INTRODUCTION

Bauer et al. [1] described a novel technique for tooth replacement with an oral implant and preserving hard and soft tissues without the use of regenerative materials. The proposal was the retention of the buccal root segment with immediate implant placement. There have been descriptions by several authors for the preservation of alveolar volume with leaving root remnants. [2] Casey and Lauciello [3] claimed that endodontically retained roots preserved bone resorption under complete dentures. O'Neal et al. [4] completed a histological study on root canal treated teeth after root submergence technique below 2 mm of the bone. The research showed osteocementum and connective tissue around the root along with the newly formed bone. Guyer and Bowers et al. [5,6] did the same kind of submergence of the root with 27- and 6-month follow-up and showed histological proof of cementum, new attachment, and bone surrounding the root. A recent report by Choi et al. [7] showed that root submergence can be successfully applied at the pontic site with a fixed dental prosthesis. The purpose of all these procedures was to prevent the loss of bundle bone after tooth extraction. Gluckman et al. [8] in 2016 proposed a technique called partial extraction therapy; these were precollapse interventions that used the tooth itself to offset the loss of alveolar tissue. This included root submergence technique, pontic shield, proximal shield technique, and socket-shield technique. The socket-shield technique uses facial or buccal root section alone to maintain tissues along with immediate implant placement. The buccal gap may be grafted with slow resorbing materials. It may be considered a more conservative ridge preservation procedure for teeth stated for extraction.

CASE REPORT

The patients selected for the clinical study were from the regular outpatient department of the faculty. The subjects chosen had fractured upper anterior teeth. Each underwent careful oral examination and assessment of complete dentition. The oral hygiene was measured with plaque, calculus, and bleeding indices initially. The caries present in the mouth if any were restored before the start of the study. After complete satisfaction for hygiene maintenance and commitment for regular follow-up. The patients selection criteria were medically healthy adult (ASA Classification 1).
I-II), hopeless anterior tooth with neighbouring teeth on the mesial and distal with intact buccal periodontal tissues, tooth to be included should be between canines in either of the arch, surpragingival fracture of teeth, any periodontal phenotype, non-smoker, it should not be considered restorable other than total replacement, oral hygiene maintenance, motivation for follow up, no mobility and written informed consent.

Exclusion criteria were tooth with past/present periodontal disease, severe attachment loss, horizontal/vertical fracture, external or internal resorption, periapical pathology, widening of lamina dura and pregnancy.

All the cases selected had teeth with a hopeless prognosis in the upper and lower anterior dentition. The patients were of the age group from 22 to 55 years and agreed for an oral implant-retained single prosthesis with regular follow-up period for 5 years. Periodic recall evaluations were kept all along with the study, i.e., every 6 months. The clinical outcomes of 15 patients (11 males and 4 females) treated between 2011 and 2018 were retrospectively evaluated. The work was done with the written consent of each patient and according to the World Medical Association Declaration of Helsinki and approved by the ethical committee of our institute.

**TECHNIQUE**

Immediate implant placement is a technique-sensitive procedure. Proper planning is needed from an experienced clinician. Tooth to
be replaced should have healthy tissues around it. The adjacent teeth should be free from any pathology. The gingival phenotype and scallop should be adequate. The tooth piece present should not be restorable other than total replacement. Computed tomography (CT) of the treatment site is prerequisite for the collection of data and planning. All the patients underwent oral hygiene therapy before the start of the procedure. The oral health maintenance with plaque score of <25% in frequent recalls was considered good. The sequential steps were done according to the Gluckman et al. guidelines.

1. Adequate anesthesia before the start of the procedure. Decoronation of the tooth till the gingiva with the protection of the adjacent structures. High-speed handpiece with a diamond rotatory instrument (NSK Japan) was used to bring the tooth surface to the soft tissues.

2. The tooth canal was taken as a guide to further section the root vertically in the mesial and distal direction. An endodontic file was used to orient and measure the length of the root.

3. Periotomes were used around the lingual or palatal part to detach the ligaments from the bone. Once the part became mobile, it was removed with micro forceps. The buccal part was never touched or applied pressure.

4. The buccal shield was further reduced in thickness to approximately 2 mm. A concave shape was designed on the retained root surface from inside of the socket.

