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Review Article

Socket Shield Technique- A Review

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INTRODUCTION

Aiming to preserve rather than compensate, the socket-shield technique has been effective for implant placement in the esthetic zone.[1]

'The Socket Shield Technique' (SST) applied first on animals and humans. The idea was to retain on the buccal side a part of the root section. The assumption was that leaving the tooth's root portion maintains the periodontal ligament and its vasculature that supply the bundle bone, consequently preventing the periodontium's collapse.[2]

A tooth might be extracted due to several reasons which include endodontic involvement, root fracture, resorption, periapical pathology, root perforation etc. The socket shield technology can be advantageous in such situation where extraction site involve little or no periodontal bone loss.[3]

Accurate tooth fragment preparation and implant placement is the key to successful treatment with the socket-shield technique.[1]

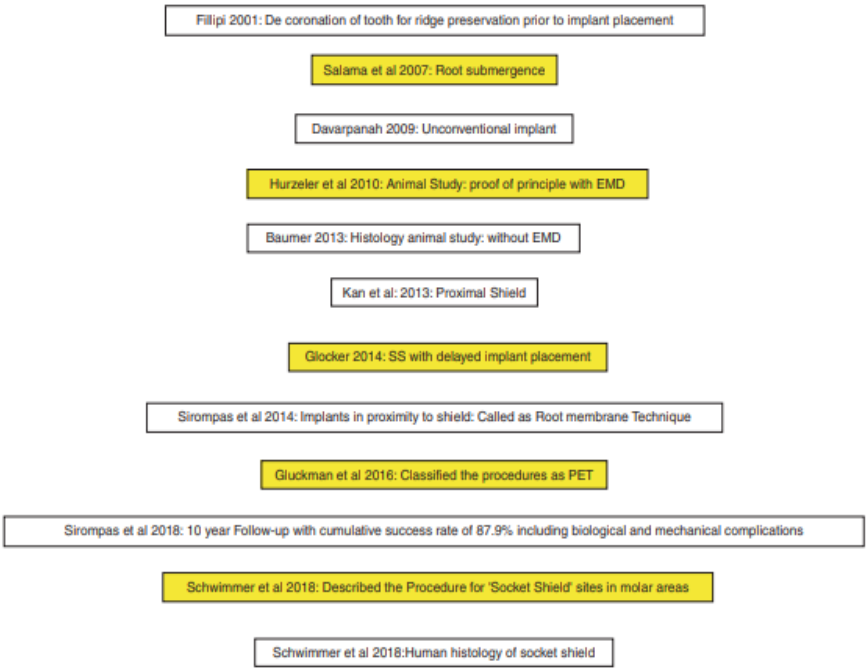


Figure 1- Timeline describes the evolution of Socket Shield Technique.

EVOLUTION OF SOCKET SHIELD TECHNIQUE

When a tooth is extracted, the abundant periodontal ligament (PDL) vascular system that nourishes the bundle bone of alveolus is severed. Demineralization of the socket post extraction is therefore unavoidable. If the anchoring tissues at the site of implant placed immediately after extraction resorb and are made worse by risk variables for recession of soft tissues, then there may be considerable aesthetic and as well as functional failure of implants. The partial extraction therapies (PET) recommend substantial preservation of root of tooth to keep the periodontium present buccal or labial to it in suitable condition.[4]

The theory has been that keeping the tooth root or a portion of it will conserve the PDL fibres that hold it to the alveolar bone and the PDL blood supply that feeds the bundle bone, which will keep every one of the periodontium' s tissue constituents in suitable condition . In order to preserve the alveolar ridge, invention of root submergence therapy in year 1953 recommended keeping roots of decoronated tooth under complete removable dentures. The idea changed in 2007 to be used at pontic locations underneath affixed partial dentures. With longitudinal segmentation of a buried root at the site of immediate implant implantation, the socketshield technique advanced, and histology of healed tissue was shown. The labial root segment remained in place and supported the periodontal tissues.[5]

