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Original Research Article

Prospective evaluation of socket shield technique for immediate implant placement in anterior maxilla

Amrish Bhagol*, V. Ashwin, Virendra Singh

Department of Oral & Maxillofacial Surgery, PGIDS, Rohtak 124001, Haryana, India

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Dental implant / immediate placement / shield technique

Abstract – Purpose: The purpose of the study was to report the four year implant survival rate for immediate implant placement using socket shield technique. Objectives included evaluation of the esthetic outcomes and to report any complications associated with this technique. **Material and methods:** This study is a prospective cohort of 10 consecutive patients with Implant placement between the maxillary first premolars using socket shield technique. Data were collected (PPD, BOP, PES, buccal width of keratinized mucosa, peri-apical radiographs and photographs) to assess and compare the changes in peri-implant tissues in pre-operative and follow up visits. **Results:** All the implants osseointegrated successfully without any adverse events. Peri-implant probing revealed healthy conditions in terms of pocket depth and bleeding on probing. Mean buccal width of keratinized mucosa of 4.1 was achieved. A mean pink aesthetic score of 12.3 was recorded. **Conclusion:** Within the limitations of this study, the results were suggesting that socket shield technique is effective in maintaining the hard and soft tissue architecture of anterior maxillary region and delivers high esthetic outcomes with shorter duration of treatment period. However, a prospective randomized study to compare socket shield with other techniques is needed to draw any definitive conclusion.

Introduction

Dental implants being one among the most preferred modes of replacing missing teeth with a good success rate, have their own limitations. Patient compliance, systemic diseases with associated co-morbidities and certain local factors like oral hygiene, bone level and its quality plays a major role in case selection for dental implants.

Significant level of bone resorption along with the soft tissue recession awaits inevitably as a sequel following extraction of teeth [1–3]. The amount of bone resorption are based on various factors such as the periodontal status of the tooth, mechanical trauma and its effect on periosteal blood supply after flap elevation during extraction, the thickness and density of bone present, patient related risk factors such as smoking, oral hygiene status, host response to healing and compliance [4]. Eventhough dental implants are one among the reliable modes of replacement of teeth, the continuous bone resorption and associated deteriorative peri-implant soft tissue changes make the treatment modality debatable on a long term basis for its esthetic outcomes [5]. There is gingival recession through the years following implant placement as the soft tissue architecture shows proportionate distortion to hard tissue changes. These progressive changes affect the aesthetics and life span of implants and become a considerable challenge.

The buccal cortical bone in the anterior maxillary region shows significant bone loss following tooth removal as it is thinner and more porous compared to the other dentate regions of the jaw [6]. A large portion of the buccal cortical bone in the anterior maxilla is formed by bundle bone which tends to show aggressive resorption following extraction of tooth [2,7]. The bundle bone receives blood supply primarily from periodontal ligament and this serves the reason for aggressive resorption of cortical bone following an extraction as the blood supply to bundle bone is compromised [8]. In a study by Braut *et al.*, it was stated that this bone resorption which is caused mainly due to the interference of blood supply within the periodontal ligament was a biologic response [9]. For an implant site with aesthetic demands having a thin or absent facial bone wall whose resorption is anticipated, there is necessity for an adjunctive bone augmentation procedure simultaneously during implant placement.

Even though immediate implant placement is done to overcome this bone loss, as the compromise in blood supply following loss of periodontium is inevitable, resorption of bundle bone follows [7,10,11]. The conventional approach prolongs the total duration of treatment and may necessitate for additional surgical procedures for bone augmentation [12].

* Correspondence: bhagol.amrish@gmail.com

Hence, as an attempt to preserve the periodontium and keeping the additional grafting procedures and duration taken for the treatment in mind, a novel approach was introduced in which the tooth was sectioned before extraction to retain only a portion of the root facing the buccal wall within the socket in proximity to an immediately placed implants known as the 'socket-shield technique' [13,14]. The technique involving the segmental extraction of tooth retaining the buccal portion of the root within the socket served the purpose of nullifying the impact of extraction on the buccal wall preserving blood supply of periodontium [15], thereby adjacent associated structures such as cementum, bundle bone and the buccal bone wall [12,16]. Some studies reported evidence of cementum formation in the histologic sections between implant and tooth root retained following SST technique [14,17–19].