5. Complete removal of pathology and obturation materials if any from the socket.

6. The shield was reduced till the alveolar crest. An internal beveled chamfer created in the upper part of a shield with a large round bur. This was to accommodate the required prosthetic space for the emergence profile of the crown.

7. An osteotomy was prepared lingual/palatal in the extraction socket. After the sequential drills, implants, Tag Implants (T. A. G. Medical Products Corporation Ltd., Kibbutz Gaaton, Israel), were placed with good insertion torque. The buccal/facial gap was filled with bone grafts (Biooss, Geistlich Pharma), if the jumping space was more than 2 mm. Customized healing formers were used to close the top of the implants and not temporization.

8. The patient was given postoperative instructions and advised to take the prescribed medication which included an antibiotic (Novamox 500 mg, Cipla Med, India; 1 h before surgery, and three times daily for 5 days), analgesic (Ibuprofen 400 mg, Albert David, India; two times for 4 days) and a chlorhexidine mouthrinse (Clohex Plus 0.12%, Dr Reddy Lab, India, two times daily for 14 days).

9. The flaps were not raised in any patient and the implants were left submerged for 6 months with individualized healing abutment. The impression procedure for each patient was standardized with the use of impression post and analogs, and the material used was addition silicone (Aquasil, Dentsply). The abutments were either castable or prefabricated. Crowns were both cement retained and screw tightened. The materials used for crowns were lithium disilicate (IPS e.max Ivoclar) and porcelain-fused metal crowns. Occlusion was always mutually protective with proper anterior guidance. Each patient was kept on recall for an initial 6 months and then 1 year. The total time frame for each patient after that was 4 years. The postoperative CT was taken after 2 years for each patient.

The periodontium around each shield replaced tooth was assessed for papilla, gingival scallop, buccal contour, and hard-tissue architecture. There was a failure with one case, as pus came out through shield before commencing for the prosthetic procedure. Although the implant underneath had osseointegrated, the contaminated root was removed and bone grafting on the buccal aspect was completed through SMART minimally invasive bone grafting procedure. [10]
Fourteen patients had excellent soft- and hard-tissue volume after 5 years around each socket shield replaced teeth [Figures 1-10].

**Volumetric analysis**

After 2 years of the treatment, each patient underwent a repeat computed tomography by a 64-slice CT scan. The state-of-the-art 64-detector row (500 slice) CT from GE health care, provided ultrafast volume imaging. All routine CT scans were done using ultra-thin 0.625 mm slices with volume acquisition and isometric reconstruction which can be obtained in any plane. The same preoperative slice of the involved tooth was measured in width at the particular position with a postoperative shield retained implant crown. The width measurement was taken in millimeters giving an estimation of hard tissue along with implant in the socket [Table 1]. The pink score gave soft-tissue assessment.

The subjective score of the pink esthetic score of each patient, especially in the anterior maxillary region, was quite impressive.

**DISCUSSION**

Bone resorption is inevitable after tooth extraction. The periodontal ligament is lost after the stoppage of vascular supply providing nutrition to the buccal bone. The bone of extraction socket resorbs more buccally than lingually or palatally. Immediate implants in extraction sockets may prevent further bone resorption. This was analyzed in early or delayed placement in the sockets along with buccal bone grafting with autogenous bone. The cases were followed for 10 years and the conclusion was the inability to prevent buccal bone volume. In a systematic review and metaanalysis by Clementini *et al.*, concluded dimensional changes after immediate implant placement with or without simultaneous regenerative procedures. The report concluded that current evidence does not allow any conclusive statements regarding the efficacy of regenerative materials in preventing the amount of alveolar reduction.

However, Chappuis *et al.* proposed long-term stability for soft and hard tissues with the early placement of implants (6–8 weeks) with contour augmentation. The graft
Tooth number
7.5
7.6
6.8
7.3
6.9
6.7
8.0
6.7
6.9

Pre (mm) | Post (mm) | Tooth number
--- | --- | ---
6.9 | 6.5 | 21
7.1 | 6.9 | 21
7.7 | 7.5 | 21
7.6 | 7.5 | 33
6.8 | 6.6 | 11
7.9 | 7.8 | 13
7.3 | 7.1 | 11
6.9 | 6.3 | 42
7.5 | 7.4 | 21
6.9 | 6.8 | 22
6.7 | 6.4 | 32
8.0 | 7.7 | 23
6.7 | 6.6 | 11
6.9 | 6.7 | 11

used was a two-layer composite mixture of autogenous bone and bovine bone mineral (DBBM; Bio-Oss, Geistlich Pharma). This was a prospective study of 20 patients with follow-up of 10 years. The conclusion confirmed that long-term effectiveness of early implant placement with simultaneous contour augmentation through guided bone regeneration offered stable bone conditions and low risks of a mucosal recession.

