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Original Research Article

A Comparative Clinic-Radiographical Assessment of the Stability and Crestal Bone Loss of Implants Placed using Osseodensification and Traditional Drilling Protocol

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Conflict of interest: Nil

Abstract

Aim: to evaluate and compare the stability of the implant and the loss of crestal bone in the implants placed using OD drilling and traditional drilling technique.

Material & Methods: The study was approved by institutional review board. The study was conducted in the department of prosthodontics, to evaluate and compare the stability and crestal bone loss (CBL) of implants placed using traditional and OD drilling technique. It was conducted over a period of 1 year in the Department of Maxillofacial Surgery, Narayan Medical College & Hospital, Sasaram, Bihar, India. In the present study for Group II, the mean values of implant stability RFA1 (baseline) and RFA2 (6 months) was 67.4 Ncm and 65.8 Ncm, respectively, however, in the Group I, the mean values RFA1 and RFA2 are 54.3 Ncm and 69.2 Ncm. In the intragroup comparison the data was found to be statistically significant at 4 months for Group II and at 8 months for Group I ($P < 0.05$).

Conclusion: Within the limitations of this study following conclusions were drawn: there was no statistically significant difference in implant stability between the traditional drilling and OD drilling ($P < 0.05$). On comparison of crestal bone levels between OD and traditional drilling, no statistically significant difference was found between the two groups ($P < 0.05$).

Keywords: Crestal bone levels, implant stability, osseodensification, resonance frequency analysis

Introduction

Dental implants have become a popular alternative in the oral and maxillofacial rehabilitation after the introduction of the concept of osseointegration. The volume and quality of the bone present at the site are important factors determining the type of surgical procedure and the type of the implant, and they are related to the success of dental implant surgery. [1] Maxilla and mandible present a wide variation in respect to the bone density and the type of bone present in different regions. A poor density bone, such as in the maxillary posterior region, can negatively influence the bone to implant contact and delay osseointegration. [2-3] A regular sequential osteotomy removes a considerable amount of bone to make the preparation enough to receive an implant with decided diameter. This may be deleterious in a condition where the bone is soft or the density of the bone is poor such as in maxillary posterior region. Therefore, a new osteotomy preparation technique, osseodensification, has recently been developed. [4-5]

Nevertheless, adequate primary stability is necessary to predict the survival of dental implants. This has led to the practice of under-preparing the implant bed to be significantly narrower in diameter than the thread diameter of the implant, especially in soft bone. This is associated with the self-tapping screw implant design, which guarantees a close fit of the dental implant and bone [6, 7]. Although this widely used surgical technique can achieve high insertion torque(IT) or implant stability quotient (ISQ) values, it can produce excessive strain on the bone, which causes transient necrosis in the surrounding bone and may delay or impair bone remodeling [8,9]. Further, friction between the dental implant and bone could damage the implant surface owing to the release of titanium particles [10]. Thus, the under-preparation of the implant bed produces high primary stability; however, it increases peri-implant remodeling and subsequent stability loss during the short-term healing [11].

A new concept for osteotomy preparation known as osseodensification (OD) utilizes custom-designed burs, which allow bone preservation and condensation through compaction auto grafting during osteotomy preparation, thereby increasing primary stability. [12]

Thus, we aim to evaluate and compare the stability of the implant and the loss of crestal bone in the implants placed using OD drilling and traditional drilling technique.

Material & Methods:

The study was approved by institutional review board. The study was conducted in the department of prosthodontics, to evaluate and compare the stability and crestal bone loss (CBL) of implants placed using traditional and OD drilling technique. It was conducted over a period of 1 year in the Department of Maxillofacial Surgery, Narayan Medical College & Hospital, Sasaram, Bihar, India.

For the purpose of the study, a total number of 25 patients who required implant-supported prosthesis in maxillary anterior region were selected from the outpatient department. Patients with signs of parafunctional habits, untreated periodontal disease, heavy smoker (more than10 cigarettes/day), and pregnant or lactating women were excluded from the study. Furthermore, all patients met the following inclusion criteria: good oral hygiene, single tooth missing in the maxillary region with D3 (350–850 HU) and D4 (150–350 HU) bone with adjacent and opposite tooth present. Patients were given oral and written information regarding the risk of surgery and written informed consent and ethical clearance was obtained.

