

Evaluation of the Effect of Socket Shield Technique on the Success of Immediate Dental Implants

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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.

Keywords: 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 technique called later the socket shield technique for immediate implant insertion in teeth extraction socket that have good 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].

Socket-shield was made by preparing the tooth that would be extracted and followed by immediately placed fixture. The teeth were cutted to be 1 mm coronal to the crest of alveolar bone, then the tooth root was divided along the full length into labial and lingual portions. The lingual part was extracted and any pathological lesions found was cleaned from the apex of the tooth. The labial part was then shaped with a tapered dental stone to be concave in shape. The implant was then inserted lingual to the shield [16].

Material and Method

This 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 Outpatient Clinic of the Oral and 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 {diabetes mellitus when uncontrolled, autoimmune disease, ...etc.}, Pregnancy and Patients with bruxism.

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 ensure right selection of the patient and evaluate the tooth to be extracted for mobility, fractures and surrounding gingival tissue figure A1.

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.

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 always not to damage the gingival tissue.
- If the tooth was endodontically treated, the root canal filling material should be removed. figure A2.
- Thereafter, along shank surgical bur was utilized with water cooling to section the tooth in mesiodistal direction and along its full length taking the root canal as reference to cut the tooth in to a labial and a palatal part. figure A3.
- The labial part of the root that remains in situ was instrumented on its palatal aspect with a sharp probe, checking for immobility. figure A4.
- The palatal half was luxated by a small straight elevator and extracted using a remaining root forceps. figure A5.
- All remnants within the socket apex was to be carefully curetted out and rinsed by copious saline rinse. the coronal part of the labial root section was reduced to be within 1 mm above the alveolar bone margin using large round diamond bur associated with water cooling. It was critical not to injury the gingival tissue. The labial root part was modified and shaped as a concave crescent shape concavity similar to the labial aspect of the alveolus using a tapered and flame shaped burs. figure A6.
- The initial step to prepare implant bed was made with a pilot drill, the osteotomy was then enlarged using the next drill and the final drill suitable to the size of the implant. The implant was then inserted into the palatal bone palatal to the socket shield. figure A7.
- 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 A8.

Postoperative Phase:

All ten patients were asked to apply cold packs on the extra oral area every 10 minutes for 2 hours during the first day. mouth wash containing Chlorohexidine was started to be used on the 2nd day postoperatively for one week. antibiotic tablet containing Amoxicillin 875 mg /clavulanic acid 125 mg was taken one tablet twice daily for five days. Analgesic with non-steroidal anti-inflammatory drugs 50 mg tabs was taken 3 times daily for five days. After one week the sutures were removed.

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]: The depth of gingival sulcus was measured at the distance from the gingival margin palatal, buccal, distal and mesial. The 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 ex-

pressed 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: CBCT was used to calculate dimensional changes of the facial bone horizontally and vertically after immediate implantation. It will be taken just after implantation and after 6 months.

Horizontal bone level: A reference line was taken from the shoulder of the implant at fixed distance and the level of the horizontal bone was measured.

Vertical bone level: From the apex of the implant a reference line was taken to be parallel to the CBCT reference horizontal line and the length of buccal bone plate was measured from marginal bone crest to the reference line at implant apex.

Prosthetic phase: After four months the healing cap was removed and a porcelain fused to metal crown was fabricated.

Results

This clinical study was performed on 10 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 Osseo integrated 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.

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 ten patients had mild edema that completely disappeared after 5 days of surgery table 1.

Peri -implant probing depth: Probing depth undergo insignificant changes from the period of 4 months when the final prosthesis was cemented to 6 months table 2.

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 table 3.

Post-operative pain	2 nd day	1 Month	4 Month	6 Month	Fr	P
Min. – Max.	3.0 – 5.0	0.0 – 0.0	0.0 – 0.0	0.0 – 0.0		
Mean ± SD.	4.0 ± 0.82	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	30.0*	<0.001*
Median	4.0	0.0	0.0	0.0		
p ₀		0.001*	0.001*	0.001*		

Table 1: Showing post-operative pain throughout the study period.
 Fr: Fr for Friedman test, Sig. bet. Periods was done using Post Hoc Test (Dunn’s).
 p₀: p value for comparing between 2nd day and each other periods.
 *: Statistically significant at p ≤ 0.05.

