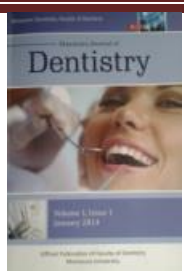

Evaluation of The Effect of Socket Shield Technique on The Success of Immediate Dental Implant

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Abstract:
Introduction: Immediate insertion of post extractive single implants in areas of high esthetic value remains a challenge for the clinician because it is difficult to obtain a restoration that can mimic the emergencies and profiles of nature, in perfect symmetry with the natural, contralateral tooth. To achieve a successful esthetic outcome with a single implant supported restoration in the anterior region, in fact, it is mandatory to preserve and maintain intact bone, as well as the overlying soft tissues architecture.
Aim of the study: This study is designed to evaluate success and stability of immediately placed dental implant using socket shield technique.
Material and Method: This randomized controlled clinical study was conducted on ten adult patients of both genders. All patients had maxillary single rooted teeth indicated for extraction and immediate implant placement. implants were placed in association with the socket shield technique
Results: it was found that the amount of bone loss at the period from implant placement to 6 months was statistically insignificant. And all implants were osseointegrated successfully without any post-operative complications.
Conclusion: socket shield technique could preserve buccal plate of bone and provide high aesthetic results.
Key Words: socket shield technique, immediate dental implant, buccal bone plate, ridge preservation.

Introduction

Immediate implant placement is a well-recognized and successful treatment option following tooth removal. Although the success rates for both immediate and delayed implant techniques are comparable .Tooth loss results in altered dimensions of the alveolar ridge due to remodeling and tooth-dependent alveolar process.[1,2]

The degree of alterations varies and it can result in the loss of ridge volume and changes in ridge shape, the greatest loss occur on the buccal aspect, which is related to a thinner bone wall[2] composed of large amounts of bundle bone[2] primarily vascularized by the periodontal tooth membrane[3] and particularly susceptible to surgical trauma and resorption.[4-6] Other important reasons to maintain the bone wall while teeth are present include maintenance of the periodontal ligament and the provision of nutritional and functional stimuli.[7]

Most dimensional changes that compromise socket healing occur during the first to third months.[7] A reorganization of the alveolar ridge can be observed for up to 1 year, but with a less pronounced influence on the hard and soft tissues.[8] In most situations, these changes adversely affect the esthetic outcome ,treatment planning, implant positioning, material selection, and osseointegration.[1]

Several approaches have been described for contouring the socket alterations caused by tooth extraction[9-11] include :positioning of the implant on the palatal/lingual wall ("palatal approach"), preserving the buccal wall Contact, performing the surgery using the flapless technique to maintain vascularization and using soft-tissue or bone grafts to maintain the dimension of the ridge by socket augmentation.[8] Recent studies concentrated either on immediate implants or on the use of grafts, but they also stated that remodeling cannot be avoided with these techniques but can continue even after 3 to 6 months of healing.[1,12]

Techniques for submucosal vital and non-vital root retention have already been described [13]. Salama [14] demonstrated that the so-called root submergence technique (RST) preserves the natural periodontium, thereby completely preventing bone resorption. Von Arx et al. [15] have recently published a new method to preserve the alveolar ridge after post traumatic ankylosis and external root resorption by leaving the de-crowned root fragments.
In 2010 Hürzeler and colleagues, introduced a new approach (the socket shield technique) for immediate implantation in extraction socket of teeth with healthy periodontal tissues. The socket-shield (SS) technique provides a promising treatment adjunct to better manage these risks and preserve the post-extraction tissues in aesthetically challenging cases. [9]

The principle is to prepare the root of a tooth indicated for extraction in such a manner that the buccal / facial root section remains in-situ with its physiologic relation to the buccal plate intact. The tooth root section's periodontal attachment apparatus (periodontal ligament (PDL), attachment fibers, vascularization, root cementum, bundle bone, alveolar bone) is intended to remain vital and undamaged so as to prevent the expected post-extraction

socket remodeling and to support the buccal / facial tissues. [16]

Materials and Methods

This randomized controlled clinical study was conducted on ten adult patients of both genders. All patients had maxillary single rooted teeth indicated for extraction and immediate implant placement. The patients were selected from the Out-Patient Clinic of the Oral & Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University.