For the purpose of the study, patients were divided into two groups, i.e., Group I and Group II. In Group I, 10 implants were placed in maxilla using traditional drilling technique, while in Group II, 10 implants were placed using OD drilling technique following the standard two-stage procedure of implant placement. The patients selected for Group II were mainly with narrow ridges. Preoperative analysis of surgical site was done clinically and by using cone-beam computed tomography (CBCT). To reduce the postoperative swelling, patients were given antibiotic therapy, i.e., 500 mg amoxicillin + 125 mg clavulanate potassium (AUGMENTIN 625 mg Duo, Galaxo SmithKline) 24 h prior to surgery which was continued for 5 days post-surgery. Paracetamol 325 mg and dexamethasone 0.75 mg were given half an hour before commencing the surgery. The surgical site was prepared following standard surgical protocol. A crestal incision was made and a full-thickness mucoperiosteal flap was raised at the site of implant placement. Following elevation of flap, surgical stent was placed at the site and optimal implant location was then marked using a surgical round bur with the guidance of surgical stent. ADIN Touareg S spiral dental implants of various diameter and length were used for the study. Decision tree for osseodensification protocol [Table 1] was followed. For Group I (traditional drilling technique), the osteotomy was prepared up to the desired depth using the Pilot Drill (speed of 800–1000 rpm at 1:20 reduction torque), thereafter, traditional drills were used in sequence as per the implant diameter protocol. For example, if a 3.75-mm diameter of implant was to be placed, the traditional drills (Alpha Bio – DFI, Israel) of gradually wider diameter ranging from D2.8, D3.2, and D3.65 were used. After final implant placement, veneer grafting was done (Bio-Oss granules, Geistlich) using membrane (periocol–GTR) and primary closure was achieved.

For Group II, Osteotomy was prepared to the desired depth using the pilot drill (clockwise drill speed 800–1500 rpm with copious irrigation) thereafter Osseodensification drills were used in sequence as per the implant diameter protocol). [13] For example, if a 3.75-mm implant was to be placed, drilling is performed in a clockwise direction.

Using VT1525, then depending on the density of the bone (soft or medium), the drill motor is reversed (counter clockwise drill speed 800–1500 rpm with copious irrigation). Gradually wider diameter burs were used, i.e., VT1828, VT2535, and VT2838. The final placement of implant was done, and simultaneous buccal veneer grafting was performed. The second stage was done after 6 months [14] and standard prosthetic protocol is followed for fabrication of implant prosthesis. During the course of study, implant healing was uneventful. All 25 implants remained stable and showed no sign of pain, suppuration, or peri-implant infection throughout the study.

The stability of each implant was measured clinically using resonance frequency analysis (RFA) (Osstell™, Integration Diagnostics, Savedalen, Sweden). RFA was carried out at the time of implant placement and 6 months after surgery. It was recorded three times for each implant at every interval. The system frequency response was measured by attaching transducer to the implant in buccolingual direction. The excitation sign was given over a range of frequencies (typically 5-15 KHz with peak amplitude of 1 V), and the first flexural resonance was measured.

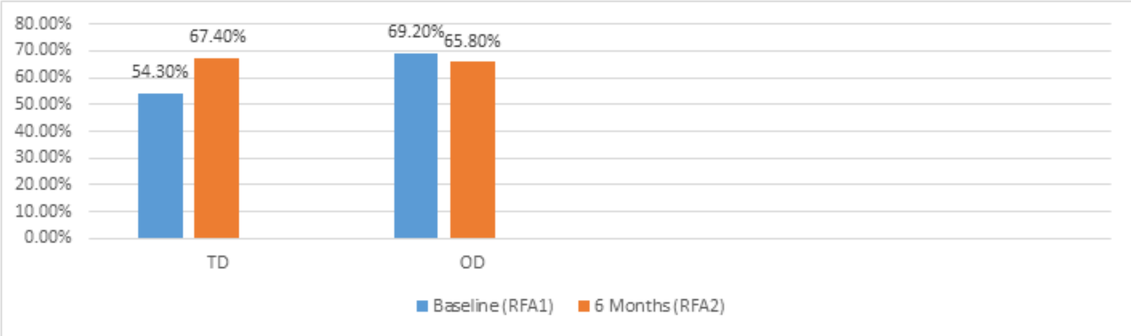
The crestal bone levels were evaluated around the implant at baseline, after 6 and 8 months (post loading) using CBCT. The palatal and labial measurements were done on the sagittal section, while mesial and distal measurements were done on the tangential or coronal sections in the CBCT using measuring tools. The CBL was indicated by a negative value (−) and bone growth was indicated by a relevant to each parameter, i.e., RFA values and crestal bone levels which were recorded at baseline, 6 and 8 months were expressed in the form of mean, standard deviations, and maximum and minimum scores. Unpaired t-test was used to make intergroup comparisons, while one-way ANOVA F-test was used to make intragroup comparisons. Standard prosthetic procedure was used for the fabrication of prosthesis.

