Immediate Non-functional Loading of Single Tooth UnitTM Implants into Avulsed Tooth Sockets Following Ridge Augmentation in the Anterior Maxilla: A Case Series

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Abstract To assess the clinical effectiveness of immediate non-functional loading of single-tooth implant placed into avulsed tooth socket following ridge augmentation in the anterior maxilla with bioglass bone substitute and biocollagen membrane. The clinical outcome of immediate non-functional loaded implants up to 24 months after placement into avulsed tooth sockets in anterior maxilla were evaluated in 15 patients. Implants were immediately restored with acrylic resin provisional crowns. Post-operative follow-up and intraoral radiographs were obtained at 6, 12, 18 and 24 months. Survival rate, implant threads exposure immediately after placement and at 6 month interval using CT 3D reconstruction was assessed. Marginal bone loss did not extend beyond the first thread and 3D CT scan showed adequate bone mineral density with no signs of radiolucent lesion around the implant during 24 months follow-up having survival rate of 100 %. Within the limits of the present study, immediate non-functional loading of single tooth implant placed into avulsed tooth socket following augmentation with bioglass bone substitute and biocollagen membrane in the anterior maxilla is one of the viable treatment alternatives for rehabilitation of immediate loading implant.

Keywords Single tooth implants · Ridge augmentation · Anterior maxilla · Bioglass bone substitute · Biocollagen membrane · Immediate non-functional loading · Avulsed tooth · Bioglass · 3D CT scan

Introduction

One of the most challenging problems in dentistry is the choice of treatment for replacement of one or more maxillary incisors that have been lost as a result of traumatic injuries. Most traumatic dental injuries occur in childhood and adolescence [1, 2]. Avulsion (also known as exarticulation or total luxation) of teeth affects mostly the maxillary central incisors in young and adolescent [2]. The problem of restoring esthetics and function varies significantly according to the age of the patient, the location of the traumatic injury and the extent of the trauma. Single-implant tooth replacements have been documented with success, [3–5]. Traditional guidelines have suggested that 2–3 months of alveolar ridge modeling following tooth removal and an additional 6 months of load-free healing are needed for implant osseointegration [6, 7]. This extended treatment period and the need for a removable prosthesis during the healing phase may be inconvenient to certain patients. Furthermore osseous and/or gingival tissue loss following tooth exfoliation and implant surgical treatment may compromise esthetics and present additional challenges [8]. The traditional implant protocol [7, 9, 10] has several disadvantages. Among them are extensive treatment time, multiple surgeries and the need to wear a removable restoration. Thus several aspects of this protocol have been re-evaluated and new techniques have been pioneered [11]. Osseointegration and clinical stability of the implants can be maintained despite bone remodeling as long as the micro movement is not more than 100 µm during the healing phase [12, 13]. Furthermore the success of implant dentistry has also created a demand for implant placement in compromised sites.

The hypothesis of the present clinical study was that the clinical outcome of immediate non-functional loading of implants in avulsed maxillary incisal region following

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augmentation with bioglass bone graft and resorbable biocollagen membrane could be a predictable treatment approach compared to submerged maxillary anterior single tooth implants. The outcome was evaluated based on bone mineral density over the implant after 6 months on 3D CT scan, changes of radiographic crestal bone level from implant placement to an average of 24 months after insertion and survival rate of implants after 24 months.

Materials and Methods

The study was conducted at Armed Forces Dental Establishment (Secunderabad, India) by a team of specialists. Routine dental inspection was carried out for the troops in station. Cases with missing single maxillary central incisor were sidelined. A questionnaire containing of a set of 3 questions was given to them

1. Was the tooth lost due to trauma?
2. How long has it been since you lost the tooth?
3. Was the tooth extracted by the doctor or lost completely due to trauma?

