Partial Extraction Therapies (PET) Part 2: Procedures and Technical Aspects

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Partial Extraction Therapies (PET) Part 2: Procedures and Technical Aspects

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Part 1 of this series introduced the partial extraction therapies as a group of techniques for ridge preservation at immediate implant placement and beneath pontic sites. The concept proposes a paradigm shift away from extract and augment toward partly retaining the tooth root to preserve the ridge and prevent buccopalatal collapse. The revolutionary socket-shield technique was introduced in 2010; however, there has been no follow-up literature to guide the clinician in terms of procedural steps. While root submergence is well established, the socket-shield and pontic shield are still in their clinical infancy and require long-term clinical data before they can be proposed as routine in everyday implant dentistry. Yet without sound knowledge on how to carry out the partial extraction therapies, a global dental community cannot participate in their application or contribute to the growing knowledge base. In this, the second part of the series, the procedures for root submergence, socket-shield, and pontic shield are addressed, step by step, supplemented with applicable guidelines as the first such publication guiding the clinician to apply these root- and ridge-preservation techniques. Technical aspects and complication management are also addressed. Int J Periodontics Restorative Dent 2017;37:377–385. doi: 10.11607/prd.3111

Successful implant therapy as we know it today is not merely a pursuit of osseointegration, but a full integration of healthy and esthetic peri-implant tissues framing the prosthesis. Akin to ensuring healthy periodontium around a tooth, establishing healthy peri-implant tissues is of paramount importance. The health, stability, and volume of bone has been the focus of the implant-restorative treatment dilemma for some time, yet the entire peri-implant tissue complex requires careful management. Healthy bone maintained at the coronal implant supports the establishment of the biologic width, namely connective tissue and the long junctional epithelium. With tooth loss, however, these tissues recede apically, as is evident at immediate implant placement. An understanding of the periodontium and this loss of tissues postextraction alludes to the underlying process—removal of the tooth sever the rich periodontal ligament (PDL) vasculature that supplies the alveolus bundle bone. Subsequently, resorption of the postextraction socket is inevitable. At an immediately placed implant site, the resorption may have significant esthetic and functional failure if the supporting tissues recede and when exacerbated by risk factors for recession.

To address this, the partial extraction therapies (PET) propose...
The partial retention of the tooth root to maintain the periodontium buccal/labial to it. The hypothesis has been that retention of the tooth root or part of it retains the PDL fibers that anchor it to the alveolus and preserve the PDL vasculature that supply the bundle bone, thus preserving all tissue components of the periodontium. Chronologically, root submergence introduced in 1953 proposed retaining decoronated tooth roots beneath full removable dentures to maintain the alveolar ridge. In 2007, the concept evolved to be applied at pontic sites beneath fixed partial dentures. The socket-shield technique progressed from there, and healed tissue histology has been demonstrated following sectioning of a submerged root at immediate implant placement—the labial root section remaining in situ and supporting the periodontal tissues. In 2015, the socket-shield technique’s partial root submergence was combined with socket grafting to preserve the ridge at pontic site development—viz the pontic shield. These PET collectively encompass the root- and ridge-preservation techniques as applied in implant and restorative dentistry. They collectively use the tooth itself to offset the loss of ridge tissues by retaining the attachment to the periodontium with its vascular supply, preserving the tooth-PDL-bundle bone complex, and thus challenge the conventional extract and augment approach. The authors propose that strategically saving part of the tooth is the ultimate preservation technique for retaining soft tissue esthetics at implant and pontic sites.

However, it is pertinent that rigorous testing be applied to newer techniques that long-term data be used to scrutinize. This would not be possible if there were vast heterogeneity in the application of PETs with no congruency as to how the treatments are applied and thus no data to accurately inspect. Therefore, step-by-step instructions for these techniques are provided here (Table 1). The aim of this work is to facilitate carrying out and reporting on these techniques and accumulation of significant clinical and research data to allow the techniques to be scrutinized for validity, or lack thereof, in restorative and implant dentistry.

The term buccal denotes the cheek and may be used incorrectly in the literature. For clarification, buccal in this report will refer to outer aspects of the teeth and ridge opposed to the vestibule up to the mesial edge of the first premolar, and labial or facial will refer to the outer aspects of the ridge and teeth opposed to the vestibule of the anterior teeth, distal canine to distal contralateral canine. While the technique may be possible in mandibular anterior tooth sites, for the sake of descriptive purposes the anterior maxilla will be referred to throughout this review.

**PET Preparation**

**Preparation Aspects: The Socket-Shield**

To date, two or more variants of the socket-shield have emerged, notably the root-membrane technique.