Table 1: Decision tree for osseodensification protocol

Implant diameter	Drill	Bur 1	Bur 2	Bur 3	Bur 4
3.5, 3.7, 3.8	Pilot drill	VT1525	VT2535		
4.0, 4.2, 4.3	Pilot drill	VT1828	VT2838		
4.5, 4.7, 4.8	Pilot drill	VT1525	VT2535	VT3545	
5.0, 5.2, 5.3	Pilot drill	VT1828	VT2838	VT3848	

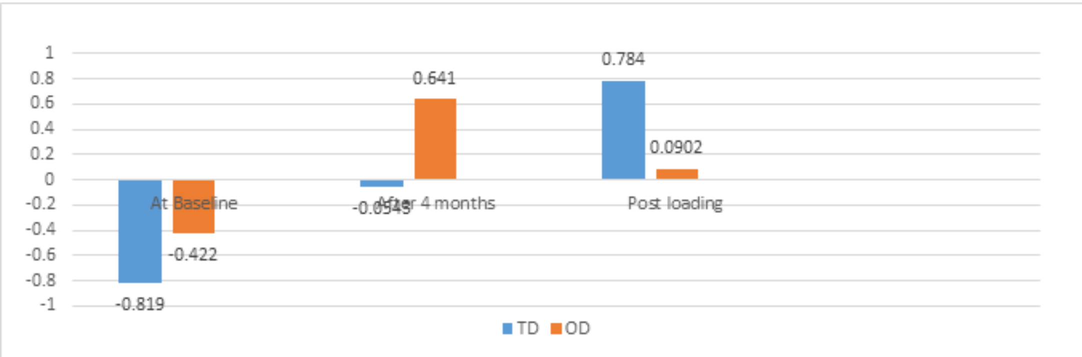
Results:

In the present study for Group II, the mean values of implant stability RFA1 (baseline) and RFA2 (6 months) was 67.4 Ncm and 65.8 Ncm, respectively, however, in the Group I, the mean values RFA1 and RFA2 are 54.3 Ncm and 69.2 Ncm [Graph 1].



Graph 1: Comparative evaluation of the stability of implants placed using osseodensification and traditional drilling technique

The crestal bone levels showed positive bone growth in all the cases which was comparatively slightly higher for Group II as compared to Group I [Graph 2].



Graph 2: Evaluation of the crestal bone levels on the labial/buccal site using osseodensification and traditional drilling technique

The primary stability of implant placed using OD drills was found to be slightly higher than implant placed with traditional drill. On comparison, there was no statistical significance of primary stability obtained at baseline and 6 months when subjected to unpaired t-test ($P > 0.05$) [Table 2]

Table 2: Crestal bone levels from first implant thread after 6 months

Serial Number	Post loading (Osseodensification method)				Post loading (Traditional drilling method)			
	Labial buccal	Palatal	Mesial	Distal	Labial buccal	Palatal	Mesial	Distal
1	0.36	0	−0.20	0	0.36	0	−0.20	0
2	−0.83	0	0.056	0	0.38	0	−1.16	−1.26
3	0	0	−1.26	0.38	0.38	0	−1.16	−1.26
4	0.36	0	0.38	0	0	0	−1.19	−0.37
5	0.37	0.23	0.23	0.17	1.24	1.63	0.28	0.27
6	0.36	0	−0.20	0	0.36	0	−0.20	0
7	0.36	0	0.38	0	0	0	−1.19	−0.37
8	0	0	−1.26	0.38	0.38	0	−1.16	−1.26

9	0.36	0	0.38	0	0	0	−1.19	−0.37
10	0.37	0.23	0.23	0.17	1.24	1.63	0.28	0.27
Mean	0.552	0.261	−0.333	−0.060	1.366	0.712	0.083	0.172
SD	1.138	1.142	0.663	1.227	1.867	0.962	1.252	1.080
Minimum	2.34	2.03	0.62	1.53	4.78	2.38	2.21	2.02
Maximum	−1.26	−1.99	−1.37	−2.62	0	0	−1.15	−1.26

After 6 months of implant placement, crestal bone levels for Group IIwere 35.52% and in Group I was 7.18% of baseline. After 8 months, these values were 36.90% for Group II and 29.84% for Group I. However, when the data were subjected to unpaired t-test, there was no significant difference between the two groups (P > 0.05) [Table 3].