Inclusion criteria: Maxillary single rooted teeth indicated for extraction, Age ranging from 18-50 years, Good oral hygiene, Non-smoking patients, Free from any pathological lesions related to the tooth to be extracted.

Exclusion criteria: Acute infection in the tooth to be extracted, Patients on chemotherapy or radiotherapy, Patients who have systemic disorders that interfere with bone healing {uncontrolled diabetes mellitus, autoimmune disease, …etc.}, Pregnancy and Patients with parafunctional habits.

A. Preoperative phase:

All patients were examined by proper history taking and thorough clinical and radiographic examination as follow:

History of the patient: The preoperative data were collected and recorded in full details including demographic data.

Clinical examination: Local visual examination and palpation of the entire oral and para-oral tissues to insure right selection of the patient and evaluate the tooth to be extracted for mobility, fractures and surrounding gingival tissue. (figure A (1)

Radiographic examination: Cone beam computed tomography (CBCT) was obtained for every patient to evaluate: Buccal bone plate as no buccal bone no shield, to see if there were any pathological lesions, Vital structures related to the tooth to be extracted as nasal cavities and maxillary sinuses and Suitable implant size for every patient was selected data.

B. Operative phase:

- All patients were anesthetized using local anesthesia (2% Mepivacaine hydrochloride with 1 :20000 Levonordefrin).
- The tooth was decoronated to the gingival level if it was more coronal, with care taken at all times not to damage the gingival tissue.
- If the tooth was endodontically treated, the root canal filling material should be removed. (figure A (2).
- Thereafter, with the use of an irrigated long-shank surgical root resection bur, the tooth root was 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. (figure A (3).
- Absolute care was taken not to penetrate bone or neighboring teeth mesially or distally. Once labial and palatal root halves are adequately separated, a straight apexo elevator was inserted into the palatal PDL space, carefully displacing the palatal root section labially into the recess created by the sectioning bur and retrieving it with a remaining root forceps. (figure A (5).
- The labial root section that remains in situ was then instrumented on its inner aspect with a sharp probe, inspecting for immobility.(figure A(4) All remnants within the socket apex was to be thoroughly curetted out, followed by copious saline rinse. Thereafter, the coronal aspect of the root section was reduced and shaped to within 1 mm above the alveolar socket crest by an irrigated large round diamond bur. It was critical not to damage the gingival tissue. the root section was reduced and shaped as a crescent shaped concavity conforming to the labial aspect of the alveolus using a tapered and flame shaped burs. (figure A (6).
- The initial preparation of the implant bed was done with a pilot drill, the osteotomy was then widened using an intermediate drill and the final drill according to the diameter of the implant. The implant was then inserted into the bone palatal to the root. (figure A (7).
- The gap was left graftless to be filled with blood clot.
- A PRF membrane was then prepared to be used with healing cap to improve coronal seal and rapid healing of soft tissue around implant [17]. (figure A(8).

C. Postoperative Phase:

All patients were advised to apply cold packs extra orally intermittently every 10 minutes for 2 hours on the first day. Chlorohexidine mouth wash was started on the 2nd postoperative day for one week. Amoxicillin 875 mg /claviulanic acid 125 mg antibiotic tablet one tablet every 12 hours for 5 days postoperatively. Diclofenac sodium non-steroidal anti-inflammatory drugs 50 mg tabs one tablet every 8 hours for five days. The sutures were removed after one week post surgically.

D. Follow up phase:

Clinical evaluation: All patients involved in this study were evaluated for:

Post-operative pain: Pain will be evaluated at the second day and after 1,4,6 months through Visual Analogue Scale from 0 to 10. [18]

Peri-implant probing depth [19]**:** Measuring the distance from the gingival margin buccal, palatal, mesial and distal crestal bone margins. Mesial and distal pockets were measured from the buccal aspect as close as possible to contact points while facial and lingual pockets were measured at the midline of the implant.