In a study by Gluckman *et al.*, literature on socket-shield technique and similar methods were reported which constituted only few case reports, case series and a retrospective study [20]. The purpose of this prospective cohort study was to evaluate whether the socket shield technique is effective in maintaining the soft and hard tissue architecture after implant placement in anterior maxilla?

The primary objective of this study was to estimate the 4-year implant survival using SST. The secondary objectives were to assess the clinical-radiological outcomes and complications of the procedure. The periodontal probing depth, buccal width of keratinized mucosa, bleeding on probing, change in bone level, duration of operating time, requirement of reconstructive procedure and complications represented secondary parameters evaluated in this study.

Materials and methods

Study design and patient population

This study was designed as a prospective cohort evaluation and a total of 10 systemically healthy patients aged between 18 and 45 years, who had a non-restorable tooth (Fig. 1) replaced by immediate implant placement using the socket shield technique inanterior maxilla constituted the study group. All patients underwent oral prophylaxis preoperatively and apart from the regular visits they were called for data collection at first month, third month, sixth month and one year visits. Patients who refused to give consent for the treatment, tobacco users in any form, pathologies and/or fractures involving the buccal portion of the teeth to be treated and any history of periodontal flap surgery involving the study site were excluded from the study. The informed and written consent included details about the clinical procedure, possible alternative treatment options, associated risks and complications. The study protocol was carried out in accordance with the ethical standards outlined in the World Medical Association Declaration of Helsinki, 1975 (DoH), as revised in 2013. The study design was reviewed and approved by the Institutional Review Board and the ethical acceptance (PGIDS/IEC/17/32) was obtained from the Institutional Ethics Committee.

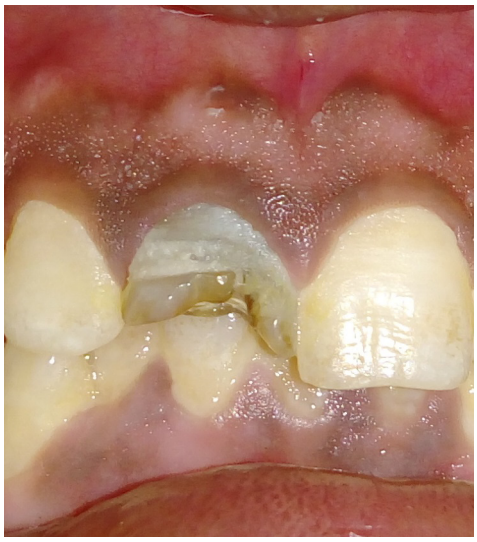

Fig. 1. Pre-operative photograph showing non-vital hopeless tooth root (case inclusive criteria).

Surgical procedure

Following the consent, tooth extraction was done by socket shield technique using a sequential usage of burs in Partial extraction technique kit by Dr. Howard Gluckman. First step involved sectioning the crown of tooth at cervical level (0.5–1.0 mm coronal to buccal cortical bone) followed by sectioning the tooth root mesio-distally using a diamond tapered fissure bur with copious irrigation. This split the buccal and palatal portions of tooth-root followed by atraumatic removal of palatal portion of tooth-root along with the root apex by a sequential usage of periotomes and root-tip forceps. This left the buccal wall of root and its attachment apparatus intact (Fig. 2) Following the contouring of buccal wall in a crescent shape, the implant was placed within the socket, which on buccal side was surrounded by the tooth-root (Fig. 3) and palatally by bone. In cases with submerged root stumps with history of longer duration, there was need for raising the flap in order to expose the root stump. In such cases, care was taken to raise a full thickness mucoperiosteal flap as atraumatic as possible, only for access of the root stump at the desired region.

Healing protocol

In all the cases, it was chosen for non-submerged healing by placement of healing abutments following implant placement to guide the mucosal healing and to achieve the desired gingival contour. In those cases where flap was raised, stay sutures were placed mesial and distal to the healing abutment with least possible tension. Complete healing of the peri-implant soft tissues was achieved in 3 weeks. Following four months after implant placement, prosthetic phase was started. Impressions were made for fabrication of the final prosthesis. Healing abutments were placed again during the interim duration. Crowns were fabricated for screw retention in four