Peri-implant probing depth	4 Months	6 Months	t	P
Mid buccal				
Min. - Max.	1.0 - 2.0	1.0 - 2.0	1.000	0.343
Mean ± SD.	1.45 ± 0.50	1.50 ± 0.47		
Median	1.25	1.50		
Mesial				
Min. - Max.	2.0 - 3.50	2.0 - 3.50	1.000	0.343
Mean ± SD.	2.70 ± 0.54	2.75 ± 0.49		
Median	3.0	3.0		
Distal				
Min. - Max.	2.0 - 3.50	2.0 - 3.50	1.500	0.168
Mean ± SD.	2.70 ± 0.54	2.80 ± 0.54		
Median	3.0	3.0		
Average				
Min. - Max.	1.67 - 3.0	1.67 - 3.0	1.780	0.109
Mean ± SD.	2.29 ± 0.50	2.35 ± 0.45		
Median	2.42	2.42		

Table 2: Showing peri-implant probing depth at 4 and 6 months post operatively.
t: Paired t-test.
p: *p* value for Paired t-test for comparing between 4 Months and 6 months.
 *: Statistically significant at $p \leq 0.05$.

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

Table 3: Showing implant stability measurements throughout the study period.
F: *F* (ANOVA) with repeated measures, *Sig. bet. periods* were done using Post Hoc Test (Bonferroni).
p: *p* value for comparing between three periods.
p1: *p* value for comparing between immediate post-operative and 4 Months.
p2: *p* value for comparing between immediate post-operative and 6 Months.
p3: *p* value for comparing between 4 Months and 6 Months.
 *: Statistically significant at $p \leq 0.05$.

Radiographic evaluation

CBCT was used for each patient to evaluate dimensional changes of buccal bone vertically and horizontally. table 4 and (figure A11and A12).

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

Table 4: Showing vertical and horizontal bone levels immediately after implant placement and after 6 months.
t: Paired t-test.

p: p value for Paired t-test for comparing between Immediate post-operative and 6 months.

*: Statistically significant at $p \leq 0.05$.

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.

Prosthetic phase:

After 4 months the healing cap was removed leaving excellent soft tissue healing figure A9.

Porcelain fused to metal prostheses were fabricated and cemented figure A10 (Figure A).

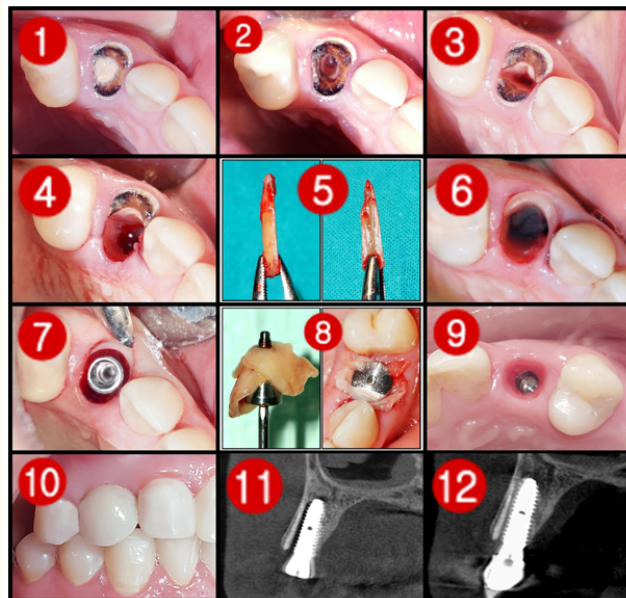


Figure A: A photograph showing the socket shield technique procedure. (1) Preoperative clinical photograph showing maxillary right canine remaining root. (2) A clinical photograph after removal of root canal filling material. (3) Hemi section of the root. (4) Labial Root section. (5) Palatal fragment. (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.

Discussion

Ridge volume complete maintenance 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 was successful [9]. 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 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.

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, because of minimal amount of bone loss, soft tissue grafting would not be necessary in most of the patients treated by this technique [26]. In our study there were excellent soft tissue volume and contour without any inflammatory responses.

Regarding 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 microorganism's leftovers in apex of the root, which is an indication of sensitivity of the approach. 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 Osseo integrate and a fibrous capsule covered their surfaces with cellular cementum deposition on 2 implants [26].

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 resorption after placement of immediate implant. 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 now. 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 osseo integrated 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 radiolucency's 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 ± 4.69 ISQ, which increased to be 71.90 ± 2.11 ISQ after 6 months from implant placement which was an indication of successful osseointegration. This was like 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 like 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.

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