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**Table 1 Instruments and Materials Required for PET**

<table>
<thead>
<tr>
<th>Socket-shield</th>
<th>Pontic shield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Long shank root resection bur</td>
<td>1. Socket grafting instruments: plugger, particulate graft spoon, crucible</td>
</tr>
<tr>
<td>2. Extra-large round diamond head bur (to reduce inner aspect of shield into concavity)</td>
<td>2. 6/0 nylon sutures</td>
</tr>
<tr>
<td>3. End-cutting diamond head bur (to reduce coronal aspect of shield)</td>
<td>3. SM 69 blade (or other suitable microblade, mandatory for split thickness dissection of facial and palatal pouches to tuck CTG into)</td>
</tr>
<tr>
<td>4. Gingival protector</td>
<td>4. SM 69 blade (or other suitable microblade, mandatory for split thickness dissection of facial and palatal pouches to tuck CTG into)</td>
</tr>
<tr>
<td>5. Irrigated surgical motor</td>
<td>5. 6/0 nylon sutures</td>
</tr>
<tr>
<td>6. Contra-angled surgical fast handpiece</td>
<td>6. 6/0 nylon sutures</td>
</tr>
<tr>
<td>7. Microperiotomes</td>
<td>7. 6/0 nylon sutures</td>
</tr>
<tr>
<td>8. Microforceps</td>
<td>8. 6/0 nylon sutures</td>
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The socket-shield technique, while similar, is not synonymous with these techniques. The authors here regard the techniques pioneered by Hürzeler et al9 as original and hereafter describe its preparation. The socket-shield as yet has only been demonstrated in the literature at anterior tooth sites planned for immediate implant placement. The sectioning of posterior buccal tooth roots in combination with implant treatment has not yet been described. That said, the technique’s application may be intended for all tooth sites. The only limitation is the difficulty in preparing smaller roots, as seen in the lower anterior teeth, and curved roots, as seen in posterior sites. The clinician would need to exercise discretion when attempting to prepare smaller and curved roots.

The tooth itself may provide the best biologic implant, and the decision to extract and replace with an implant-supported restoration should be highly deliberated. A tooth indicated for extraction with apical pathology may be selected for the socket-shield technique. An absolute contraindication, however, is mobility of the tooth root as a result of a previously diseased periodontium, traumatic occlusion, or the like. The prepared tooth root section (hereafter referred to as the socket-shield) must be checked for immobility. The authors also submit that active periodontitis at the tooth is an absolute contraindication to preparing it as a socket-shield.

Thorough planning always precedes any implant therapy. No socket-shield treatment planning can fail to appreciate the tooth root in relation to the labial and palatal ridge unless three-dimensional (3D) imaging is used. Thus, cone beam computed tomography (CBCT) of the preparation site and tooth is an absolute requirement (Fig 1).
The clinician is to visualize possible apical infection, resorption, possible fenestration and dehiscence, and root length and width, measuring the root width in totality as well if sectioned longitudinally. The clinician is to use the same degree of planning required for immediate implant preparation, noting the proximity of adjacent structures, the limits of the bony ridge at various aspects, the volume of soft tissue, and so forth. Additional planning by means of a 3D imaging–prepared surgical guide or conventional analog guide duplicate of an anatomical wax-up are also implicit.

Following adequate anesthesia of the site planned for immediate implant placement, the tooth is decoronated to the gingival level, with care taken at all times not to damage the gingiva (Fig 2). Thereafter, with the use of an irrigated long-shank surgical root resection bur, the tooth root is carefully sectioned mesiodistally and longitudinally midway through the root with the canal as a reference point, such that the labial and palatal halves are separated from each other entirely from the coronal to the apical aspect (Fig 3). The clinician may place an endodontic instrument within the root canal to gauge the orientation of the root, and this orientation is to be followed when sectioning into labial and palatal halves. Absolute care is to be taken not to penetrate bone or neighboring teeth mesially or distally. Periapical radiographs may aid in preparation and may be viewed with the resection bur in situ. Once labial and palatal root halves are adequately separated, a microperiotome instrument is inserted into the palatal PDL space, carefully displacing the palatal root section labially into the recess created by the sectioning bur (Fig 4) and retrieving it with microforceps (Fig 5). At no time should the labial root, labial bone crest, or labial PDL space be instrumented. It is essential to maintain a finger rest on the buccal/labial ridge. This allows for tactile sensation of the drill position as the apex is reached. When elevating the palatal root section, this tactile sensation from a finger rest may indicate movement of the socket-shield or indicate incomplete root sectioning. Observe for movement—incomplete sectioning may detrimentally dislodge the labial root section. Once it is sufficiently elevated, the palatal root section may be delivered by microforceps (Fig 5). The labial root section that remains in situ is then instrumented on its inner aspect with a sharp probe, inspecting for immobility. If the clinician is absolutely sure the root section is stable, any or all remnants of infection within the socket...
apex are to be thoroughly curetted out, followed by copious saline rinse. Thereafter, the coronal aspect of the root section is reduced and shaped to within 1 mm above the alveolar socket crest by an irrigated large round diamond bur. It is critical not to damage the gingiva, and the use of a gingival protector is mandatory (Fig 6). Care must be taken not to force the gingival protector into the PDL space but to merely shield the soft tissues from contact with the bur. The clinician is also to beware of metal debris resulting from excessive contact of the gingival protector with a dental bur. These may lead to soft tissue tattooing, though this has not occurred in the authors’ experience to date. Thereafter, the root section is reduced and shaped as a crescent-shaped concavity conforming to the labial aspect of the alveolus. The clinician here exercises subjective discretion. A thick socket-shield is stable but occupies space to accommodate the implant. An overly reduced socket-shield must be avoided and would likely be unstable. The authors’ recommendation is to reduce approximately half its thickness from root canal to its labial limit (Fig 7). The coronal portion may be thinner while maintaining a thicker apical root section. Again, the socket is thoroughly rinsed and the root section inspected with a sharp probe for immobility. A periapical radiograph may be used to visualize the completed preparation (that may require adjusting) for sharp edges of the root for orientation 1 mm above the bony crest, possible bur penetration into neighboring teeth, and so on. The final completed labial tooth section, ready for subsequent implant placement at its palatal aspect, is the socket-shield (Fig 8).

