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Partial Extraction Therapy (PET)

[1]Dr.Hiral Parmar, [2]Dr. Praveena Lakshmi, [3]Dr. Anita Panchal, [4]Dr. Khoobi Shah
post Graduate Student, College Of Dental Sciences And Research Centre, Ahmedabad
Post Graduate Student, College Of Dental Sciences And Research Centre, Ahmedabad
Professor and H.O.D, College Of Dental Sciences And Research Centre, Ahmedabad
,Senior Lecturer, College Of Dental Sciences And Research Centre, Ahmedabad
Corresponding Author: Dr. Hiral Parmar

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ABSTRACT: The loss of alveolar bone after extraction is one of the biggest obstacles faced in implant and restorative dentistry as it limits the optimal treatment and overall functionality of the given treatment. To overcome these difficulties, a variety of ridge preservation techniques can be found to combat such situation. One of these includes preservation of alveolar bone by leaving behind a piece of root into the socket, which in turn preserves the alveolar bone. These techniques are collectively known as partial extraction therapy. The article discusses the rationale and different types of ridge preservation along with its procedures, benefits and risks.

KEYWORDS: Partial Extraction Therapy, Ridge Preservation, Implant Dentistry, Socket Shield Therapy.

I. INTRODUCTION

The loss of alveolar bone after extraction is a significant challenge in implant and restorative dentistry as it limits the optimal treatment and overall functionality of the given treatment. Variety of ridge preservation techniques can be found in the literature to combat such situation**.** Studies have shown that 50% resorption of bone take place over the period of 1 year [1-4]. Thus effort has been made to overcome this problem. One of these includes preservation of alveolar bone by leaving behind a piece of root into the socket, which in turn preserves the alveolar bone. These techniques are collectively known as partial extraction therapy.

II. RATIONALE OF PARTIAL EXTRACTION THERAPY

Howell et al. showed in 1970s that when endodontically treated submerged roots were left in the alveolar bone under complete dentures, hardly any resorption was seen at 10 years [5]. Study conducted by Salama et al. in 2007 showed that retaining the buccal aspect of the root did not interfere with osseointegration and that it may be beneficial in maintaining the buccal bone contour [6].

In 2013, Baumer et al. [7] published the first histological, clinical, and volumetric data of implants placed in beagle dogs after vertical separation of the buccal fragment. Hürzeler et al. [8] in a proof-of-principle study done in animal models showed that, leaving behind the root and treating the dentin side of the root with enamel matrix protein derivative (Emdogain, Straumman, Basel, Switzerland) did not influence osseointegration. they reported that retaining a part of the root on the facial side, attached to its periodontal ligament, the body is tricked into believing that the root still exists, while the bundle bone as well as the marginal gingiva continues to get its blood supply from the periodontal ligament, thereby maintaining the hard and soft tissue contours, a phenomenon which could be referred to as "**Biologic cheating**". This forms the basis for partial extraction therapy.

III.CLASSIFICATION

At present the concept of PET as a collective group of treatments to manage the post extraction ridge and its subsequent resorption does not exist. Thus a classification to guide the clinician is proposed and indicates the clinical scenarios suitable to each therapy were proposed by H. Gluckman et al. (Table 1) [8]. Figure: 1 shows the representation of partial extraction therapies (socket shield, pontic shield, and root submergence) in buccopalatal axial view and horizontal cross section [8].

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Table 1 Partial extraction therapies (PET) and their indications

PET	Clinical situation(s) indicated
Root submergence[7]	Unrestorable tooth crown or tooth indicated for extraction Absence of apical pathology Healthy amputated pulp or endodontic therapy completed Intention to preserve the alveolar ridge Planned removable full or partial prosthesis Planned pontic site beneath fixed prosthesis Cantilever pontic site as an alternative to two adjacent implants Actively growing young patient planned for implant treatment later Ridge preservation in conjunction with other PET
Socket-shield[8]	Unrestorable tooth crown or tooth indicated for extraction Tooth root with or without apical pathology Intention to preserve the alveolar ridge, specifically to prevent buccopalatal collapse Immediate implant placement Ridge preservation in conjunction with other PET
Pontic shield[9]	Unrestorable tooth crown or tooth indicated for extraction Tooth root with or without apical pathology Intention to preserve the alveolar ridge Planned pontic site(s) beneath fixed prosthesis Cantilever pontic site as an alternative to two adjacent implants Ridge preservation in conjunction with other PET
Proximal socket-shield[23]	Unrestorable tooth crown or tooth indicated for extraction Tooth root with or without apical pathology Intention to preserve interdental papillae Planned immediate implant placement sites of two or more adjacent implants Papillae preservation in conjunction with other PET