Implant stability: Was assessed at the time of implant insertion and at all follow up visits. Resonance frequency analysis (RFA) values expressed as implant stability quotient (ISQ) will be recorded by a transducer attached to the implant by a screw and a frequency response analyzer

(Osstell Mentor Device) with the average of 2 measurements performed with the probe in 2 perpendicular directions.

Radiographic evaluation: Cone beam computed tomography (CBCT) was used to evaluate horizontal and

vertical dimensional changes to the facial bone following immediate implant placement. It will be done immediately after implant placement and after 6 months.

Horizontal bone level: Starting from the implant shoulder a fixed distance was taken as a reference line and the horizontal bone level was measured.

Vertical bone level: A line from the apex of the implant parallel to the reference horizontal line of the CBCT was drawn and the marginal bone level was measured from the reference line to the marginal bone crest.

Patients were clinically and radiographically evaluated at different times intervals during follow up period.

E. Prosthetic phase: After four months the healing cap was removed and final prosthetic treatment (porcelain fused to metal crown) was performed.

Results:

This study was conducted on ten patients with a single rooted maxillary tooth that was indicated for extraction and replacement with an immediate dental implant. The patients were with average age of 30 years. All implants were osseointegrated successfully with 100% survival rate and excellent soft tissue healing. All surgeries were done under local anesthesia and there were no recorded complications during the surgeries.