Preparation Aspects: The Pontic Shield

The pontic shield is indicated for sites planned to receive a pontic restoration, be it a removable partial denture or a tooth-supported or implant-supported fixed partial denture, but root submergence has been contraindicated due to apical infection or endodontic treatment failure. The pontic shield combines the socket-shield technique with established socket grafting treatments. The socket-shield is prepared first. Note that the treatment planning, the 3D imaging, and the entirety of the steps outlined above are repeated identically. It is essential to ensure that the apex of the root is removed along with all the apical infection. Light and magnification are essential for this procedure. After completing preparation followed by thorough...
curettage of the socket with copious saline rinse, the socket may be grafted with bone particulate or a bone substitute material of the clinician’s choosing (Fig 9). Established socket grafting principles should be adhered to. The material placed in the socket should not be densely packed with excessive pressure, and care must be taken not to disturb the socket-shield. Once the socket is adequately filled, it must be sealed. In the authors’ experience, a lack of closure of the socket by membrane material, autogenous connective tissue graft (CTG), or rotated pedicle flap results in delayed wound healing of the socket with possible complication.10 The authors recommend a CTG. A clinician less confident with harvesting and grafting autogenous tissue may use a dense polytetrafluoroethylene (dPTFE) membrane tuck beneath full-thickness pouches atop the ridge. Typically, a provisional restoration with light pontic pressure only is fixed in place for the duration of healing. The prepared labial root section and grafted tooth socket, sealed and secured with sutures, is the completed pontic shield.

Preparation Aspects: Root Submergence

The indications for each PET were tabulated in Part 1 of this series. Root submergence is indicated for preservation of the alveolar ridge beneath full dentures and fixed or removable partial dentures.8,14 Any active infection of the root and the apical area must first be resolved by endodontic treatment. An adequately root-treated tooth or a vital, infection-free tooth root may be submerged. The decision to submerge the whole root or partially submerge it as a pontic shield is based largely on the status of the root and the site. A vertical fracture may contraindicate root submergence, though it may still be prepared as a pontic shield. An apical infection may be mechanically cleared if prepared as a pontic shield and removed entirely with the palatal root section. Preparing the site as a pontic shield requires grafting the socket with particulate bone or substitute and may increase the cost of treatment. The authors regard the pontic shield as slightly more technically challenging than root submergence. Thus, selecting between these two techniques requires consideration of these factors as well as the clinician’s level of skill, experience, and preference. That said, root submergence does not necessitate 3D imaging; routine periapical radiographic views suffice. Decoronation of the tooth is identical to that for the other PET methods (Fig 2). The soft tissues are to be protected with a gingival protector instrument, and the root is prepared to slightly below bone level to avoid perforation of the soft tissue. Thereafter, the root is reduced and shaped with an irrigated large diamond bur to form a concavity that will allow soft tissue infill that when healed will frame the pontic. The authors submit that coverage of the coronal root is mandatory: by CTG for a single tooth site, and by primary intention approximation of the flap(s) for multiple tooth sites (Fig 9).

Technical Aspects

The Socket-Shield

Prosthetic sealing of the socket by customized transgingival abutment
or anatomical provisional restoration is mandatory when carrying out a socket-shield procedure coincident to immediate implant placement. The socket cannot be left open. Either of the two prosthetic options mentioned above must conform to the soft tissue periphery of the postextraction socket, with a 2-mm gap between the prosthetic component and the socket-shield to allow for soft tissue infill.