The questionnaire was given to 148 selected patients out of approximately 4,567 troops who had missing single maxillary incisor. After a thorough clinical examination and review of the questionnaire, 52 patients were selected for implant placement. Out of selected patients 15 males were included in the study with avulsed central incisor socket requiring ridge augmentation. The reason for selecting only male armed forces serving personal patients in this study was to ensure availability over a period of 24 months. The criteria for inclusion in the study were good health with no positive history of bruxism, smoking, diabetes or any other systemic debilitating illness contraindicating implant therapy. All patients selected were in the age group of 21–32 years. Intraoral examination focused on the intra arch relationship, buccolingual width, maxillo-mandibular relationship and soft tissue healing over the avulsed tooth site (Fig. 1). Digital panoramic and periapical radiovisiographs were evaluated for mesiodistal width (inter-radicular distance), socket width and root angulation. Cases with periodontal disease, periapical inflammation or a fractured root stump were excluded from the study. Implant cases requiring ridge augmentation with a bone graft and resorbable biocollagen membrane were included in this study. All patients were thoroughly educated about the procedure and informed consent was obtained. The clinical and radiologic findings along with all treatment options of two stage and single stage implant therapy were discussed with the patients. All patients received oral antibiotics for 5 days starting one day prior to surgery. Patients were prescribed Tab Augmentin 625 mg thrice

Fig. 1 Preoperative intraoral of missing tooth

daily. As a presurgical disinfectant, patients were asked to rinse with 15 ml of 0.12 % chlorhexidine digluconate solution for 60 s. Local anesthesia using 2 % lidocaine with 1:80,000 epinephrine was administered.

Surgical Procedure

A full thickness triangular mucoperiosteal flap was reflected by a midcrestal and a single buccal divergent releasing incision beyond the intercanine area. After exposure of the surgical site (Fig. 2) Uniti™ implants (Equinox Medical Technologies, Holland) were placed using the aseptic surgical procedure as advocated by the manufacturer. All 15 patients received implants of 3.7 mm diameter and 13 mm length in the maxillary central incisor region. The number of threads exposed after implant placement at the compromised surgical site was noted (Fig. 3). Implants

Fig. 2 Surgical exposure of implant site showing loss of labial plate

were placed with adequate primary stability. Bioglass graft was placed on the exposed implant threads and condensed (Fig. 4). Biocollagen membrane was then placed over the bone graft (Fig. 5) for osseous regeneration and to prevent long junctional epithelium. The implant cover screw was removed and the abutment was secured onto the implant (Fig. 6). A tension free closure of the flap was done. A temporary acrylic resin crown that was made on the abutment connected to the implant immediately after implant placement (Figs. 7, 8). It was adjusted in order to avoid any centric and eccentric contacts.

The patients underwent close follow-up and the temporary restorations were reviewed after 1, 3 and 6 months after implant placement. IOPA radiovisographs (SOPIX², SO-PRO ACETON Imaging, France) were taken at 6, 12, 18 and 24 months (Fig. 9) of implant placement to evaluate marginal bone loss. After 6 months a CT scan (SENSATION-40,

Fig. 5 Biocollagen membrane covering the bone graft

Fig. 3 Implant placement showing the exposed threads

Fig. 6 Abutment secured onto the implant

Fig. 4 Implant threads covered by bioglass

Fig. 7 Provisional crown cementation

Siemens) was done and the bone mineral density over the implant was checked (Fig. 10). The provisional crowns were substituted with functionally loaded ceramo metal restorations. Subsequent follow-up examinations were carried out after 6, 12, 18 and 24 months.

Fig. 8 Pre and post operative extraoral

Results

Fifteen patients were selected who required placement of a single tooth implant in complete avulsed tooth region requiring ridge augmentation in the anterior maxillary area. Implant placement followed by ridge augmentation with bioglass and biocollagen membrane was carried out. All the implants were non-functional loaded with provisional restorations. The implants placed were evaluated post surgically with IOPA radiovisiographs at 6, 12, 18 and 24 months, 3D CT scan at the end of 6 months and for survival of implant after 24 months.

IOPA radiovisiographs showed no marginal bone loss beyond the first thread for all the implants placed. The bone level on IOPA at 6, 12, 18 and 24 months was recorded (Table 1). It was noted that in 13 cases the marginal bone level was below first thread and in 2 cases the bone level was at the implant crest with no thread exposure. There was no clinical thread exposure and all implants were in function at the end of 24 months.

A 3D CT scan was performed after 6 months to assess the bone mineral density over the implant. A successful osseointegration with no signs of radiolucency over the implant was noticed indicating successful augmentation with bioglass bone substitute and biocollagen membrane.