In order to protect the alveolar ridge at the site for pontic establishment through the pontic shield approach, partial root submergence approach and socket grafting were used in combination for the first time in 2015. These PET comprise root- and ridge-preservation methods used in implant dentistry and operative dentistry as a whole.[4]

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.[6]

O'Neal et al. in 1978 proved that the coronal surface of submerged roots showed new cementum and connective tissue which separates the dentin from the new bone.[7]

Filippi et al. [FILIPPI 2001] showed that an ankylosed tooth retained bone, submerged roots allowed to form bone and cementum on top of them.[8]

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.[9]

Davarpanah and Szmukler-Moncler [DAVARPANAH 2009] published an alternative to extraction of deeply placed, impacted teeth that were not communicating with the oral cavity, clinically and radiographically healthy teeth that come in the pathway of implant placements. They suggested that, instead of removing the roots with invasive surgery it may be prudent to place the implants directly in contact with them. In small sample size of six patients with seven implants, they placed implants in contact with root fragments. They reported good success rates with some bone loss in one of the cases. Although the sample size was small, the paper was a positive step retaining healthy roots around implants and was an important milestone in the history of PET.[10]

In 2010, **Hurzeler et al.** [HURZELER 2010] conducted a beagle dog study to demonstrate that the retention of root helped in holding the alveolar volume. They used an enamel matrix derivative to fill the gap between the implant and the retained root. They reported, histologically, the formation and maintenance of supra-alveolar connective tissues, the formation of cementum along the root surface, but no-epithelial down migration between the root and the bone. The authors then depicted the first clinical case of the socket-shield technique. The study 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. This proof-of-principle study sets in motion the use of socket shield/PET as a treatment modality for the prevention of buccal tissue loss.[11]

In 2013, **Baumer et al.** (BAUMER 2015) published the first histological, clinical, and volumetric data of implants placed in beagle dogs after vertical separation of the buccal fragment.[12]

In the same year, **Kan et al.** published the use of proximal shield to maintain interdental soft tissue in the aesthetic zone. Although it was just a case report, it did open up newer possibilities in the management of the shield to harness the aesthetic potential of biologic entities around the implant with root fragments, intentionally prepared and left in the socket.[13]

In 2014, **Glocker et al.** (GLOCKER 2014) published a modified socket shield technique in three cases, in which they prepared the shield, but did not place an implant immediately in the alveolar socket. Implants were placed 6-months later. They concluded stating that the complete preservation of the buccal lamellar bone was observed intra- operatively in all three cases. This technique now became a viable alternative in cases where implant placement was not possible immediately after partial extraction.[14]

In the same year, **Siormpas et al.** coined the term "root membrane technique" for cases in which there is an intentional retention of buccal root fragment to prevent buccal bone loss. The difference between the root membrane technique and the others was that, in this technique the implant deliberately touches the root fragment. They published clinical results and radiographic data of 46 patients followed up to 5 years post loading, with a success rate of 100% as far as implant integration was concerned and loss of one root to resorption that did not affect the implant.[5]

In 2016, in a significant technique article, **Gluckman et al.** coined the term "Partial Extraction Therapy" that included various different terminologies under

one name. Root submergence technique, socket shield technique, and pontic shield technique were collectively called partial extraction therapies.[15]
Gluckman et al. then followed up with part 2 of the article in 2017 where they described the various procedures and technical aspects of partial extraction therapy.[16]
At this point in literature it was well established that intentional retention of a part of the root on the labial side of the socket is indeed a good way to prevent buccal bone loss and thereby provide excellent tissue contours. It was also clear that the apex of the root should be totally removed and that no residual endodontic filling material must be retained behind on the shield.[13]
In 2017, **Gharpure and Bhatavadekar** in a systematic review of the available literature on socket shield doubted the long-term outcomes of the procedure. It takes years, if not decades for a new technique to get refined in procedure and gain acceptance, and their review of the very limited literature at that point may have been premature.[17]
Sirompas et al., in 2018, published up to 10 years of retrospective data on clinical results of the
root membrane technique for periodontal ligament-mediated immediate implant placements.[18]

