The Partial Extraction Therapies: Root-mediated Ridge Preservation in Restorative & Implant Dentistry

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I. INTRODUCTION

Face and alveolar ridge changes as a result of tooth loss were documented, classified, and reported more than 60 year ago already. Augmentations are usually necessary to treat the atrophy at edentulous sites, recession at immediate implants, and other tissue loss as a result of extractions. As clinicians in 2020 we still struggle with rehabilitation of such patients. Some authers claim ridge preservation is the solution. These techniques of grafting the sockets with materials also date all the way back about 40 years. Around the same time, the first jaw augmentations were reported. The 1990's saw the first augmentations by bone substitute and membrane, what we now know as guided bone regeneration (GBR). As the GBR era grew widely popular over the years, another technique receded into obscurity. First introduced in the 1970's also, root submergence was a technique to use the patient's own tooth, own tissue, to prevent post-extraction ridge collapse.

Despite decades of commercial industries driving the use of biomaterials, some reports of saving the patient's own teeth have still persisted and were even developed further. There are 20 and 30-year data reporting on molar root resection, saving these teeth instead of extracting them. The early 2000's saw tooth-mediated ridge preservation techniques progress into implant dentistry. There were reports of intentionally placing implants through impacted or ankylosed tooth roots with success. Later there were reports of submerging roots beneath implant-supported fixed partial dentures. These likely led to the socket-shield technique – sectioning the facial root portion such that it remains attached to bundle bone adjacent to the immediate implant, to prevent socket resorption.

Our working group took these techniques, developed them, and combined them into a collective concept known as the partial extraction therapies. This is an umbrella term for selected evidence-based techniques that use the patient's own tooth root to maintain its attachment apparatus for ridge preservation in implant and restorative dentistry. Today, there are abundant reports and studies on these techniques, the majority produced by the team and author of this thesis.

II. STATEMENT OF THE PROBLEM

1. The alveolar ridge loses volume after teeth are extracted. This resorption varies and is greater at multiple sites of adjacent tooth loss.
2. Repairing this loss requires extensive treatment, surgeries, time, discomfort for the patient, considerable financial cost, etc.
3. Industries promote the use of commercial biomaterials, products to "regenerate" alveolar ridge tissues. These techniques and materials also have their limitations and are not all perfect in all cases.
4. Leaving roots to remain within extraction sites has a negative stigma. The "extract-and-augment" mindset has been become more familiar and conventional.
5. Attempting to disprove that mindset is a challenge, that socket grafting does not adequately prevent ridge collapse, that GBR with commercial bone is an imperfect technique, that immediate implant placement does not have the severely poor performances rates that some authors have tried promulgating, etc.
4. Furthermore, convincing doctors with that mindset that there are valid alternatives to extractions, requires substantial evidence.
5. Such evidence to support the partial extraction therapies before about 2015 was limited.

AIMS

Thus, the aim of this thesis was to present a sound argument why the partial extraction therapies are beneficial to both clinician and patient, and to support that argument by making numerous contributions to the literature on the overall topic.

III. METHODOLOGY

Evidence review

The textbook chapters we published set the background for the partial extraction therapies and why other techniques and materials have limitations. The largest systematic review of the root submergence technique was also carried out.

Radiographic studies

Our CBCT studies reported on the anterior esthetic zone. The first study reported on the prevalence of root angulation, and how it relates to immediate implant placement. The data also reported on the thickness of the facial bone plate. The second study measured the width of the ridge, facial bone to palatal, and how that relates to socket grafting/ridge preservation.

Retrospective studies

A retrospective study was carried out to report on the socket-shield technique in 128 patients. Clinical and radiographic data at up 4-years follow-up reported on implant survival, complications, and other treatment outcomes.

Technical reports

Our team published the first technical report on the collective concept known as partial extraction therapies (PET). Several technique reports were subsequently published to prevent the complications identified, to improve methods, etc. We published improved prosthetic management of implants with PET. We provided two technique reports for root submergence. We newly introduced the pontic-shield technique as an alternative to submerging roots with apical pathology. We reported on the first molar socket shield. At two-staged implant treatment, we also described a unique implant exposure technique. Years of research and experience was compiled in our most recent, updated PET protocol for the socket-shield technique.

Histological study in animals

A cross-sectional observational study was carried out of the socket-shield technique in 8 beagle dogs. The study experimented on different preparations of the socket shield.

Histological studies in humans

In a case series, we published histological data from complications after grafting the anterior esthetic zone with connective tissue. Another prospective study showed histological evidence that PRF does not improve alveolar bone healing. Compared to these negative outcomes, in another study we published histological evidence from a patient of bone growth possible between an implant and a root portion.

Web-based questionnaire study

We carried out an online survey reporting data from 260 clinicians, to demonstrate which ridge preservation techniques they prefer, and possibly why root submergence is not widely reported on today.

Pre-clinical cadaver study

A pre-clinical human cadaver study was carried out, to test a digital guided approach to the socket shield. Reported in this thesis are several prototypes we tested with promising results.