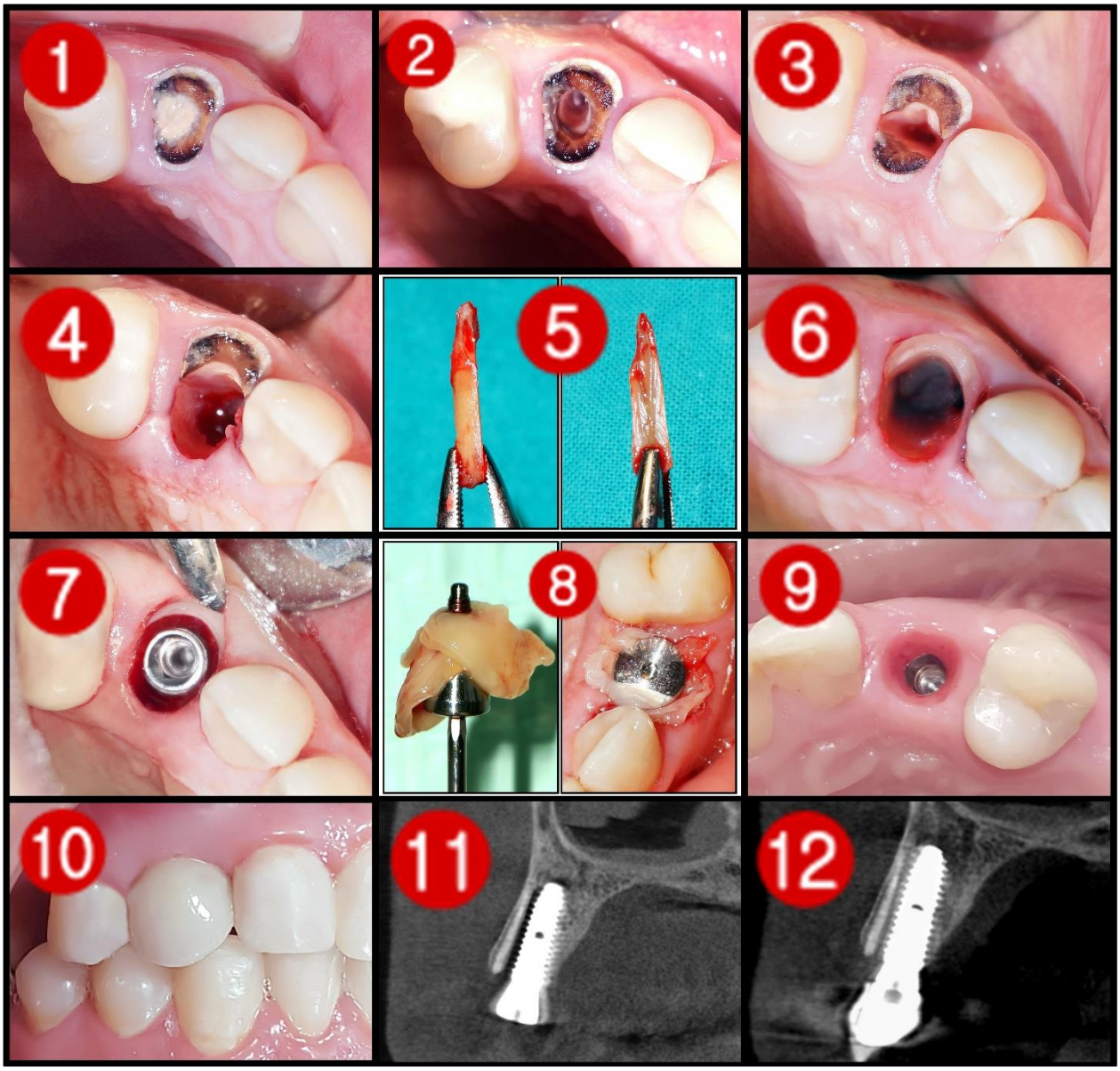

Figure (A): A photograph showing the socket shield technique procedure. (1) Preoperative clinical photograph showing maxillary right canine remaining root. (2) A clinical photograph after removal of root canal filling material. (3) Hemi section of the root. (4) Labial Root section. (5) Palatal fragment. (6) Labial fragment after final shaping. (7) Implant placement palatal to the socket shield. (8) Healing abutment with a PRF membrane. (9) Soft tissue after removing of healing abutment. (10) Final cemented metal ceramic crown. (11) A CBCT immediately after implant placement. (12) A CBCT after 6 months.

I- Clinical evaluation.

All patients have uneventful healing with no complications post operatively. All patients in the study were evaluated for:

Post-operative pain: All patients experienced mild pain at 2nd day of surgery. The pain disappeared after 2nd and 3rd day completely and no pain at all follow up intervals. All patients experienced mild to moderate edema that completely disappeared after 5 days of surgery.

Peri -implant probing depth: Probing depth undergo insignificant changes from the period of 4 months when the final prosthesis was cemented to 6 months.

Implant stability: The mean implant stability quotient was measured immediate post operatively and was 59.0 ± 4.69 ISQ, after 4 months was 70.50 ± 2.71 ISQ and after 6 months was 71.90 ± 2.11 ISQ which was Statistically significant.

Implant stability	**Immediate post-operative**	**4 Months**	**6 Months**	**F**	**P**
Buccal & palatal					
Min. – Max.	50.0 – 66.0	65.0 – 75.0	68.0 – 75.0		
Mean ± SD.	56.80 ± 4.61	69.40 ± 2.95	70.70 ± 2.26	104.909*	<0.001*
Median	57.0	69.50	71.0		
Sig. bet. Grps	p_1<0.001*, p_2<0.001*, p_3=0.083				
Mesial& distal					
Min. – Max.	54.0 – 72.0	67.0 – 76.0	70.0 – 77.0		
Mean ± SD.	61.20 ± 5.01	71.60 ± 2.67	73.10 ± 2.08	56.171*	<0.001*
Median	60.0	72.0	73.0		
Sig. bet. Grps	p_1<0.001*, p_2<0.001*, p_3=0.045*				
Average					
Min. – Max.	52.0 – 69.0	66.0 – 75.50	69.0 – 76.0		
Mean ± SD.	59.0 ± 4.69	70.50 ± 2.71	71.90 ± 2.11	87.758*	<0.001*
Median	58.25	70.25	72.0		
Sig. bet. Grps	p_1<0.001*, p_2<0.001*, p_3=0.049*				