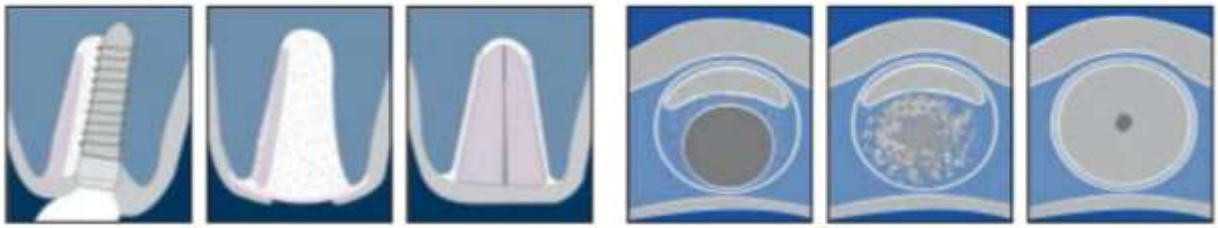

Figure.1: Partial extraction therapies (socket shield, pontic shield, root submergence in buccopalatal axial view and horizontal cross section [8].

IV. ROOT SUBMERGENCE THERAPY (RST)

In 1961, Bjorn was the first person to publish a report of root submergence [9]. This technique was introduced to prevent residual ridge resorption in complete denture patients [10]. The technique involves complete removal of the coronal portion of the tooth leaving behind an intact root.

RST has been described for both vital and non-vital teeth. Guyer (1975) submerged vital root for the first time in humans and reported vitality of the pulpal tissue through the apices and collateral occlusal circulation from the soft tissue [11].

Indications [12]:

- Unrestorable tooth crown with absence of apical pathology.
- The tooth should have healthy amputated pulp or endodontic therapy must have been completed.

Contraindications [13]:

- To the procedure which includes apical pathologies, root caries, root resorption, ankylosis, periapical pathology, endo-perio lesion and soft tissue perforation.

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Selection of roots for submergence [14]:

- Adequate thickness of buccal cortical plate should be present on the retained roots – needed for the retention of roots.
- Roots must not have any undercuts because the prosthesis will not sit properly if not considered.
- Wide zone of attached gingiva.

Clinical Procedure:

Nonvital tooth procedure:

The tooth is endodontically treated before decoronation. This technique involves the removal of the crown of a tooth and allowing the root to remain in the alveolar bone. The procedure of decoronation should be 2 mm apical to crestal bone with the help of straight fissure carbide bur under copious irrigation. Then, the teeth were horizontally sectioned and gutta-percha was burnished with a ballpoint burnisher, and residues of the tooth and gutta-percha were washed with saline [14].

Vital tooth procedure:

In 1975, Guyer [11] reported vital roots submerged in a human. This procedure is performed by reflecting the full-thickness mucoperiosteal flap. The coronal aspect of the teeth selected for vital root submergence is reduced to 2 mm apical to the alveolar crest, and the root stump/s are irrigated using 0.9% saline irrigation. The irregularly/sharper end surface of the sectioned part and adjacent bony irregularities are smoothened and finished using a round bur using a straight handpiece. Using a bone file, the interdental bone is smoothened. The pulpal tissue in the root portion remains vital owing to the blood supply through the apical ramification and collateral occlusal circulation from the adjacent soft tissue.

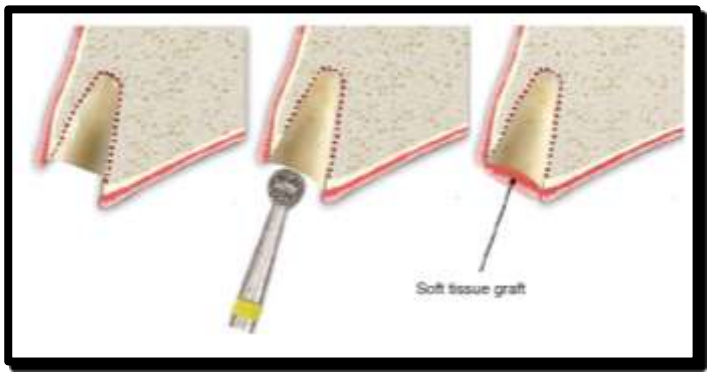

Figure.2: Preparation of the root submergence technique [15].