BIOLOGIC RATIONALE FOR PARTIAL EXTRACTION THERAPIES

Partial extraction therapy makes the body believe that the tooth is in the bone and makes it behave as such. The procedure relies on the concept that, the alveolar bone resorption is a consequence of loss of bundle bone and the only way to preserve the bundle bone is to retain the periodontal ligament attachment to it.
The loss of the periodontal ligament attachment to the buccal bone and loss of the bundle bone due to the extraction of the tooth/root has been determined as the principal factor in the loss of alveolar bone. This led to the emergence of the concept that, if a part of the root is retained, then it may be possible to retain the corresponding part of the bone.[13]
By 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 the Socket shield technique and its variants—the Pontic shield and Glocker's technique for ridge preservation.[14,15]

PRINCIPLEOFSOCKETSHIELDTECHNIQUE

The socket shield technique involves preserving the coronal third of buccal surface of root tocreate a buccal shield by modifying the root of the tooth indicated for extraction and carefully extracting the palatal aspect such that remaining facial root fragment remain intact in situ with relation to buccal bone, subsequently immediate implant placement is performed thereby preserving the periodontal apparatus along with its vascularization, attachment fibers, cementum thereby preventing the post operative facial bone loss and preserving esthetics.[19]
The SST appears to be a safe technique to preserve alveolar bone, as it leads to less horizontal and vertical bone loss than conventional implantation.[20]

SOCKET SHIELD TECHNIQUE

A study on a beagle dog, proposed by Hürzeler et al. (2010), showed the socket-shield technique suggesting that partial/incomplete retention of tooth roots is done to avert the buccal bone from resorption. A piece of the root is preserved through a minimally invasive surgical treatment called the socket-shield method, which helps in maintaining natural soft and hard tissue forms.[21]
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.[14]

Indications[22]:

- 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.
- Crown bridge reconstructions.
- To improve the prosthesis base for removable dentures.

Contraindications[22]:

General contraindications-

- All usual restrictions of oral surgical procedures
- Bisphosphonate medication
- Immunosuppression
- Radiation therapy
- Anti coagulation
- Local contraindications-
- Absent buccal lamina which develops for instance after vertical root fractures or periodontitis.

Ideal shield design and dimension:

- 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.[23]
- The shield should be at least 1.5 mm in width or one/fourth the buccolingual dimension of the root, whichever is lesser. Another guideline to follow is half the distance between the labial bone and the root canal space of the root to be sectioned.[24]

- 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.[25]
- It should have a bevel or S-shaped curve on the internal aspect.[26]

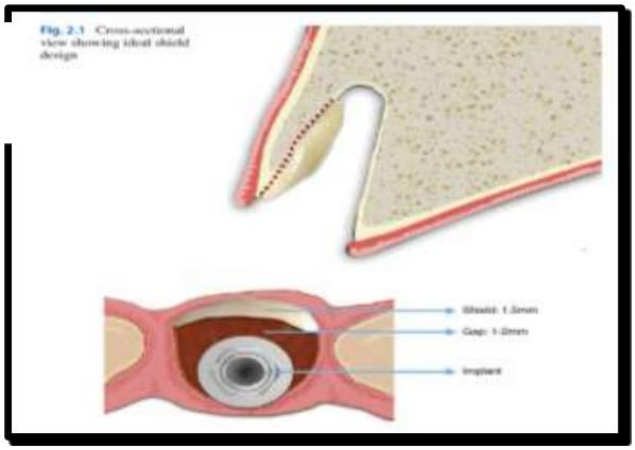


Figure 2- Cross sectional and occlusal view showing ideal shield design, implant position and gap between implant and shield.