F: F (**ANOVA**) with repeated measures, Sig. bet. periods was done using **Post Hoc Test (Bonferroni)**
p: p value for comparing between three periods
p_1: p value for comparing between **immediate post-operative** and **4 Months**
p_2: p value for comparing between **immediate post-operative** and **6 Months**
p_3: p value for comparing between **4 Months** and **6 Months**
*: Statistically significant at $p \leq 0.05$

II-Radiographic evaluation: CBCT was used for each patient to evaluate dimensional changes of buccal bone vertically and horizontally. (figure A (11,12)

Vertical bone level: There was insignificant difference between height of buccal plate of bone immediately after implant placement and after 6 months.

Horizontal bone level: There was insignificant difference between width of buccal bone immediately after implant placement and after 6 months.

Bone level	Immediate post-operative	6 months	T	P
Vertical bone level				
Min. – Max.	11.05 – 15.29	10.80 – 14.74		
Mean ± SD.	12.60 ± 1.18	12.47 ± 1.09	1.737	0.116
Median	12.49	12.49		
Horizontal bone level				
Min. – Max.	2.18 – 4.25	1.86 – 3.94		
Mean ± SD.	3.26 ± 0.72	3.12 ± 0.71	1.847	0.098
Median	3.18	2.98		

t: Paired t-test
p: p value for **Paired t-test** for comparing between **Immediate post-operative** and **6 months**
*: Statistically significant at $p \leq 0.05$

III- Prosthetic phase:

After 4 months the healing cap was removed leaving excellent soft tissue healing (figure A (9) and porcelain fused to metal prostheses were fabricated and cemented (figure A(10).

Discussion:

Complete Maintenance of ridge volume after tooth extraction with techniques of preservation which using the available current materials for a resorption prevention is not yet possible [20]. On the other hand, teeth roots retention in the alveolar bone may preserve dimensions of the ridge tissues. Hürzeler et al. in Their report stated that the retained attachment of the buccal plate of bone to the SS by a normal PDL was clean of any inflammatory responses. The buccal bone crest presented an absence activity of osteoclasts and free from active remodeling. The coronal gingival tissue has a junctional epithelium that was physiologic free from any inflammatory response and the osseointegration of the implant inserted in conjugation with the SS technique [9] was successful. This finding is consistent with clinical and observations of excellent ridge dimensional stability following retention of a buccal root fragment in our study.

Regarding bone loss, there is still insufficient evidence to support the SST with simultaneous implantation. Only a few case reports are available showing variable data of bone loss. In a case-control study in 2014, a medium vertical bone loss of 0.8 mm was reported in 26 implants on 25 patients after 24 months of follow-up [21]. In a prospective clinical case series study, the marginal bone loss was reported to be 0.7 mm on average after 6 months [22]. In a retrospective study on 10 patients in 2017, an

Regarding soft tissue, the soft tissue volume contraction is often related to tooth extraction and the resulted bone loss [24]. Moreover, mucogingival surgeries applied for increasing the gingival volume, such as connective tissue grafts, often resulted in a soft tissues volumetric reduction of about 30% [25]. On the other side, as a consequence of minimal amount of bone loss, soft tissue grafting would not be necessary in most of the patients treated by this technique [21]. In our study there were excellent soft tissue volume and contour without any inflammatory responses.

In regard to the fate of the retained root fragment, no signs of resorption of the root portions left in situ have been observed in the present study. However, such a phenomenon, observed by some authors in other studies, Bäumer et al in 2017 in their publication, stated that CBCTs showed the retained part of the root labial to the implant placed. Only in 1 case, there were resorption of the shield apically which may be as a result of microbiological leftovers in apex of the root, which is indicative of sensitivity of the technique. This was resolved spontaneously without affecting the success of implant rehabilitation. In this regard, it is appropriate to consider some authors suggesting that root resorption phenomena are counteracted by a subsequent phase of bone remodeling and new apposition without infectious events [23].