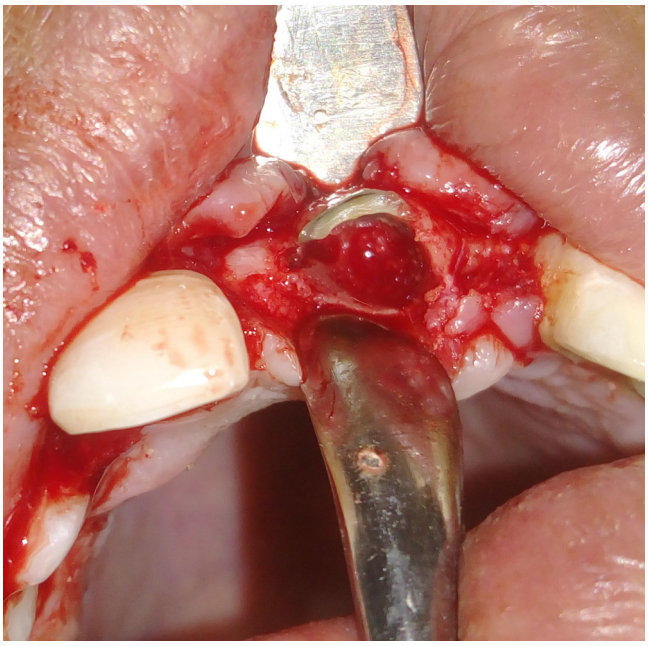

Fig. 2. Prepared socket shield.

cases and for cementation using glass ionomer luting cement in six cases.

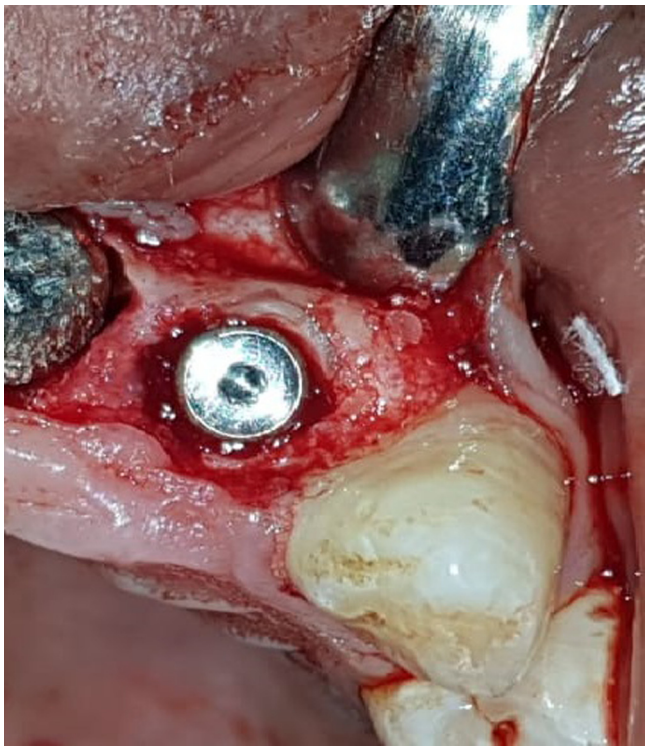

Fig. 3. Shows final relation of implant with the buccal shield (SS).

Data acquisition and follow up

Prior to extraction to assure peri-implant health, clinical measurements were taken. Radiographs and photographs were taken prior to extraction procedure, after implant placement and during follow-ups at regular interval. The follow up included clinical and radiographic assessments at preoperative visit (baseline), at 1 month, 6 months and yearly visits. Following parameters were taken into consideration: Periodontal pocket depth (PPD), Bleeding on probing (BOP), Buccal width of keratinized mucosa (BKM), Pink aesthetic scores (PES), Marginal bone loss. The aesthetic outcomes were evaluated by Pink Aesthetic Score (PES) proposed by Furhauser *et al.* A series of clinical photographs pre-operatively and at 1st month, 6th month and yearly follow-up for implant site and adjacent site were evaluated. Radiographic Marginal Bone Loss (MBL) was assessed using IOPA X-rays at various follow up visits. Bone loss was assessed on radiographs using computer assisted image analysis, Image J software (US National Institutes of Health, Bethesda, MD, USA) 50, which standardizes the measurements and reduces the margin of error. Two parallel lines were drawn both starting from the upper line of IOPA X-rays at the same point, one to the implant platform and second to the first bone-implant contact from the implant platform. These two lines were then subtracted to find the bone loss.

