

COMPARATIVE EVALUATION OF CRESTAL BONE LOSS AROUND COMPRESSION SCREW IMPLANTS PLACED IN HEALED SITES AND FRESHLY EXTRACTED SOCKETS

ABSTRACT

Aim: The aim of the study was to evaluate crestal bone loss around immediate loading compression screw implants.

Study design: A Randomized controlled clinical trial.

Method: In this randomized study, 15 subjects with 30 edentulous sites in the maxillary and mandibular anterior regions (incisors and canines) willing for replacement were taken into consideration. A total of 14 implants were placed in healed sites and 16 implants were placed in freshly extracted sockets and immediately loaded in both groups. Provisional restoration was delivered on the same day of implant placement. Crestal bone loss was evaluated at baseline (immediately after implant placement), 1 month, and 4 months. The final prosthetic restoration was delivered after 4 months following implant placement.

Results: No statistically significant difference for crestal bone loss was observed between delayed and immediate implant placement at 4 months interval.

Conclusion: Within the limitations of this study, immediate placement of one-piece implant produced crestal bone loss comparable to delayed placement. The unique design of a one-piece implants eliminates the fixture abutment interface (microgap) and resembles the natural tooth with a seamless transition of the radicular unit to the coronal unit. Therefore, in the maxillary and mandibular anterior regions, one-piece implants with immediate loading can be considered as a viable solution for the replacement of missing teeth with better esthetics.

Keywords: Dental implant, one-piece implant, immediate loading, crestal bone loss

INTRODUCTION

Oral health and its care are very important to maintain proper mastication, phonation, esthetics, and psychological well-being of an individual. Loss of teeth adversely affects oral health care. The replacement of missing teeth with dental implants has now become a treatment modality for fully and partially edentulous patients. Original Branemark protocol of implant placement consists of implant submersion for 3-6 months to achieve good bone to implant contact. But this protocol leads to fibrous tissue formation instead of osseointegration, leading to implant failure. The prolonged nature of the waiting period before loading raised concerns about treatment length and at the time of surgery,

immediate loading with a provisional restoration was suggested [1].

Recently, improvement in surgical technique, implant design, and treatment of titanium surface (micro and macrostructure of the implant), led to the concept of immediate loading protocol [2]. The prototype has thus shifted from “No load on implants during healing” to “No micro-movements of implants” [3]. Immediate loading of implants is defined as a situation where the superstructure is attached to the implants no later than 72 hours post-surgery [4,5]. This concept has gained popularity by offering shortened treatment time, reduced trauma, decreased patient anxiety and discomfort, and also improvement in function and esthetics [6]. Studies conducted by Schnitman et al. [7] and Schincaglia et al. [8] have reported 95-100% success rates with immediate loading of implants. Studies conducted by Barewal et al. [9], Pellicer Chover et al. [10], Felice et al. [11] reported similar rates of success, implant survival, and Crestal Bone Loss (CBL) for Delayed Loading (DL) and Immediate Loading (IL) of implants.

One-piece implant is defined as an anchorage unit and contiguous prosthetic part manufactured as one unit. The unique design of one-piece implants eliminates the fixture abutment interface (microgap) and resembles the natural tooth with a seamless transition of the radicular unit to the coronal unit [12]. The other advantages of one-piece implants are, less time consuming, better healing, more patient satisfaction, immediate function as well as immediate placement into fresh extraction sockets, using either a traditional flap or flapless surgical procedure [13].

Osseointegration is a measure of implant stability, which ultimately determines the implant's success. The stability is obtained at two different stages. First, the primary stability that is gained during the implant installation, and second, secondary stability during the healing process. The primary implant stability plays an important role in the success of immediate loading. Primary implant stability is the mechanical phenomenon related to the quality and quantity of bone at the recipient site, the type of implant used, and the design of the implant [14].