Regarding the gap between implant and socket shield: Parlar et al. the 1st clinician who insert 18 fixtures in hollow chambers prepared in the center decoronated teeth roots having sections at the periphery in 10 mongrel dogs. After 4 months, the specimen's examination histologically resulted in that formation of new root cementum and PDL in the gap between the implant and the shield. They failed to osseointegrate and a fibrous capsule covered their surfaces with cellular cementum deposition on 2 implants [26].

average bone loss of 0.33 mm mesially and 0.17 mm distally were reported [23]. This finding is consistent with our study results where there was insignificant difference between vertical and horizontal bone levels at the time of implant placement and after 6 months. Totally, these low tissue alterations can explain good esthetic outcomes and the clearance of esthetic results that may be compromised.

Hurzeler et al. retained a labial part of tooth root intentionally and brushed with derivative of enamel matrix (Straumann, Emdogain), to prevent the buccal bone plate at the time of placement of an immediate implant from resorption. They were firstly named the technique as socket-shield. four implants are examination after inserted in the jaw of beagle dog Histologically presented that creation of cementum on the surface of implant where a direct implant-root contact was present. When the root piece and the implant were in close contact without contact

the surface, about 0.5 mm band of connective tissue were present in-between the buccal root piece and the implant [9].

A systematic review on the SST introduced by Amit S. Gharpure et al in 2017 in order to evaluate the available literature about the SST and evaluate its biological tolerance and long-term prognosis clinically. After going through the literature available, the total evidence that support the SST were restricted at the moment. This histological information indicates osseointegration failure, cementum deposition, periodontal ligament or periodontal ligament like fibrous tissue on the surface of implant that were close to the shield, rapid bone loss, and weakens the biologic plausibility of the technique [27].

On the other side: Buser et al had experimented with implantation into retained primate teeth. This novel study demonstrated that a cementum layer formed on the implant surfaces and that a periodontal ligament consistently was present, inserting fibers from implant cementum into adjacent bone [28]. Fifteen years later, Parlar and coworkers similarly aimed to investigate the potential of periodontal tissues to form around dental implants placed into canine teeth. The teeth were hollowed, and implants were inserted wholly inside the teeth. Slits in the teeth were prepared to allow passage to the periodontal ligament. The results of this study also failed to demonstrate successful osseointegration [29].

Mitsias and coworkers had reported histology of a similar technique—the root membrane. While differing from the socket-shield by preparing the implant osteotomy through the tooth root, the authors similarly reported the presentation of bone between implant and root dentin [11]. Also, Baumer et al. presented this technique by a matching design of the study with a bigger sized sample. Their results histologically stated that bone formed in between the shield and the implants after healing by 4 months and osseointegration [10].

Charles Schwimer et al in 2018 represent a case report that presented the first human histologic evidence that Bone can occupy the space between an implant surface and a socket-shield, as is the desired outcome of an osseointegrated implant [30]. In our present study and by evaluation of the patients radiographically it was shown that after 6 months of immediate implant placement with socket shield there was no signs of periodontal tissue formation as there was no radiolucencies appear between implant and shield but the gap appeared to be radiopaque which indicate bone formation.

The primary implant stability in the present study was 59.0 ± 4.69ISQ, which increased to be 71.90 ± 2.11ISQ after 6 months from implant placement which was an indication of successful osseointegration. This was similar to the study presented by Chang-Hun Han et al in 2018 [31] in which thirty patients (15 females ,15 males; mean age was 48years) were enrolled in the study and installed with 40 immediate implants. After 1 year, no biologic complications were reported, and the incidence of prosthetic complications was low. all implants were functioning, for a survival rate of 100%; excellent implant stability was reported (mean implant stability quotient at placement: 72.95 after 1 year: 74.62).

The clinical and radiographic results of our study were similar to the clinical and radiographic criteria proposed by Albrektsson et al [32]. and adapted by Buser et al [33]. and Karoussis et al [34]. which used to define implant success and this indicate that socket shield technique improved success of immediate implant placement in aesthetic zone.