Table 3: Comparison of implant stability at baseline and 6 months for osseodensification and traditional drilling technique

Stability	Probable values of unpaired t-test between osseodensification and traditional drilling technique	Significance
RFA1	0.1851**, P>0.05 (NS)	NS
RFA2	0.6520**, P>0.05 (NS)	NS

**The values came out to be not significant i.e., >0.05. NS: Not significant, RFA: Resonance frequency analysis

In the intragroup comparison the data was found to be statistically significant at 4 months for Group II and at 8 months for Group I (P < 0.05) [Tables 4 and 5].

Table 4: Comparison of crestal bone levels for labial/buccal, palatal, mesial, and distal sites of implant at baseline, after 6 months, and 8 months between osseodensification and traditional drilling technique

Sites	Probable values of unpaired t-test between osseodensification and traditional drilling technique		
	At baseline	After 6 months	After 8 months
Labial buccal	0.7687**, P>0.05 (NS)	0.3812**, P>0.05 (NS)	0.8529**, P>0.05 (NS)
Palatal	0.7619**, P>0.05 (NS)	0.0666**, P>0.05 (NS)	0.7593**, P>0.05 (NS)
Mesial	0.0591**, P>0.05 (NS)	0.9428**, P>0.05 (NS)	0.5749**, P>0.05 (NS)
Distal	0.0118*, P<0.05 (S)	0.5428**, P>0.05 (NS)	0.4428**, P>0.05 (NS)

Table 5: Comparison (by one-way ANOVA-F-test) among the different sites for different time points (at baseline, 6 months and 8 months) for osseodensification and traditional drilling technique

Time points	**Source of variation**	**P**	**F (Cal.)**	**df**
At base line	Between groups (traditional drill method)	0.082**, P>0.05 (NS)	2.63	3
	Between groups (Osseo densifying drill technique)	0.173**, P>0.05 (NS)	1.730	3
After 6 months	Between groups (traditional drilling technique)	0.455**, P>0.05 (NS)	0.998	3
	Between groups (Osseo densifying drilling technique)	0.014*, P<0.05 (S)	3.529	3

After 8 months	Between groups (traditional drilling technique)	0.014*, P<0.05 (S)	3.663	3
	Between groups (Osseo densifying drilling technique)	0.152**, P>0.05 (NS)	1.713	3

Discussion:

The recently introduced concept of Osseodensification has limited implant survival rates in humans, as reported in the literature [15-16]. One study reported a survival rate of 97% in crestal maxillary sinus lift procedures [16], which was similar to the success rate observed in this study (98.1%). Another study reported survival of 92.8% when Osseodensification was used for alveolar ridge expansion [15], which was inferior to the 98.1% success rate in this observation. A recent study showed a 100% success rate on implants placed by Osseodensification, but with a small sample size (10 implants) [17]. This report provides further evidence to support Osseodensification as a valid method to increase success rates in immediate implant placement protocols, with and without immediate loading, using a larger sample size. Despite the limited long-term evidence of success, Osseodensification has shown to improve primary stability of dental implants [18]. This appears to be more significant during immediate loading protocols, where high insertion torques are required for successful treatment. Recent in vitro studies compared standard drilling sequences with Osseodensification protocols in low-density polyurethane blocks, and also concluded that OD resulted in higher primary stability values [19-20]. Fresh extraction sites are known to provide reduced insertion torque and consequently inferior primary stability for implant placement. A recent study, however, presented a 93.1% implant survival rate in immediate implant placement in molar areas with septum expansion instrumented by Osseodensification [21].

Other authors [22-24] have noted that implant stability also depends on the geometry of the threads. Larger implant threads with higher pitches contact more bone trabeculae and have improved bone-chip compaction. In the present study, the implant geometry had a square thread profile with a large pitch, observed through SEM, and exhibited adequate primary stability for both drilling protocols. These data agree with that of previous studies, which showed that large and self-cutting implant threads have higher primary stability than implants with small-thread designs in regions of poor-density bone [22-25].

Studies were carried out by Hindi et al. where they compared the implant stability and bone density after osseodensification, and they noticed in increased implant stability. [26-28] Study done by Seo et al. also showed similar results. [29]

Maiorana et al. [30] who concluded that bio-Oss can be placed on grafted area taking advantage of its osteoconductive property and compensating for the natural bone resorption that always occurs. The auto grafted bone chips in the osteotomy wall of Group II were also nuclei for more and dense bone formation as compared to Group I. Since the bone graft requires a very long time for its resorption, bone healing was slower in Group I.

Conclusion:

Within the limitations of this study following conclusions were drawn: there was no statistically significant difference in implant stability between the traditional drilling and OD drilling (P < 0.05). On comparison of crestal bone levels between OD and traditional drilling, no statistically significant difference was found between the two groups (P < 0.05).

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