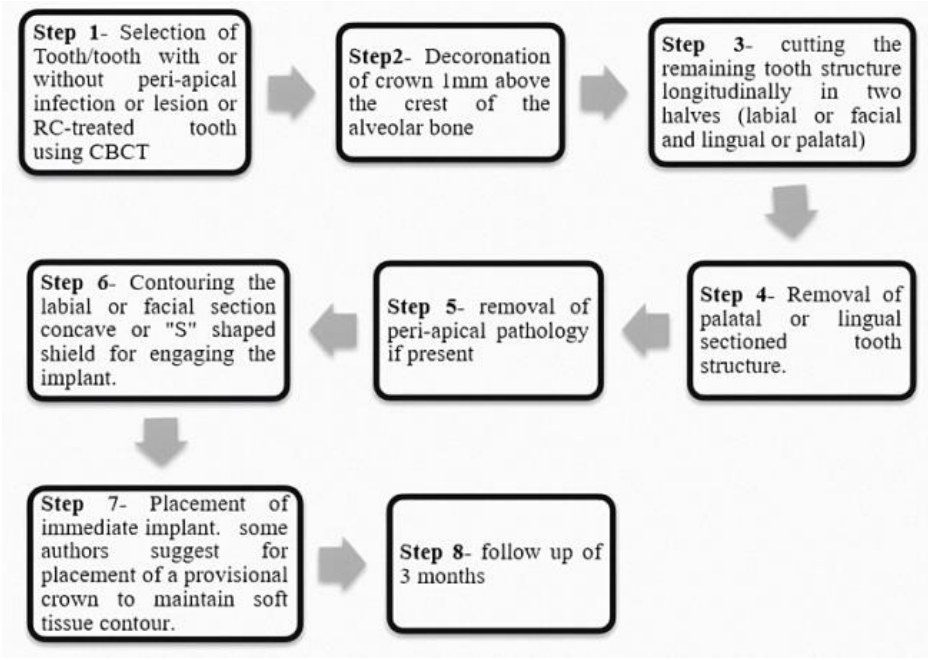


Figure 3- Procedural steps in socket shield technique.

Step by Step Procedure[22]:

- 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.

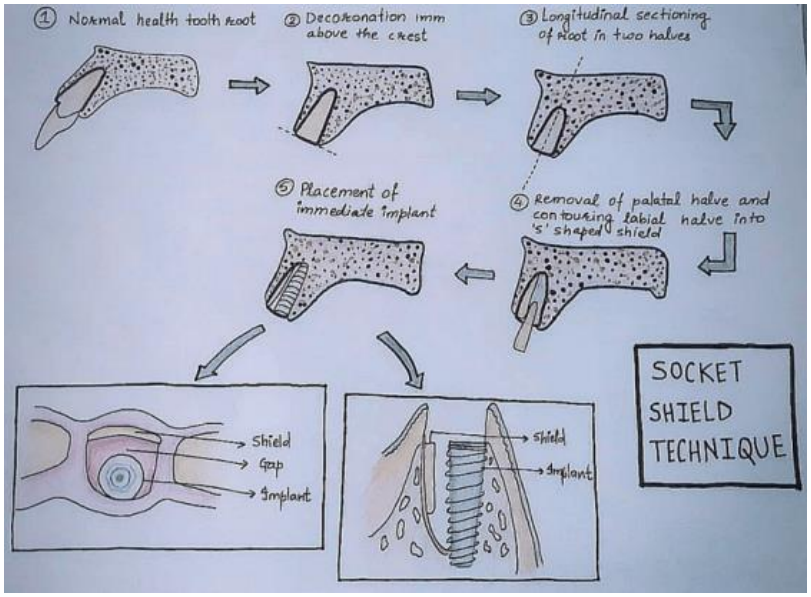


Figure 4- Diagrammatic presentation of socket shield technique.

Advantages[22]

- 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.
- 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[22]

- 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.

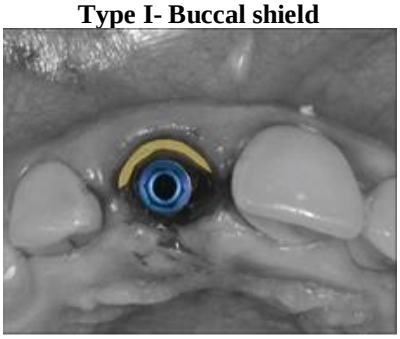
CLASSIFICATION OF SOCKET SHIELD

It is proposed that the classification of SST technique will help in understanding the clinical application of this technique depending on the position of the shield in socket.[27] This classification has been proposed depending on the position of the shield in the socket.[19]