Conclusion:

From the presented study we can say that socket shield is a minimally invasive surgical procedure help in maintaining hard and soft‑tissue contours. It minimizes the need of soft and hard tissue grafting procedures and hence shortens the overall treatment duration. This is a highly promising technique in terms of maintaining pink and white esthetics and provides a solution for esthetically critical cases such as high lip line and maxillary anteriors.

Recommendations:

The clinician needs to be specially trained and need to have a high degree of clinical skills. The procedure requires a little more time and patience to avoid mobility in the shield. If the shield becomes mobile during surgery, it is removed, and the conventional immediate implant placement or the grafting procedure is to be done. The case selection is very important for the success of the procedure. The technique is not recommended in mobile teeth, teeth which are out of the arch and teeth with large periapical lesions. The intactness of the shield plays an important role in the success of the treatment.

References

1. *Passoni BB, Marques de stro DS, de Araujo MA, et al. -Influence of immediate/delayed implant placement and implant platform on the peri-implant bone formation. ClinOral Implants Res 2016; 5:1–8.*
2. *Araujo MG, Sukekava F, Wennstr - om JL, Lindhe J. Tissue modeling following implant placement in fresh extraction sockets. Clin Oral Implants Res 2006; 17:615–24.*
3. *Glocker M, Attin T, Schmidlin P. Ridge preservation with modified "socket-shield" technique: a methodological case series. Dent J 2014; 2:11–21.*
4. *Wilderman MN. Repair after a periosteal retention procedure. J Periodont 1960; 34:487–503.*
5. *Wilderman MN, Wentz F, Orban BJ. Histogenesis of repair after mucogingival surgery. J Periodont 1963; 31:283–99.*
6. *Araujo MG, Sukekava F, Wennstr - om JL, Lindhe J. Ridge alterations following implant placement in fresh extraction sockets: an experimental study in the dog. J ClinPeriodontol 2005; 32:645–52.*
7. *Araujo MG, Wennstrom JL, Lindhe J. Modeling of the buccal and lingual bone walls of fresh extraction sites following implant installation. Clin Oral Implants Res 2006; 17:606–14.*
8. *Araujo MG, Silva CO, Misawa M, Sukekava F. Alveolar socket healing: what can we learn? Periodontal 2000 2015; 68:122–34.*
9. *Hurzeler MB, Zuhr O, Schupbach P, et al. The socket-shield technique: a proof-of-principle report. J ClinPeriodontol 2010; 37:855–62.*
10. *Baumer D, Zuhr O, Rebele S, et al. The socket-shield technique: first histological, clinical, and volumetrical observations after separation of the buccal tooth segment – a pilot study. Clin Implant Dent Relat Res 2015; 17:71–82.*
11. *Guirado JL, Troiano M, Lopez-L - opez, et al. Different configuration of socket-shield technique in peri-implant bone preservation: an experimental study in dog mandible. Ann Anat 2016; 16:30124–8.*
12. *Araujo MG, da Silva JC, de Mendonca AF, Lindhe J. Ridge alterations following grafting of fresh sockets in man. A randomized clinical trial. Clin Oral Implants Res 2015; 26:407–12.*
13. *Garver DG, Fenster RK. Vital root retention in humans: A final report. J ProsthetDent1980;43: 368-73.*
14. *Salama M, Ishikawa T, Salama H, Funato A, Garber D. Advantages of the root submergence technique for pontic site development in esthetic implant therapy. Int J Periodontics Restor Dent 2007;27: 521-7.*
15. *Von Arx T, Brägger U, Scheuber S, Bosshardt D. Implant attherapienachFrontzahntrauma. SchweizMonatsschrZahnmed2013;123: 417-27.*
16. *Hürzeler MB, Zuhr O, Schupbach P, Rebele SF, Emmanouilidis N, Fickl S. The socket shield technique: a proof-of-principle report. Jclin Periodontal 2010; 37:855-62.*
17. *Qiao J, An N. Effect of concentrated growth factors on function and Wnt3a expression of human periodontal ligament cells in vitro. Platelets.2017;28(3):281-286.*
18. *Campbell W, Lewis S. Visual analogue measurement of pain. The Ulster medical journal. 1990;59(2):149-154.*
19. *Mombelli A, Muhle T, Bragger U, Lang NP, Burgin WB. Comparison of periodontal and peri-implant probing by depth-force pattern analysis Clin Oral Implants Res. 1997; 8:448-54.*
20. *Bäumer D, Zuhr O, Rebele S, Schneider D, Schupbach P, Hürzeler M. The socket-shield technique: first histological, clinical, and volumetrical observations after separation of the buccal tooth segment - a pilot study. Clin Implant Dent Relat Res. 2015;17(1):71-82.*
21. *Abadzhiev M, Nenkov P, and Velcheva P. "Conventional immediate implant placement and immediate placement with socket-shield technique – which is better," International Journal of Clinical Medicine Research, vol. 1, no. 5, pp. 176–180, 2014.*
22. *Troiano M, Benincasa M, Sánchez P, and Guirado J. L. "Bundle bone preservation with Root-T-Belt: case study," Annals of Oral Maxillofacial Surgery, vol. 2, no. 1, p. 7, 2014.*
23. *Bäumer D, Zuhr O, Rebele S, and Hürzeler M. "Socket shield technique for immediate implant placement - clinical, radiographic and volumetric data after 5 years," Clinical Oral Implants Research, vol. 28, no. 11, pp. 1450–1458, 2017.*
24. *Vignoletti F, Sanz M. Immediate implants at fresh extraction sockets: from myth to reality. Periodontology 2000 2014;66: 132–152*
25. *Donos N, Mardas N, Chadha V. Clinical outcomes of implants following lateral bone augmentation: systematic assessment of available options (barrier membranes, bone grafts, split osteotomy). J Clin Periodontol 2008;35(8 suppl):173–202*
26. *Parlar A, Bosshardt DD, Unsal B, Cetiner D, Haytac C, Lang NP. New formation of periodontal tissues around titanium implants in a novel dentin chamber model. Clin Oral Implants Res. 2014;66: 132–152.*
27. *Gharpure A. S. and Bhatavadekar N. B. "Current evidence on the socket-shield technique: a systematic review," Journal of Oral Implantology, vol. 43, no. 5, pp. 395–403, 2017.*
28. *Kan JY, Rungcharassaeng K. Proximal socket shield for inter implant papilla preservation in the*