Statistics analysis

- Data obtained was compiled on a MS Office Excel Sheet (v 2010, Microsoft Redmond Campus, Redmond, Washington, United States).
- Data was subjected to statistical analysis using Statistical package for social sciences (SPSS v 21.0, IBM).
- Descriptive statistics like frequencies and percentage for categorical data, Mean & SD for numerical data has been depicted. Comparison of frequencies of categories of variables with groups was done using chi square test.
- Normality of numerical data was checked using Shapiro-Wilk test & was found that the only data of buccal width of keratinized mucosa values followed a normal curve; hence parametric tests have been used for comparisons.
- Intra group comparison was done using repeated measures ANOVA (for >2 observations) followed by post Hoc test.
- Normality of numerical data was checked using Shapiro-Wilk test & was found that all other data did not follow a normal curve; hence non-parametric tests have been used for comparisons.
- Intra group comparison was done using Friedman's (for >2 observations) followed by followed by pair wise comparison using Wilcoxon Signed rank test.
- For all the statistical tests, $p < 0.05$ was considered to be statistically significant, keeping α error at 5% and β error at 20%, thus giving a power to the study as 80%.

Results

In the present study, all implants healed uneventfully with no signs of peri-implantitis and peri-implant mucositis during the follow-up visits. The Periodontal probing depth and buccal

Table I. Showing PPD and BWK at implant site and adjacent teeth between pre-op and post-op 4th Year visit.

S. no.	PPD implant site	PPD adjacent teeth	BWK adjacent teeth pre-op/post-op	BWK implant site pre-op/post-op
1.	2.34/1.8	2.25/2.25	3.5/3.5	3/3
2.	2.17/1.6	2.17/2.17	4/3.5	3.5/4
3.	2.17/1.6	2.25/2.25	4/4	3.5/4
4.	2.17/1.5	2.34/2.41	3.5/3.5	3.5/3.5
5.	2.17/1.5	2.17/2.17	3.5/3.5	4/3.5
6.	2.34/1.6	2.5/2.5	5/5	5/4.5
7.	2.34/1.8	2.25/2.25	5/5	4.5/4.5
8.	2.5/1.8	2.5/2.5	4.5/4.5	4/4
9.	2.5/1.8	2.5/2.5	4.5/4.5	4.5/4.5
10.	2.34/1.6	2.34/2.5	4.5/4.5	4.5/4.5
Over all mean	2.3/1.6	2.3/2.35	4.2/4.2	4/4

Table II. Showing BOP pre-op/post-op and radiographic bone loss mesial and distal sites.

Sl no.	BOP(Pre)	BOP(Post-Op)	BONE LOSS MESIAL	BONE LOSS DISTAL
1.	0.5	0	0.56	0.62
2.	0.34	0.17	0.27	0.32
3.	0.17	0	0.38	0.41
4.	0.5	0.17	0.34	0.27
5.	0.5	0	0.39	0.44
6.	0.34	0	0.44	0.46
7.	0.17	0.17	0.29	0.44
8.	0.17	0	0.37	0.39
9.	0.34	0.17	0.40	0.43
10.	0.34	0	0.28	0.34
OVERALL MEAN	0.5	0	0.372	0.41

width of keratinized mucosa of implant site and adjacent teeth mesial and distal to the operative site showed no significant changes from pre-op and 4th year follow-up visits (p value = 0.270 and 0.332 respectively for former and 0.857 and 1.00 respectively for the latter, Tab. I). This exhibits the efficiency in maintaining the soft tissue architecture which is in accordance with the findings as reported in a study [7]. Bleeding on Probing at the surgical site showed a marked drop in the percentage of sites showing bleeding on probing between 1st month and 4 year follow-up with highly significant statistical difference (p value = 0.007, Tab. II).

Pink Aesthetic Score (PES) assessment showed a mean score of 12.3 at four year follow-up (Tab. III). Eventhough statistically significant difference between pre-op and 1 month post-prosthesis visits existed; it can be attributed to the changes in the gingival colour and texture due to inflammation. The score has been improved in subsequent visits to an overall mean of 12.3 (Figs. 4 and 5).

The overall mean marginal bone loss mesial and distal to implant site was 0.37 mm and 0.41 mm respectively at 4th year follow-up (Tab. II and Fig. 6). The primary stability achieved was within normal limits with in all the cases. The details about indication for tooth replacement, primary stability achieved intra-operatively and type of final prostheses were summarized in Table IV.