TYPE I: BUCCAL SHIELD

A case can be classified as buccal shield when the shield lies only in buccal part of the socket,(between proximal line angles of tooth). It is indicated in single edentulous site with both mesial and distal tooth present.[27]

Type I- Buccal shield

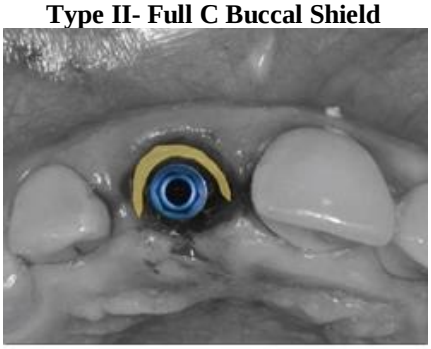


TYPE II: FULL C BUCCAL SHIELD

A case can be classified as buccal shield when the shield lies only in buccal part of the socket,(between proximal line angles of tooth). It is indicated in single edentulous site with both mesial and distal tooth present.

This shield design is recommended for the following clinical scenarios:

Type II- Full C Buccal Shield



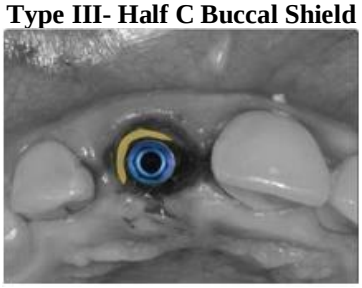
- Existing implant on either side of the proposed site

- Missing tooth on either side without an implant
- Having implant on one side and missing tooth on the other side.[19]

TYPE III: HALF C BUCCAL SHIELD

A case can be classified a shalf C buccal shield when the shield lies in buccal part and one of the interproximal part. This design is recommended when there is tooth on one side and im-plantoramissing tooth on the other side.[27]

Type III- Half C Buccal Shield



TYPE IV- INTERPROXIMAL BUCCAL SHIELD

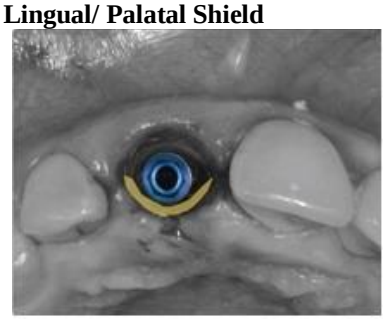
A case can be classified as interproximal shield when shield lies only in mesial or distal part of the socket.This design is indicated when there is buccal bone resorption requiring graft, and there is an adjacent side with missing tooth or an implant. Extraction of the complete tooth in such cases may lead to loss of the valuable interproximal bone.[19]

Type IV- Interproximal Buccal Shield

TYPE V- LINGUAL/PALATAL SHIELD

A case can be classified as Lingual-Palatal shield when the shield lies on the lingual or palatal side of the socket. This type of shield design has few indications but could be considered for maxillary molars.[27]

Type V- Lingual/ Palatal Shield

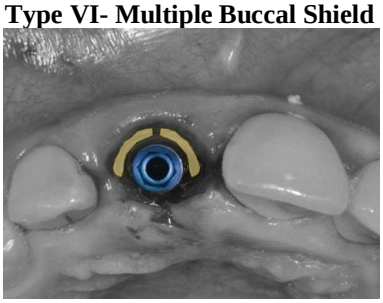


TYPE VI- MULTIPLE BUCCAL SHIELD

A case can be classified as multiple buccal shields when it has two or more shield in the socket.