More recently, compression screw implants have been introduced which can result in condensation of spongy bone areas. Compression of bone along the vertical axis of the screw implant leads to “corticalization of bone” leading to increased primary stability [15]. However, very little information is currently available regarding outcomes of immediate loading compression screw implants with no clinical studies. Therefore, this study was conducted to evaluate the crestal bone loss around immediate loading compression screw implants.

MATERIALS AND METHODS

The study was conducted in the Department of Periodontics & Implantology, Drs. Sudha & Nageswara Rao Siddhartha Institute of dental sciences, Chinaoutapalli, Andhra Pradesh. A total of 15 subjects with 30 edentulous sites were divided into two groups: **delayed and immediate implant placement groups** in the maxillary and mandibular anterior regions (incisors and canines) willing for replacement were taken into consideration. **In delayed group, a minimum of 4 months of bone crest healing period was considered prior to implant placement.** The sample size was determined from the site www.openpi.com. Healthy subjects with good oral hygiene, stable occlusal relationships with no pronounced bruxism and deep bite, presence of sufficient bone volume for placing implants with a length of at least 10mm, implant site that is free from infection were included in the study. Exclusion criteria included patients with systemic diseases contraindicating any type of surgery, under bisphosphonate therapy, chronic smokers, any evidence of pathology or active diseases of the implant bed, subjects who underwent radiation therapy, and need for cantilever prostheses.

SURGICAL PROCEDURE

Surgical site was examined and implant length and diameter were selected for each patient based on Cone Beam Computed Tomography (CBCT) interpretation. Local anesthesia was given i.e., lignocaine 20mg/ml with adrenaline 1:80,000. In the immediate implant placement group, atraumatic tooth extraction was performed. In the delayed implant placement group, after incision and surgical site exposure, the osteotomy site was prepared. In both groups, KOS (Ti6AL4V) single-piece implants of desired diameter and length were placed according to the manufacturer's instructions. These implants are designed with an apical compression thread and straight or angled solid abutment. It has a micro-thread area with 2.5mm of height and with a cylindrical neck consisting of a height of 3.5mm and a diameter of 2mm. It is made sure that minimum torque of 35 Ncm is obtained while screwing in the implant as this is a prerequisite for immediate loading. Flaps are approximated and sutured with 3-0 black braided silk sutures. After implant placement, a hydrocolloid impression is made and an immediate temporary crown with acrylic was made, which was cemented onto the abutment on the same day of implant placement with Glass Ionomer luting cement. It was made sure that the crown was relieved out of occlusal contacts.

Post-surgery, all the patients were prescribed with Amoxicillin and Clavulanic acid of 625mg (Augmentin) twice daily for 5 days, Ibuprofen 400mg thrice daily for 5 days along with 0.2% chlorhexidine mouth rinse twice daily until complete oral hygiene habits were resumed. Patients were advised not to brush on the operated site for a week and recalled after 1 week for suture removal. Patients were instructed not to bite hard on the prostheses. The procedure for fabrication of permanent prostheses was performed 4 months following implant placement. Crestal bone loss was the parameter measured at mesial and distal implant surfaces and averaged to yield mean marginal bone loss for that implant by using standard intra-oral periapical radiographs along with grid. At baseline, measurements were recorded by calculating the radio-opaque squares from the implant shoulder to the apex of the implant (reference point). At 1 month and 4 months, the crestal bone levels were evaluated by calculating the radio-opaque squares from the first bone-implant contact to the apex of the implant. The result obtained by subtracting the radio-opaque squares at 1 month and 4 months from the radio-opaque squares at baseline signifies the crestal bone loss.

STATISTICAL ANALYSIS

Comparison of implant diameter and length between 2 different types of implant placement was done by unpaired t-test. Comparison of bone loss between immediate implant placement and delayed implant placement at different time intervals was done by Mann-Whitney U test.

RESULTS

A total of 15 patients with 30 edentulous sites were included in this study. Among these 15 patients, 8 were males and 7 were females aged between 19-60 years. A total of 30 implants were placed in these patients out of which 8 implants were placed in the maxillary anterior region and 22 implants were placed in the mandibular anterior region. During the study period, one implant in the maxillary anterior region got failed at 1-month follow-up because of failure of osseointegration. The distribution of length and diameters of implants in relation to maxilla and mandible are detailed in (Table 1). There was no significant difference on comparing the mean implant diameter and length between the 2 different types of implant placement. (Table 2).