Moreover, the socket-shield has been modified by the inventor of the technique, and the authors regard the first demonstration by Hürzeler et al of the socket-shield preparation as original.9 The first report by this working group demonstrated the histology of a healed socket-shield in contact with an osseointegrated implant palatal to it. The methodology of the report included the use of an enamel matrix derivative on the root section’s aspect facing the implant. The group later omitted this step, and the present authors recommend this omission. The space between the implant and the alveolar socket wall, regularly termed in the literature as the buccal gap, is similarly regarded here as the gap from the implant to the inner surface of the socket-shield facing the implant. The authors recommend grafting this gap with a particulate bone material. The clinician is to gauge necessity. Should the buccal gap be negligible and the coronal aspect of the implant closely apposed to it such that there is no space to accommodate instrumentation and particulate material, this step may be omitted (Fig 9).

The literature reports on improved histologic outcomes following grafting of the buccal gap.15 Thus, grafting of the void between implant and socket-shield is a biologically sound recommendation. Bäumer et al16 demonstrated the formation of new bone between the implant and the dentin surface (Fig 10).

The authors of the original technique also described the intimate contact of implant threads to the cementum of the socket-shield and apposition of newly formed cementum on the implant surface. This was later modified by the same working group. For clarification, contact of implant to socket-shield is not a requisite or a recommendation. Contact may occur as a result of space limitation at time of placement and may pose no concern other than displacement of the socket-shield and damage of the PDL attachment. Care should be taken to avoid this.

Root Submergence

Root submergence has been described without primary closure of the site, resulting in incomplete soft tissue coverage of the root and requiring CTG later.14 The authors strongly recommend primary closure, or soft tissue grafting to achieve it. This may present a challenge and require extensive periosteal release, especially in multiple adjacent submerged roots. In cases with removable interim prosthesis, impact to the healing tissues must be monitored for possible exposure complication. The clinician must ensure the absence of sharp edges at the coronal root periphery that might cause perforation of the overlying soft tissues. Orthodontic tooth movement may also later present a challenge if tooth roots are moved into a submerged root. Alternatively, the root may spontaneously overerupt. In the absence of pathology or infection, the coronal aspect may be reprepared and resubmerged.

Managing Complications

The totality of possible complications cannot yet be known. The following, however, may guide the clinician toward better application of PET and management of possible complications. With the socket-shield as with other PET, the retained tooth root section must be free of
sharp edges. Sharp edges and overextension above the alveolar crest may result in exposure through the soft tissue. The root section may be reduced and reshaped to manage such a complication. Primary closure should again be achieved, or intimate contact between the soft tissue and the restoration ensured. Exposure of the coronal aspect of the root section in the absence of any other pathology should be scrutinized if overextending the 1-mm supracrestal guideline. Reduction of the socket-shield and soft tissue closure may adequately treat this complication without loss of the implant or the socket-shield (Fig 11). Any exposure in the absence of additional pathology may be managed by soft tissue closure—by advancing the overlying soft tissue for primary closure, CTG, rotated flap, or free gingival graft, in accordance with the clinician’s preference and skill set.

In PET cases where infection of the root section is coupled with mobility, removal is mandatory. The site may then be managed as for any other recession complication around implants, highlighting the advanced skill and experience required to carry out these techniques. In the unlikely event of endodontic inflammation subsequent to root submergence, the clinician may select a root canal procedure and resubmergence in lieu of extraction, if access to the canal can be achieved. Mobility of a socket-shield adjacent to an implant or of a pontic shield always necessitate its removal. If the implant fails to osseointegrate but the socket-shield is stable, immobile, and free of infection, the implant may be removed and the site closed and left to heal before reevaluation as a pontic shield site, or treatment may be reattempted at implant placement.

Conclusions

The partial extraction therapies are a highly promising set of techniques that may significantly alter future management of the failing dentition and postextraction ridge, viz a paradigm shift from extract and augment to salvaging the patient’s own tissues where possible. Of equal importance are the degree of advanced knowledge and experience required to apply these therapies and the need for more abundant histologic evidence and long-term data to refute or support their use in established clinical practice. The present technical report provides clinicians with the information needed to contribute to the growing literature.

Acknowledgments

The authors reported no conflicts of interest related to this study.

References


Erratum
In the article by Sarmiento et al (A Classification System for Peri-implant Diseases and Conditions), in Volume 36, Number 5 (September/October), 2016, a correction is needed to Table 1. For “Peri-implantitis induced by extrinsic pathology,” the correct definition is “Implants that present with bone loss caused by an unrelated pathology, systemic disease, and/or periapical pathology migration to an implant.”