It is indicated in cases with a vertical root fracture. There is evidence to show bone deposition in between fractured roots which could assist in holding the two fragments in place.[19]

Type VI- Multiple Buccal Shield



ERRORS AND COMPLICATIONS IN SOCKET SHIELD TECHNIQUE

The errors and complications that are likely to occur during the SST procedures are categorized into the following (summarized in Fig 5):

1. Diagnostic errors.
2. Surgical errors.
3. Complications in restorative phase.

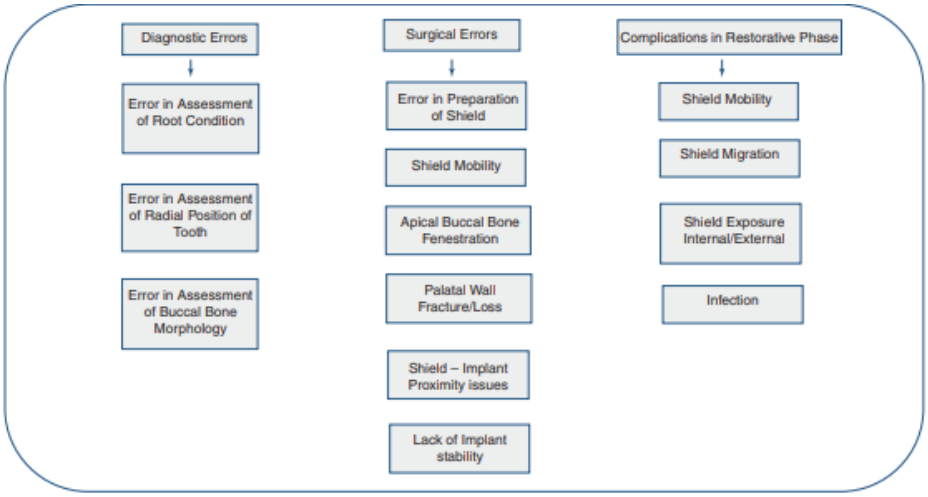


Figure 5- Classifications of errors and complications in partial extraction therapies[13]

CONCLUSION

Prof. Branemark introduced the concept of osseointergration more than five decades ago. Back then, clinicians were more focused on evaluating the ability of the human body to accept dental implants. Today, clinicians are seeking treatment options for their patients, wherein replacement of teeth with implants are virtually indistinguishable from what was given by Mother Nature. Partial extraction therapies are just getting started and are already making it possible to achieve near-natural outcomes with dental implants. The sound biological basis for the concept and the clinical and histological studies published so far is reassuring for clinicians to adopt these procedures in their practices.[13]

After tooth extraction, alveolar ridge collapse is a severe problem, compromising the cosmetic result in the anterior zone.[2]

In cases involving immediate implant insertion post-extraction, socket shield therapy has shown very promising results in preventing alveolar ridge resorption.[21]

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.[22]

SST is meticulous alternatives with a big future in preventing alveolar bone from resorption after tooth removal, preserving the bundle bone resorption, and providing a long-term esthetic outcome.[2]

This treatment modalities have advantage of, ultimate esthetic outcome imitating the natural emergence profile, preserving the soft and hard tissue volume, lack of bone loss, additional material cost, No co-morbidity, Single surgery, Applicable in sites with endodontic apical pathology. The disadvantage include not yet reliable or predictable, no long-term data available.[28]

Immediate implant positioning with the SST offers the best cosmetic and functional performance. The most significant disadvantage of SST appears to be the delicate surgical method.[2]

The following recommendations may be useful for predictable clinical outcome of SST for immediate implant placement:[29]

- It is a technique sensitive procedure. The case selection is critical and the surgical procedure should be performed by the expert clinicians.
- A CBCT evaluation of the preparation site is very essential for preoperative evaluation of root anatomy and visualization of any possible apical infection, resorption, fenestration, and dehiscence.
- The thickness of the shield should be at least 1.5 mm to ensure resistance to fracture and resorption.
- Apex of the root should be completely removed, and it should be ensured there is no vertical fracture or mobility in the shield.
- Tapered implants with knife-edge threads provide excellent implant stability.
- Customized transgingival abutment or provisionalization with a screw-retained provisional restoration is preferred for a better emergence profile.

The partial extraction therapies are an evolving science. As the collective experience of the fraternity increases in this field, there will be variations of the classic approach. The clinicians practicing this science need to update their knowledge in this field and look out for ways to make the procedure safer, faster, and more predictable.[13]

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