Advantage of RST: [16]

- It preserves the alveolar bone resorption thereby maintaining the soft tissue profile thus giving esthetically more favorable result.
- It is relatively simple and easy procedure with good proprioceptive, perceptive, and physiologic patient response.

V. SOCKET SHIELD TECHNIQUE

Submucosal root retention can virtually eliminate bone resorption, the retention and stabilization of the coronal and buccal bundle bone and the retention of the periodontal membrane by retaining a coronal tooth fragment (so-called “socket shield”), as adequate blood supply is maintained [17].

Indications:

- Vertical fractures of teeth without pulpal pathologies, where the tissue preservation and aesthetics are a priority.
- As a part of delayed or late implantation approach or optimization of pontic support in crown bridge reconstructions or to improve the prosthesis base for removable dentures.

Contraindications General contraindications:

- All usual restrictions of oral surgical procedures:
- Bisphosphonate medication
- Immunosuppression

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- Radiation therapy
- Anti coagulation

Local contraindications:

- Absent buccal lamina which develops for instance after vertical root fractures or periodontitis.

Ideal shield design and dimension (Figure.3):

- No palatal or apical portion of the root should be present.
- The shield must be about two/third the length of the original root or at least 8 mm long, whichever is more [15].
- The shield should be at least 1.5 mm in width, or one/fourth the buccolingual dimension of the root, whichever is lesser. Another guide-line to follow is half the distance between the labial bone and the root canal space of the root to be sectioned [18].
- It should follow curvature of labial bone from mesial to distal line angle.
- It should be trimmed down to the level of labial bone crest [19].
- It should have a bevel or S-shaped curve on the internal aspect [20].

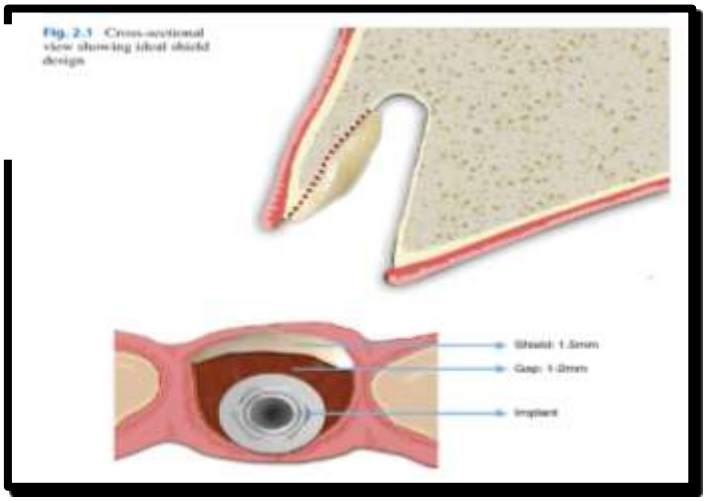

figure.3: Cross sectional and occlusal view showing ideal shield design, implant position and gap between implant and shield [21].

Step by Step Procedure:

- Local anaesthesia should be administered. The crown of the tooth to be extracted is decoronated with a coarse-grained diamond bur.
- The root of the tooth is sectioned mesiodistally with a long tapered fissure diamond bur coupled to a hydrated high-speed hand piece into facial and palatal halves followed by conservative extraction of the palatal root fragment using periotome, luxators and forceps preserving the facial root section unmanipulated and attached to the tooth socket.
- Periotomes can be inserted between the palatal root section and the alveolar socket wall to severe the PDL and the section of root can then carefully delivered with so as not to disturb the facial root section.
- The tooth socket's palatal wall and apex are then curetted to remove any tissue or infective remnants.

With the preparation steps complete, the tooth root hereafter was known as the socket-shield. If planned for an immediate implant placement, an osteotomy is then sequentially prepared and a selected implant was inserted palatal to the socket shield. The gap between the shield and implant surface was left to enable blood clot formation.

Advantages:

- Help ensure physiological preservation of labial and buccal bone structures if implant is placed in contact to the natural tooth fragment (shield) and prevent lamellar bone resorption.
- Tissue preservation-preserves healthy periimplant tissues.
- Buccal shield serves as a guiding structure when placing implants in optimum position.
- Complete osseointergration can be achieved.

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- Formation of fibrous tissue around implant can be avoided.
- Cost effective.
- Minimal invasiveness.
- Minimal material requirement (no bone substitute, GTR etc).
- Helps maintain aesthetics.

