocytes and vacuoles containing remnants of dentin fragments, which were most probably dislodged during insertion of the implant. the bone tissue between the threads presented mineralization with concentric lamellae, that is, mature bone.

This case report of an unplanned socket-shield at an immediate implant site suggests that the space between dentin, bone and implant surface can be occupied by bone tissue, which is the ideal outcome for the long-term success of dental implants.

III. 2.2. Case Report #2[4]

A healthy, non-smoking, adult male, 43 years of age, presented with a ferrule-less central maxillary incisor (tooth 21). The tooth had endodontic treatment with a failing post-core crown. Immediate implant placement was planned concomitant with socket-shield preparation. After local anaesthesia, the crown was removed, and the root was sectioned in a mesio-distally with a long-shank resection bur. With the help of periotomes, the periodontal ligament was severed in the palatal area, after which the palatal fragment was carefully removed. The buccal section of the root was reduced coronally to 1 mm above the crest, and thinned into a concave contour using a long-

[4] Gluckman H, Du Toit J, Salama M. The socket-shield technique to support the buccofacial tissues at immediate implant placement. International Dentistry African Edition 2015;5(3):6-14.

shank round diamond bur. The socket's palatal wall and the apex were curetted to remove potentially infected tissue and the immobility of the shield was confirmed using a sharp probe. The osteotomy for a 4 x 13 mm internal conical connection implant was prepared and the implant was inserted palatal to the socket shield with the help of a surgical guide.

A xenograft was placed in the jump gap. The implant received a provisional crown with an S-shape emergence profile, in order to provide adequate space for soft tissue growth between the crown and the shield.

Healing was uneventful and the implant was successfully osseointegrated and presented optimal cosmetic results after 1-year follow-up, with soft tissues comparable to the neighbouring natural central incisor. The final CBCT showed thick facial tissues at the implant site.

Management of post-extraction ridge alterations is a common challenge in restorative dentistry. The socket-shield constitutes a promising solution for the prevention of post-extraction alveolar loss and this study reports the stability of the outcome after a year.

III.3. Technique Reports

III.3.1. Technique Report #1[5]

Partial extraction therapies, such as the socket-shield technique, use the patient's tooth tissues and periodontium to preserve the alveolar ridge and limit postextraction resorption. Internal exposure through the overlying peri-implant mucosa has been reported as the most common complication, suggesting that the preparation technique requires modification. In this report we proposed an approach to the prosthetic management of the socket-shield technique, emphasizing preparation of the shield to the bone crest, and the creation of an S-shape prosthetic emergence profile to support maximal soft tissue infill.

Internal exposure can be nearly avoided through a reduction of the height of the shield in its coronal portion. In order to optimize long-term results, the prosthetic management of the site is also imperative and needs to include a customized transgingival healing abutment prepared in an S-shape, in order to allow for maximal infill of the coronal soft tissue around the interim and definitive restoration. When these steps are followed, the rate of complication decreases substantially, thus increasing the efficacy of the socket shield technique.

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[5] Gluckman H, Nagy K, Du Toit J. Prosthetic management of implants placed with the socket-shield technique. J Prosthet Dent. 2018 Dec 13.

III.3.2. Technique Report #2[6]

Buccopalatal collapse of the postextraction ridge is a significant challenge in restorative and implant dentistry. A variety of ridge preservation techniques using tissue and augmentative materials have been proposed in the literature. A slightly different approach is to use the tooth itself. Root submergence has been reported in the literature for more than 4 decades, and it has been demonstrated that the submerged tooth root retains the periodontal tissues and preserves the bone in pontic sites or below dentures to retain the ridge. The socket-shield technique entails preparing a tooth root section simultaneous to immediate implant placement and has demonstrated histologic and clinical results that are highly promising to esthetic implant treatment. The pontic shield technique preserves the alveolar ridge at sites intended for pontic development where the root submergence technique is not possible. This study presents a review of PET, as well a classification and guidelines for their clinical application.