No major complications were faced in the study at four year follow-up (Fig. 7), though 2 of the cases showed exposure of the shield coronally which was examined for mobility and after confirming that there is no signs of inflammation and infection, it was trimmed to equigingival level using a high speed handpiece and copious irrigation (Fig. 8).

Discussion

Delayed implant placement, immediate implant placement and socket preservation following extraction are some of the treatment modalities at present for replacement of hopeless and/or non-restorable teeth, which may even necessitate bone augmentation procedures in edentulous ridges which are not restored for a longer duration of time. These augmentation

Table III. Showing changes in PES scores of adjacent teeth and implant site between pre-op and post-op visits.

Sl no.	PES ADJACENT TEETH PRE OP/POST-OP	PES IMPLANT SITE PRE OP /POST-OP
1.	13/13	13/12
2.	14/14	13/13
3.	14/14	14/12
4.	13/13	14/13
5.	13/13	12/12
6.	12/13	13/12
7.	13/13	12/12
8.	13/13	13/13
9.	12/12	13/12
10.	12/12	12/12
OVERALL MEAN	12.9/12.9	12.9/12.3

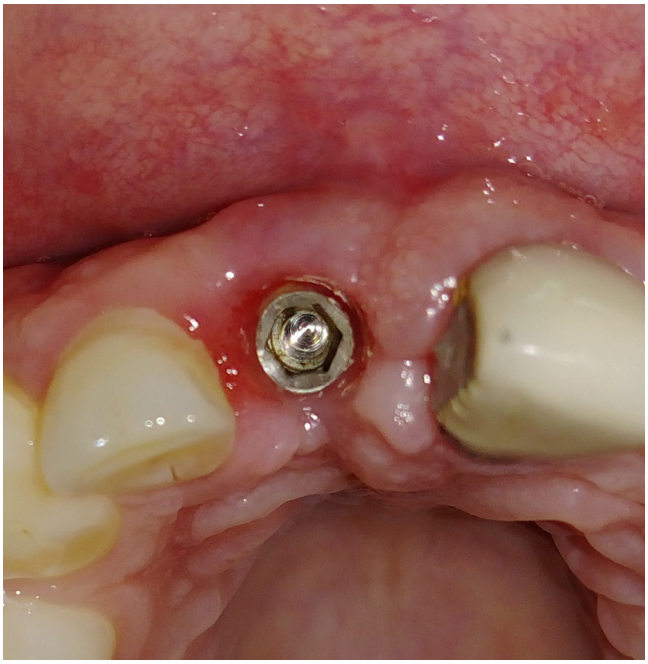

Fig. 4. Healed peri implant mucosa showing socket shield and implant. (Note the thick prototype of mucosa).

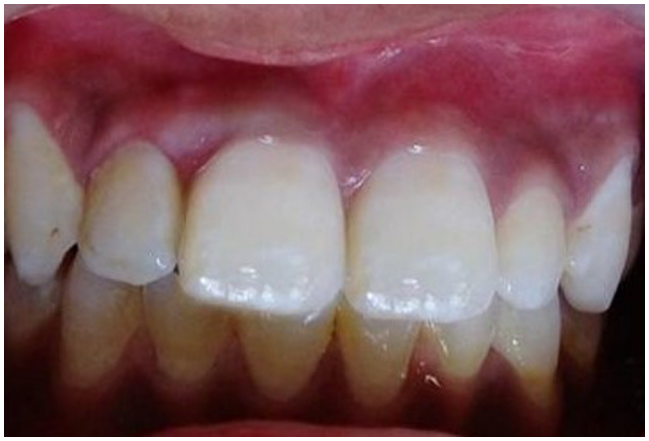

Fig. 5. Post operative clinical photograph at four year follow up.

procedures help build the bone volume in order to place implants providing biologic safe distance from vital structures and also to support soft tissues thereby improving its aesthetic and functional results.

Delayed implant placement protocols provide various benefits like predictable outcome, better primary stability and fewer anticipatory complications but the prolonged treatment duration and need for additional surgical procedures was a major shortcoming. In order to overcome the time factor, immediate implant placement was followed, in which various benefits like socket serving as a guide for implant site preparation (substitution for socket guided drilling) and implant angulation during placement which is subject to modification in order to provide ease in prosthetic rehabilitation and simultaneous GBR if needed at the time of implant placement was made possible. In the socket preservation technique, bone graft materials are filled within the socket following extraction to prevent the socket morphology from further distortion during period of edentulism and as an attempt to reduce the bone resorption [20].