Disadvantages and limitations:

- Resorption associated with usual biological long term complication that may occur especially in the presence of pre existing or developing periodontal or endodontic infections or inflammations of the retained root fragments.
- Technique sensitive: Displacement of buccal root fragment or even buccal lamellar bone.
- Long term behaviour of the buccal shield has not yet been completely clarified.

VI. PONTIC SHIELD TECHNIQUE:

One of the contraindications of the RST is the presence of an apical infection in the root to be submerged. To overcome this limitation, Gluckman et al. proposed a novel technique called the pontic shield [6, 22]. The procedure necessitates preparing the root exactly like the socket shield procedure and leaving it under a pontic.

Indication:

- For an extraction could potentially be converted into a pontic shield.
- The prepared pontic shield could be used under an implant supported bridge.
- Roots with a small periapical lesion.

Contraindications:

- Mobile root: A mobile root is likely to migrate or erupt overtime.
- A root that is vertically fractured buccolingually: A fracture in the mesiodistal direction will be suitable for PS since the palatal fragment can be extracted and the labial fragment (if firm) can be retained for the shield preparation. A buccolingually fractured root should be extracted.
- Very narrow or severely curved roots: Technical difficulties will be encountered during the shield preparation if the roots are curved or too narrow like the lower incisors.

Procedure:

The preparation of the root for the pontic shield follows the exact guidelines as the socket shield technique described above. However, placement of a bone graft will ensure a complete bone fill which may be beneficial if that site is to be used for an implant placement in future. After shield preparation and socket grafting, soft tissue closure is achieved with the help of an autogeneous soft tissue grafting procedure similar to that for a root submergence technique [21].

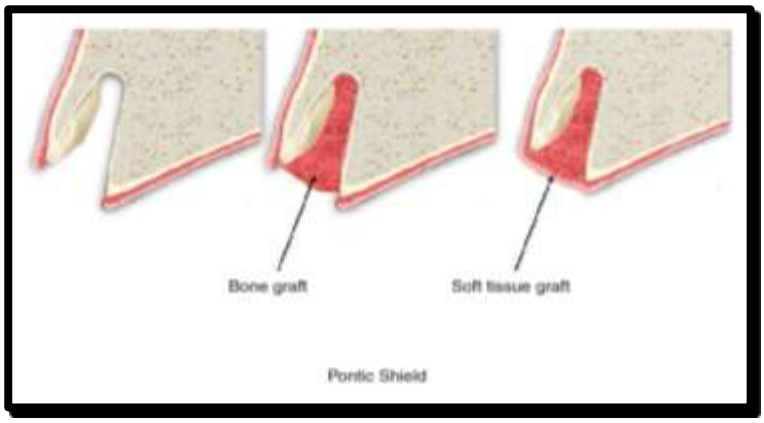

Figure.4: Steps for the pontic shield procedure [15].

Advantage:

- To maintain the soft tissue contours which will allow excellent emergence profile for the pontic.
- Maintain the alveolar ridge dimension and prevents its potential collapse overtime.

VII. COMPLICATIONS OF PET:

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Shield Thickness

If the shield is prepared too thin, it will not have enough remaining structure to allow a stable attachment to the bundle bone which lines the socket. On the other hand, a very thick shield may lead the shield and the implant being in close proximity. A thick shield also compromises the space required for the emergence of the provisional and permanent restorations [22, 23].

Inadequate Length of the Shield

The shield must be of sufficient length to maintain its integrity without any mobility [15]. The optimum length should be 8 mm or 2/3rds the length of the root; whichever is more. A shield shorter than 8 mm may perform its function of maintaining the buccal bone only as long as it is stable.

Root Apex Left Behind

The success of socket shield and pontic shield procedures depends on the removal of all endodontic filling material and the apex of the root [22]. If the apex has not been removed, the residual infection in the implant site will lead to postoperative infection. To ensure complete removal of the canal contents and the root apex, an intraoral periapical x ray should be taken after shield preparation.

Incorrect Shield Shape

The goal of the shield is to encompass approximately 150° of the socket diameter, to prevent labial bone loss [15]. The C-shaped shield covers more area by extending into the interproximal space. Whilst this is advantageous when it comes to preservation of the interdental papilla, there is a greater risk of contacting the implant [23, 24]. This may limit the vascular supply to the peri-implant area and may affect the process of osseointegration. If the shield is not shaped adequately to cover sufficient circumference of the socket it may become loose and be eventually lost.