On comparison of mean bone loss from baseline to 1 month and 1 to 4 months interval for delayed and immediate implant placement, there was no significant difference between the groups (Table 3).

Table 1: Implant distribution according to dimension and arch

Implant diameter/Length	Maxilla		Mandible	
	Immediate	Delayed	Immediate	Delayed
3.2mm × 12mm	0	0	1	0
3.2mm × 15mm	1	1	5	5
3.7mm × 12mm	0	0	1	0
3.7mm × 15mm	2	1	5	5
4.1mm × 12mm	1	2	0	0

Table 2: Comparison of implant diameter and length between 2 different types of implants by unpaired t-test

	Groups	Mean	SD	SE	Mean Diff.	t-value	p-value
Diameter	Immediate	3.91	0.39	0.10	0.0233	0.1574	0.8760
	Delayed	3.88	0.42	0.11			
Length	Immediate	11.50	0.98	0.25	0.2000	0.5214	0.6062
	Delayed	11.30	1.11	0.29			

Statistically significant ($P < 0.05$)

Table 3: Comparison of bone loss in relation to 2 different types of implants placed at different time intervals by Mann-Whitney U test

Variable	Types of implant	Mean	SD	Sum of ranks	U-value	Z-value	p-value
Baseline	Delayed implant	0.00	0.00	188.50	97.50	0.0000	1.0000
	Immediate implant	0.00	0.00	217.50			
1 month	Delayed implant	0.31	0.48	194.50	91.50	-0.2764	0.7822
	Immediate implant	0.23	0.37	211.50			
4months	Delayed implant	0.50	0.65	184.50	93.50	-0.1843	0.8538
	Immediate implant	0.53	0.64	221.50			
BL to 1M	Delayed implant	0.31	0.48	194.50	91.50	-0.2764	0.7822
	Immediate implant	0.23	0.37	211.50			
BL to 4M	Delayed implant	0.50	0.65	184.50	93.50	-0.1843	0.8538
	Immediate implant	0.53	0.64	221.50			
1M to 4M	Delayed implant	0.19	0.33	176.50	85.50	-0.5528	0.5804
	Immediate implant	0.30	0.41	229.50			

Statistically significant ($p < 0.05$)

DISCUSSION

According to Branemark et al. [16], the unloaded healing period of 3-6 months is essential for achieving osseointegration in the two-stage implant surgery. However, this two-stage surgical protocol with delayed loading of implants has disadvantages of prolonged implant treatment, interim period of edentulism (without conventional denture prostheses) for a minimum of 2 weeks after implant placement, and wearing of conventional denture until 2nd stage surgery may prove inconvenient to the patient, which can cause psychological, social and functional problems especially if the edentulous area is in an esthetic zone. Other disadvantages are loose denture, difficulty in chewing with transitional removal prostheses, the necessity for second surgery which may prove inconvenient to the patient, and a long-term waiting period leading to discomfort and anxiety, thereby discouraging the pursuit of such treatment [3,17,18].

The successful healing after immediate loading of implants was 1st documented by Ledermann et al [19] in the year 1979. Studies conducted by Aparicio et al. [4] and Chow et al. [20] stated that immediate loading may be unpredictable with poor bone quality. Romeo et al. [21] Ericsson et al. [22] stated that implant design and surface patterns showed better outcomes for immediately loaded non-splinted implants. According to Lederman et al. [23], Balshi et al. [24] immediately loaded splinted implants placed in regions with non-optimal bone quality have more bone to implant contact with more mature cortical bone than delayed loaded implants.