Immediate as well as delayed implant placements are at times coupled with simultaneous augmentation of soft- or hard-tissue [18]. The simultaneous augmentation procedure may require elevation of mucoperiosteal flap. There is a marked increase in the risk of bone loss due to additional surgical intervention and inflammation or infection due to prolonged duration of surgery in both these conventional techniques [18]. There is increase in the duration of treatment and thus the period of edentulism.

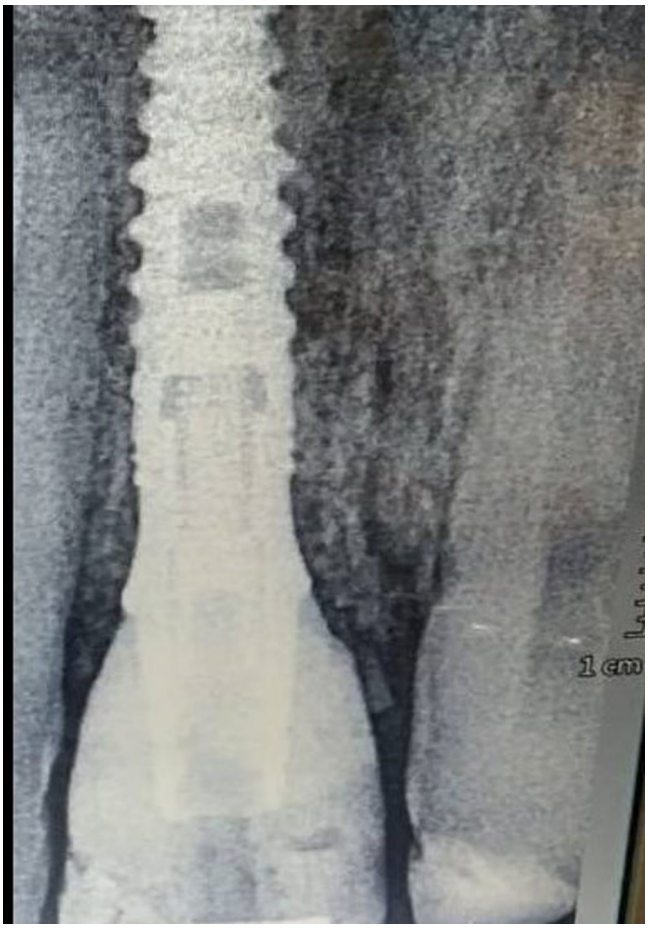

Fig. 6. Post operative IOPA radiograph at four year follow up.

Table IV. Showing indication for replacement, primary stability achieved and type of final prosthesis.

Pt No.	Pre-operative status of tooth with tooth No.	Primary stability achieved (Ncm)	Final Prosthesis
1.	Root stump 11- Post trauma	≥35	Cemented
2.	Root stump 11- Post trauma	≥35	Screw retained
3.	Fractured post 21	≥35	Cemented
4.	Root stump 12 – Post trauma	≥25	Screw retained
5.	Root stump 22- Post trauma	≥35	Screw retained
6.	Previous RC treated 11- Non-restorable	≥35	Cemented
7.	Root stump 11	≥35	Cemented
8.	Root stump 12- Post trauma	≥35	Cemented
9.	Root stump 12	≥35	Cemented
10.	Fractured post 21	≥35	Screw retained

Eventhough these conventional methods restore the lost teeth and provide an option to cope with the aesthetics, they fail to maintain the progressive resorptive changes that happens to occur in years to come by. In cases of increased gingival show on smile or patients having lip line higher than usual, the effect of soft tissue recession poses a massive effect as there is interdental papillae recession or the implant starts to get exposed [5].