esthetic zone. Int J Periodontics Restorative Dent. 2013;33(1): e24-31.

29. *Siormpas KD, Mitsias ME, Kontsiotou-Siormpa E, Garber D, Kotsakis GA. Immediate implant placement in the esthetic zone utilizing the "root-membrane" technique: clinical results up to 5 years post loading. Int J Oral Maxillofac Implants. 2014;29(6):1397-1405.*
30. *Schwimer C, Pette G. A, Gluckman H, Salama M, and Du Toit J. "Human histologic evidence of new bone formation and osseointegration between root dentin (unplanned socket shield) and dental implant: case report," The International Journal of Oral & Maxillofacial Implants, vol. 33, no. 1, pp. e19–e23, 2018.*
31. *Han CH, Park KB, Mangano FG. The Modified Socket Shield Technique. The Journal of Craniofacial Surgery.2018; 55-60.*
32. *Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants 1986; 1:11–25.*
33. *Buser D, Mericske-Stern R, Bernard JP, et al. Long-term evaluation of non-submerged ITI implants. Part 1:8-year life table analysis of a prospective multi-center study with 2359 implants. CLIN Oral Implants Res 1997; 8:161–172.*
34. *Karoussis IK, Bragger U, Salvi GE, Burgin W, Lang NP. Effect of implant design on survival and success rates of titanium oral implants: A 10-year prospective cohort study of the ITI Dental Implant System. Clin Oral Implants Res 2004; 15:8–17.*