All implants had successful 100 % survival rate after placement of definitive restoration, with no sign of mobility, pain, suppuration or peri-implantitis. The prosthetic rehabilitation was in function after 24 months follow-up.

Discussion

In the present study, promising results were shown for immediate non-functional loaded implants into avulsed tooth sockets in the anterior maxilla following augmentation with bioglass and biocollagen membrane. Immediate loading is a confrontation between the occurrence of a biological process and mechanical loading. Optimal primary stability is mandatory in these cases to support the biology and maximize the possibility of osseointegration [14]. In the present study around 4–5 threads of the apical portion of implants were embedded in the bone to achieve primary stability followed by ridge augmentation was carried out with bioglass and biocollagen membrane. Adequate occlusion with minimal centric and eccentric contacts is the best way to minimize and control the mechanical loading. Furthermore, the occlusal forces exerted by the patient can be reduced by limiting the diet to soft foods for 2–4 weeks after implant insertion [15].

In the post-follow-up radiographs, marginal bone loss did not extend beyond the first thread. Consequently, the excellent papilla formation in these patients can be related to the bone maintenance [16]. In the present study 15 Uniti™ dental screw implants 13 mm long and 3.7 mm in diameter were used to allow improved mechanical stability. Bioglass has the property to promote adsorption and concentration of proteins utilized by osteoblasts to form a mineralized extracellular matrix and thus promote osteogenesis by allowing rapid formation of bone. It also may act as a barrier retarding

Fig. 9 IOPA radiovisiographs of the implant

epithelial down-growth and demonstrates antimicrobial property *in vivo* [17]. According to the clinical, histological and radioactive analysis of Schepers et al. [18], a particle of bioglass forms a protective vesica and grows an independent columella in its centre, irrespective of surrounding bone, which is facilitated by its narrow size and subsequently functions as a pivot for recovery. In other words, bioglass particles not only show osteoconductivity, but also an osteostimulatory effect.

Successful immediate implant placement defines minimum parameters such as primary stability, length, diameter, bone quality, implant surface for immediate loading of implants with supportive augmentation. Advantages of the described technique include immediate rehabilitation of traumatized patients, elimination of second stage implant placement surgery resulting in reduced surgical trauma, minimal use of provisional removable restoration and the ability to satisfy the esthetic demands in the shortest possible time.

Fig. 10 CT scan showing adequate bone mineral density at 6th month

Table 1 Number of threads clinically exposed immediately after implant placement and at 6, 12, 18 and 24 months on IOPA radiograph

Sl. No.	Age of patient (years)	Pre bone graft threads exposed	Immediate post bone graft threads exposed	6th month IOPA threads exposed	12th month IOPA threads exposed	18th month IOPA threads exposed	24th month IOPA threads exposed
1	21.8	3	0	0	1	1	1
2	22.3	2	0	0	0	1	1
3	24.4	2	0	0	0	0	1
4	24.8	1	0	0	0	0	0
5	25.7	1	0	0	0	0	1
6	26.3	3	0	0	1	1	1
7	26.9	2	0	1	1	1	1
8	28.5	3	0	0	0	1	1
9	28.7	2	0	0	0	0	1
10	29.6	1	0	0	0	0	0
11	30.3	2	0	0	1	1	1
12	30.6	2	0	0	1	1	1
13	31.4	1	0	0	0	1	1
14	31.9	2	0	0	1	1	1
15	32.1	1	0	0	0	1	1

Although the technique is simple but technique sensitive and is recommended only for experienced clinicians. Until there is more information on the subject, the surgeon, the prosthodontist, the periodontist and the patient must be aware of potential complications. Treatment alternatives should be thoroughly emphasized to the patient. Further clinical and histologic studies are necessary to promote routine clinical application of this technique.

Conclusion

Within the limits of the present study, the preliminary clinical and radiographic data indicate that immediate non-functional loading of single tooth UnitiTM implant into avulsed tooth sockets in the anterior maxilla following augmentation with bioglass bone graft and biocollagen membrane can result in successful implant integration and stable peri-implant conditions up to 24 months.

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