Bone loss in crestal region is comparatively of greater concern in anterior dentate region as it plays a major role in the esthetic outcomes as the support of overlying mucosa and shape of papillae are determined by the crestal alveolar

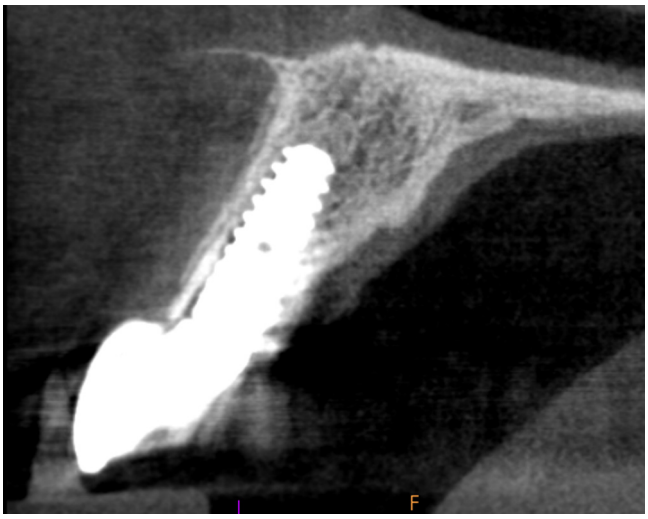

Fig. 7. Four year follow up section of CBCT showing intact shield.

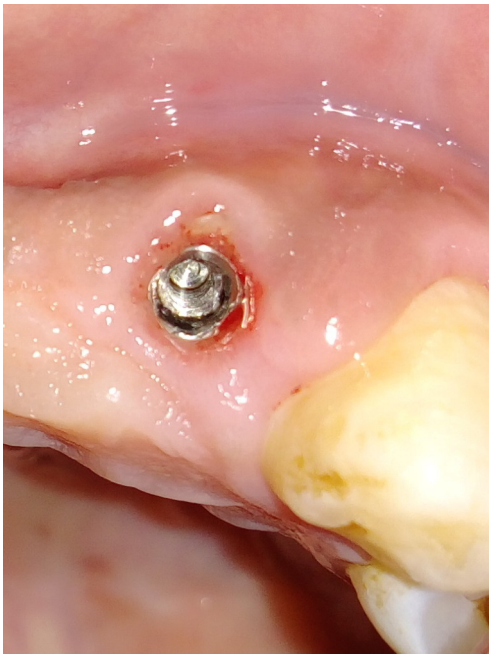

Fig. 8. Showing exposure of shield internally.

bone [2]. If the progressive loss of the bone structure is not addressed, mucosal recession follows, leading to compromised aesthetic outcomes.

In the literature there are reports of significant bone resorption after immediate implant placement which in anterior maxillary region is less favoured due to its impact on aesthetic outcomes [3,21]. In the anterior dentate region, aesthetics is comparatively more weighted than function and comfort [6].

When it comes to anterior maxillary region, if a hard or soft tissue structure is to be repaired and restored, the concern of utmost priority to arise in patient as well as clinician's mind is regarding the ability to match with the aesthetics which was previously present. The increased treatment duration of delayed implant placement, significant vertical bone loss following immediate implant placement [3], the need for additional surgical procedures and possible added risk and morbidity along with the patient satisfaction can be listed to summarize the need for alternative approach.

Socket shield technique serves the answer as treatment duration is comparatively shortened along with marked reduction in vertical bone loss following surgery with low cost-effective ratio and need for augmentation is cutback as well.

The rationale of the study was to evaluate the implant survival using SST and to test the hypothesis that immediate implant placement using SST is effective in maintaining the hard and soft tissue architecture on anterior maxillary region as well as to report any complications associated with the technique.

Based on the results of this study, testing the hypothesis that immediate implant placement using SST is effective in maintaining the soft tissue architecture was proven at four year follow-up. However, it should be emphasized that this is a sensitive technique and it needs extensive planning and good operator's skills to obtain a satisfying and long-lasting rehabilitation.

Conclusion

Within the limitations of the study, our results are in favour of suggesting that socket shield technique for immediate implant placement is effective in maintaining the hard and soft tissue architecture of anterior maxillary region. However, a prospective randomized study to compare socket shield with other techniques is needed to draw any definitive conclusion.

Authors contributions

Amrish Bhagol: Conception and design of study; Acquisition of data: laboratory or clinical; Analysis of data; Drafting of article and/or critical revision; Final approval of manuscript. V. Ashwin: Conception and design of study; Acquisition of data: laboratory or clinical; Analysis of data; Drafting of article and/or critical revision; Final approval of manuscript. Virendra Singh: Conception and design of study; Acquisition of data: laboratory or clinical; Analysis of data; Drafting of article and/or critical revision; Final approval of manuscript.

Conflict of interest

The authors declare that they have no conflicts of interest in relation to this article.

Informed consent

The authors declare that informed consent not required.

Ethical committee approval

The authors declare that Ethical approval not required.

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