However, the structural weakness built-in two-piece implants and the presence of micro-gaps (micro-leakage) between 2 implant analogues (implant body and abutment), can lead to the development of micro-organisms followed by inflammation of soft tissue around the implants and sometimes can lead to implant failure. To avoid the above

situation and to reduce manipulation of soft tissues around the implants during initial healing periods, one-piece implants were introduced which incorporate the transmucosal abutment as an integral part of the implant and thus eliminate the structural weakness of two-piece implants. One-piece implants resemble the natural tooth which has a strong uni-body design with no split parts and has many advantages over two-piece implants [25].

The amount of crestal bone around the implant is of utmost significance to determine the success of osseointegration, as maintaining the marginal bone height is highly crucial for the long-term survival of dental implants. The crestal bone loss during the follow-up period in our study was well controlled, showing mean bone loss of 0.27 at 1 month which was increased to 0.52 at 4 months follow-up.

Broggini et al. [26] reported criteria for successful implant therapy, which include a marginal bone loss of 0.5 mm during healing, followed by an annual rate of vertical bone loss of <0.2 mm a year. The presence of micro-threads at the neck of KOS implants enhanced the bone to implant contact and lowered the rate of bone loss when compared to the smooth neck or polished neck implants. Micro-threads provide an increased interlocking of the implant and the marginal bone, which in turn reduces the marginal bone resorption.

According to **Weng et al.** [27], **Rafael et al.** [28] bone loss of 0.3-0.4 mm in the immediate loaded tapered implants is expected at 1st follow-up month. In the present study, significant bone loss was seen in both implant groups when compared from baseline to 4 months follow-up. This difference might have resulted from patient-related factors such as quality of bone, excessive chewing forces, and oral hygiene status of the patient.

In contrary to our study more pronounced bone loss was reported around one-piece implants as compared to conventional implants in two studies conducted by **Ostman et al.** [29], **Sennerby et al.** [30], whereas comparable peri-implant marginal bone loss was reported in the study conducted by **Finne et al.** [31]. However, the comparison may be compromised by the use of different baseline time points, i.e., the time of implant placement for the one-piece implants and the time of abutment placement for conventional implants, respectively. Additionally, the implant diameters differed in the listed studies from 3 to 5mm.

One-piece implant is intended for immediate function as well as for immediate placement in fresh extraction sockets [32]. Lazzara RJ et al. [33] reported that one-piece implants when placed in fresh extraction sockets may preserve the alveolar bone height and width, and provide optimal soft tissue esthetics. Moreover, manipulation of the peri-implant soft tissue after initial healing can be avoided with a one-piece implant design.

In the present study, one implant had to be removed as it showed a sign of mobility indicating lack of osseointegration. The failure can be attributed to one of the following factors such as inadequate primary stability compromising healing phase, apically placed crown margins, patient-related factor such as excessive occlusal force by not complying with the post-operative instructions after loading of the implant or from the transmission of force from the tissues (tongue, cheek).

An implant is thought to be successful only after the 1year modeling phase of osseointegration, but in this study, only a short follow-up period of 4 months is considered wherein the remodeling is not yet complete. Other limitations are, the effect of occlusal loading on bone remodeling is not ascertained, smaller sample size, and the implants are placed only in anterior regions. Further longitudinal studies with long-term follow-up periods and a larger sample size are required to confirm the results, in addition, it is necessary to evaluate the effects of one-piece implants placed in posterior regions (premolars & molars) where the prosthetic load is higher.

CONCLUSION

The data obtained in this study demonstrated that only minimal bone level changes were seen. Within the limitations of this study, one-piece implants with immediate loading can be considered as a viable solution for the replacement of missing teeth in relation to maxillary and mandibular anterior regions. In narrow ridges (especially in upper lateral and lower incisors), narrow-diameter implants can be a treatment option that offers clinical results in terms of implant success and peri-implant bone loss similar to that of standard diameter implants. Furthermore, one-piece implants placed in fresh extraction sockets may be considered as a predictable treatment procedure that improves patient satisfaction.

ETHICAL APPROVAL AND CONSENT

The study was approved by the institutional ethical committee and written informed consent was obtained from all the patients.

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