IV. RESULTS. DATA ON THE PARTIAL EXTRACTION THERAPIES

The results of our research identified some of the shortcomings of conventional treatments to manage ridge resorption. The chapter in Miron and Zhang's textbook described that not all bone substitute materials perform equally. There are very specific bone materials for specific treatment situations, all with limitations. The human histology study showed that augmenting sockets with PRF does not improve bone healing. Histormorphometric analyses showed very similar amounts of osteoid, mineralized bone, and fibrovascular tissue in both control sites and bone healed from PRF. In another human histology study, we showed rare and unesthetic complications of hyperplastic healing when using "disepithelialized" free gingival grafts for soft tissue augmentation. Patients developed keloid-like growths at augmented sites. In our CBCT study, data calculated that the anterior maxilla is 7.68 mm wide on average. If socket grafting prevents about 1.99 mm of collapse, such grafted sites will still only be about 6 mm wide. Our results predict that additional augmentation will usually be necessary to receive an implant. Our other CBCT study demonstrated that the facial bone plate is thin (1 mm or less) in almost all patients (83% of sites at the crest and 92% at the mid-root point). Bone that thin comprises almost solely of bundle bone, and is expected to resorb. Our systematic review article screened 7 709 studies to analyse 47 animal and human studies. The results identified that root exposure was a common problem, mainly due to incorrect technique.

Results from the bulk of our team's later work then established the partial extraction therapies (PET) as a collective group of treatments. Our work and results focused mainly on the socket-shield technique, root submergence, the pontic shield technique, the delayed socket shield (Glocker technique), molar socket shield, and molar root resection. Results from our retrospective study on the largest cohort of socket shield patients to date, confirmed that implant survival was comparable to other conventional implant placements (immediate, early, delayed). The same study also confirmed that exposure of the socket shield occurred in 9.4 % of cases. Our technique articles then reported results on improved methods to prevent this exposure, bettering the prosthetic management. Subsequent technique reports provided clear step-by-step methods for submerging roots at single and short-span edentulous sites, as well as full edentulous patients. Our pontic

shield article provided an alternative for pontic sites that may not have roots submerged due to endodontic infection. At a decade of clinical practice, we published a concise, updated step-by-step PET protocol for the socket shield technique. The digital guided socket shield study reported on a series of prototype guides that were developed. Each new guide solved problems of the previous, until the latest version could adequately prepare several socket shields in the cadaver jaw. These met the criteria of adequately sectioning the root, removing the root apex, and preparing the socket shield within accepted dimensions in at least 7/8 of consecutive sites.

The human histology data was precious. Such cases are rarely reported. Under light microscope, bone filled every thread space between the root dentin and the implant. There were no obvious signs of any pathology. The root portion appeared to have its apical canal present, without apparent negative impact. The same finding was noted in the animal histology study. In all sections, bone grew between root dentin and the implant surface. The animal histology study showed that probably a thicker, longer socket shield, with an internal bevelled chamfer was the best design.

V. DISCUSSION & CONCLUSIONS

Doctors can be resistant to change. Early career training and later life mentorship contributes to entrenching beliefs about the treatment we provide patients. Since the inception of dentistry, the offending and painful tooth has been removed. Patients accept and doctors attempt to repair the consequences. Surgical augmentations to repair the atrophic edentulous or partially edentulous jaw are not without costs; costs in terms of finances, surgical skill, invasiveness, morbidity, time, etc. The myth is that procedures such as GBR are the gold standard, the norm, and solution to all. It is likely influenced by an industry that profits from these biomaterials, in turn influencing our decisions as doctors. Regardless, such treatments remain curative rather than preventative.

Teeth should in most cases be saved and kept by whatever means necessary. To quote directly from Greenwall and coworkers, "implants should be viewed as a supplement to the existing teeth and used to help maintain the patient in a fully functional dentition throughout their lifetime. Implant availability should not be considered a valid reason to edentulate a patient and use implants as a preferred, total substitute for the natural dentition. Dental implants are not a superior alternative to a functioning natural dentition. Template-style treatment plans that call for routine extraction of all teeth and replacement with implants often require severe reduction of the remaining alveolar bone." Such an extract-and-augment mindset must change. The body of literature to support such a shift in mindset needs to be sizeable and convincing. The research presented in this thesis has made a considerable contribution to that endeavour. At no point does the discussion on the results attempt to convince the reader that PET is superior in all cases. However, what the discussion should impress upon the reader, is that there are valid alternatives. There is an strong argument to be made for conservative dentistry, for saving the patient's teeth. Tooth roots and even fragments thereof, if treated with intentional and careful preparation, preserve the alveolar ridge. We are now long past asking does PET work. The question for future research now is how do we make these work better?

VI. NEW FINDINGS

1. Our CBCT studies showed that the anterior maxilla in most patients is <8 mm. If attempting ridge preservation by socket grafting, a repeat augmentation will usually be necessary.
2. Our second CBT study also showed the facial bone plate is usually <1 mm. This bone is prone to resorption and a challenge to immediate implant placement.
3. Our published textbook chapters addressed augmentation materials and techniques, their details and shortfalls. The histology study in humans showed PRF does not improve bone healing.
4. Thereafter, we published the largest retrospective study of 128 socket shield cases. The results showed that implant survival rate was comparable to conventional implant treatment.
5. The human and animal histological data we published confirmed bone can grow between implant and socket shield. The latter study confirmed that a thicker, longer socket shield, with internal beveled chamfer is a better preparation.
6. Our subsequent technique articles published consecutively on improved methods. The prosthetic management article addressed the issue of socket shield exposure. The molar socket shield article introduced the treatment at posterior sites. The pontic shield technique provided an alternative to root submergence with apical pathology.
7. Finally, a 2-year study experimenting on several prototypes for a guided socket shield technique was reported with promising results.