Thoma et al.[15] in 2019 did a randomized study on buccal bone grafting before implant placement. The materials used were xenogeneic block loaded with recombinant human bone morphogenetic protein-2 (rhBMP-2) or an autogenous bone block for primary augmentation. The ridge width was evaluated by means of cone-beam CT scan after augmentation surgery and at 4 months, prior to implant placement. The present study revealed that ridge contour increased horizontally than vertically in 4 months, approximately 4 mm. This was sufficient to place the implant in three-dimensional views. However, to correct soft-tissue contours, it may require additional surgeries. The study had a short observational period (4 months) with a small sample size to arrive at a meaningful conclusion. Even more relevant fact associated with study was availability, and cost–benefit ratio of rhBMP (bone morphogenetic protein) seems unfavorable as the dosage required was very high. Mazzocco et al.[16] also evaluated bone volume changes after immediate implant placement with or without flap elevation. The graft used was an organic bovine bone and cases were nonmolar sites. The conclusion was a reduction in 0.5 mm of hard-tissue parameters and there was no significant difference between the flap and flapless cases.

Even with best regenerative materials for hard- and soft-tissue augmentation, the results with long-term follow-ups are still not up to the mark. The materials are expensive and require extensive unpredictable surgeries. An innovative approach of leaving the vascular supply of periodontium intact through bundle bone–tooth root combination and preservation of hard- and soft-tissue architecture had been pretty impressive. Bäumer et al.[17] did a clinical, radiographical, and volumetric analysis on the socket-shield technique after 5 years of its completion. Their conclusion for the descriptive study was that the technique offers reduced invasiveness at the time of surgery and high esthetic outcomes with effective preservation of facial contours. The author had ten patients in the study and was followed for 58 months. A shield was prepared in each patient and the space between implant and buccal fragment of the tooth was devoid of any graft material. There was no biological implant-related complication, especially around the retained root. Even in our cases, of 15 patients, only one had parulis formation associated with the shield of the maxillary teeth. The keratinization of the gingiva was preserved by the presence of ligament and inserting dentogingival fibers. This was evident in all our cases after 5 years of treatment. At present, there are two systematic reviews about the technology available in the literature. Gharpure and Bhatavadekar[18] wanted to assess the socket shield and its biological plausibility with long-term clinical prognosis. They reported that most of the studies are case reports, 4 animal studies (histological), and one clinical case–control study. All studies reported complications such as buccal/crestal bone loss (54.55%) and failure of osseointegration (27.27%). Other complications recorded were periodontal ligament and cementum formation on implant surfaces, pocket formation, inflammation, mucositis, and peri-implantitis. The authors had a doubt on its long-term predictability because of the unavailability of high-quality evidence.

A retrospective study done was by Gluckman et al.[19] on 128 patients from a private practice database with a follow-up of 4 years. The distribution of sites treated was as follows: maxillary incisors (64%), premolars (22%), canines (14%), maxilla (89.9%), and mandible (10.1%). 123/128 implants osseointegrated and survived 1–4 years following restoration (survival rate 96.1%). A combined complication rate of 25/128 implants occurred (19.5%). Five implants failed to osseointegrate and were removed. The remaining 20 complications were all managed or observed without management, with implants surviving at mid-term follow-up. This series matched our observation that a socket shield is a competitive technique with its survival as compared to conventional immediate and delayed implant placement. A recent systematic review by Mourya et al.[20] included 11 case reports, 6 case series,
In our report, the results with the said technique were quite promising after 5 years. Implant survival, crestal bone levels, and the pink esthetic score looked stable in all the cases. It looks like a safe surgical procedure with predictable and impressive preliminary results without the use of unpredictable regenerative surgeries and expensive biomaterials. However, it still needs to be assessed for long-term prognosis as very few RCTs have been reported.

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Conflicts of interest
There are no conflicts of interest.

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