Damage to Proximal Bone Walls during Shield Preparation

The mesio-distal sectioning of the root should be carried out carefully. An overzealous shield preparation may cause a lot of damage to the lateral walls of the socket and result in inadequate stability for the implant. If the damage is extensive, and complicates the implant placement, the procedure may need to be abandoned.

Shield Mobility

Cause:

• Mobile tooth (not indicated for PET).

• Vibration from the bur during sectioning of the root.

• Inadequate shield thickness and length.

Prevention:

The shield mobility can be prevented by selecting cases with firm teeth without large periapical lesions. Also, the drill must be used at high speed to avoid chatter and vibration. Copious amount of irrigant will help in debridement and prevent of burs from vibrating.

Management:

If the shield becomes mobile during preparation, it is necessary to remove the shield and discard it [25]. The clinician must then proceed with conventional post-extraction implant placement.

Apical Fenestration

Cause:

An existing periapical lesion that has perforated the apical buccal bone or such an apical fenestration may be caused iatrogenically.

Prevention:

The best way to prevent the apical bone fenestration is to evaluate the radiographs thoroughly and not choose cases with large periapical lesions. Also, cases in which the radial tooth position is such that the shield preparation may lead to an apical fenestration must be avoided [39].

Management:

In case, a fenestration is observed on the scans or the operator has inadvertently created one, shield preparation followed by an aesthetic buccal flap to graft the site of bone fenestration should be performed. In cases of large fenestrations, the implant should not be placed and a staged implant placement after complete socket healing maybe considered.

Palatal Wall fracture

Cause:

- Excessive pressure from the root elevators during removal of the palatal portion of the root.
- Pressure during insertion of the implant: An over-prepared palatal plate may break down if excessive torque is exerted during implant placement.

Prevention:

Preoperative assessment of the palatal bone must be done to ascertain adequate volume of bone prior to surgery. The partial root extraction should be carried out very gently. The implant should be placed under controlled torque.

Management:

In case of fracture of the palatal wall, it is necessary to evaluate if sufficient bone has remained to allow the implant to be inserted with adequate primary stability. In case of a large fracture, it may be necessary to postpone the implant placement. Augmentation of the lost bone will be necessary to compensate for the destroyed palatal bone [27].

Shield and Implant are in Physical Contact

Cause:

This may occur if the shield is too thick or the implant diameter is too large. It may also occur if the implant is placed with an incorrect bucco-lingual trajectory.

Prevention:

The coronal aspect of the shield should be thinned out to provide sufficient space for the provisional restorative material [19]. It is likely that there may be no contact of the shield and implant in the coronal aspect but at an apical level there may be some light contact between the two. In the human histology studies reported so far, such a contact does not have any detrimental effect, provided there is no pressure from the implant on the shield [28, 29].

Management:

If contact between the implant and the shield is noted then, it is better to remove the implant and trim the shield further and place the implant back in proper position.

There is a Very Large Gap between the Shield and the Implant

Cause:

• Shield too thin or implant diameter very small.
• Socket diameter is too large; as it would be for cuspids and multirooted teeth.

Prevention:

Optimal shield thickness must be achieved and the implant diameter chosen to adequately fit in the socket without obliterating it and without contacting the shield.

Management:

In cases where the gap is large between the implant and the shield, soft tissue invagination may occur. Gluckman et al. suggested if space is present between the shield and implant is more than 2mm, it should be grafted [8]. In contrast Mitsias et al., do not recommend the same since according to them preservation of periodontal ligament and the associated vascular contribution is more crucial [29]. When the primary stability of the implant is inadequate to support a provisional restoration, the gap has to be grafted and a submerged healing protocol is recommended.

Lack of Implant Stability

Cause:

• Improper osteotomy preparation.
• Poor quality of bone.
• Bone damaged during shield preparation.

Prevention:

Adequate precautions taken during shield preparation and correct surgical protocols should be followed during implant placement.

Management:

If the primary stability is inadequate, it is advisable to remove the implant and replace it with a larger diameter one, if the socket morphology allows it. If that option is not possible, it may be necessary to postpone the implant placement and graft the site keeping the shield in place.

VIII. CONCLUSION:

PET should be considered as a conservative alternative for ridge preservation for teeth that are doomed for extraction. Retention of all or a part of the tooth show enhancement of hard tissue and soft tissue available. Hence advocating its use in clinical practice. Further research for hostologic evidence and proof of long term clinical result should be considered.

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