We conclude that when a tooth is indicated for extraction, PET offer a more conservative approach for ridge preservation through the retention of the entire root or part of it. These strategies can enhance pontic sites and preservation interdental and labial soft and hard tissues

[6] Gluckman H, Salama M, Du Toit J. Partial Extraction Therapies (PET) Part 1: Maintaining Alveolar Ridge Contour at Pontic and Immediate Implant Sites. Int J Periodontics Restorative Dent. 2016 Sep-Oct;36(5):681-7.

when combined with immediate or delayed implant placement.

III.3.3. Technique Report #3[7]

PETs are a relatively new development in dentistry, and while the literature had dealt with them for some time, no guidelines were available regarding the exact way of performing these techniques.

In this study, a sequel to Technique Report #2, we sought to address the procedures for root submergence, socket-shield, and pontic shield, step by step, along with complication management. With this publication, we were the first in the dental literature to offer comprehensive clinical guidelines for the application of PETs in the everyday practice. The guidelines are based on the literature of the subject (a substantial part of which consists of the publications of our research group) and our own clinical experience with these techniques. For reasons of space, the guidelines are not discussed in this brief summary- the interested reader is referred to the thesis or the journal publication.

[7] Gluckman H, Salama M, Du Toit J. Partial Extraction Therapies (PET) Part 2: Procedures and Technical Aspects. Int J Periodontics Restorative Dent. 2017 May/Jun;37(3):377-385.

IV. DISCUSSION AND CONCLUSIONS

Over the last four years, our group published a total of seven scientific publications on PET. The retrospective study on the 128 cases (III.1.1.) provided a learning curve, as we changed our technique to become more standardized and to decrease the prevalence of complications after encountering a high prevalence of complications. As a result, the occurrence of internal and external exposure of socket-shields presented a marked reduction, as observed in our clinical practice.

Despite the relatively weak scientific evidence associated with uncontrolled case series and case reports, especially related to the lack of a comparison group, the sample size of the case series including 128 cases and the mid-term follow-up gives credibility to our results (III.1.1.). Through our case series, we were able to expand our knowledge on the socket-shield technique. During the evaluation of PET, the use of comparison groups using other ridge preservation techniques or GBR might result in alveolar ridge collapse, which can raise ethical constraints. Hence, our case series can be considered as a source of clinical knowledge on PET, as it provided new insights on implant survival and on the prevalence of complications associated with the socket shield technique.

Despite the smaller sample size and the lack of objective evaluation of the alveolar ridge, the case series including 14 cases (III.1.2) also contributes with initial data on the

pontic-shield, considering that this was the first case series on this technique.

From the two case reports published by our group (III.2.1. and III.2.2.), the most recent should receive particular attention due to the histological results confirming the presence of mature bone tissue between the implant and an unplanned socket-shield, around the implant and between its threads. These findings provide the first histological evidence on the nature of the tissues formed around a socket-shield in humans.

The last group of publications from our group include three technique reports, aiming at standardizing the clinical steps for each of the PET techniques and for the prosthetic restoration of immediate implants combined with the socket-shield (III.3.1., III.3.2., III.3.3.). These studies provide a solid step-by-step approach to minimize bias in future studies and to guide clinicians and researchers when executing PET.

The publications from our research group have greatly contributed to the current understanding of PET and have led to important clinical changes to increase the predictability, efficacy and overall success of PET. In terms of contribution to society, our studies suggest that the use of the patient's own dental tissues is a safe, reliable and less invasive option to prevent the deleterious bone loss that follows tooth loss.

Among PET techniques, the socket shield has been the most extensively studied by our group and in the literature

in general. Root submergence was extensively studied as a support for removable dentures, however, very few studies have evaluated its use in pontic sites. The pontic-shield is a brand-new technique invented by our group and requires even more consolidation from scientific studies. Altogether, despite the rise in the amount of publications on the topic, there is still a lack of robust controlled trials and our group hopes to keep contributing to the growth of PET as a tool in the clinical management of extraction sockets.

As for the future directions, we are currently developing two new studies on PET, a multi-centre study on implant survival and the prevalence of complications for the socket-shield technique, and a randomized clinical trial to evaluate a new implant design for immediate implants placed concomitantly with the socket-shield.