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Comparative evaluation of Implant Osteotomies with Conventional Technique vs Osseodensification using Cone Beam Computed Tomography – A Clinical Study

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Introduction

Replacement of missing teeth with dental implants represents one of the most successful treatment modalities in modern medicine. Achieving and maintaining implant stability are prerequisites for a dental implant to be successful. The majority of implant failures may be explained as biomechanically induced failures, since low primary implant stability, low bone density, short implants and overload have been identified as risk factors. Hence, achievement and maintenance of firm implant stability is regarded as a precondition for a successful clinical outcome with dental implants.[1]

Success of implant therapy highly depends on both, the quality and the quantity of the surrounding bone. Various bone classification schemes related to dental implants are available(Linkow in 1970, Lekholm and Zarb in 1985 and Misch in 1988).There is a correlation between high bone density and high rate of implant success, and between high bone density and implant primary stability.[1]Bone density assessment is therefore essential in treatment planning [2].CBCT could be considered a diagnostic tool for bone density evaluation based on CT Hounsfield units).Bone density and corresponding Hounsfield units will vary in each zones and regions [3]

Since early days of Dental Implantology, osteotomies have been prepared using standard implant drills. Osteotomies drilled in narrow bone may produce fenestration or dehiscence,Osteotomies may become elongated and elliptical due to chatter of the drills.,which may reduce primary stability and will require bone grafting.[4]This might prolong the healing period and is also expensive. In case of poor bone density, such as in maxillary posteriors, the insufficient bone amount around the implants could negatively influence the histomorphometric parameters (such as %Bone Implant Contact(BIC) and bone volume percentage [%BV]) and, consequently, both primary and secondary implant stabilities.[5,6]

OsseoDensification (OD) is a novel biomechanical osteotomy preparation technique used to place a dental implant. It causes low plastic deformation of bone due to rolling and sliding contact with the rotating Densah Bur / Versah Bur. Irrigation is used with the bur to eliminate overheating and to create a hydrodynamic compression wave in the osteotomy.[7] Densah Burs are novel and proprietary surgical devices. OD, a bone nonextraction technique, was developed by Salah Huwais in 2013 and done using specially designed burs (Densah burs) that help densify bone as they prepare an osteotomy.[8]

During OsseoDensification, they produce a controlled bony plastic deformation, which allows the expansion of a cylindrical osteotomy without excavating any bone tissue. They progressively increase in diameter throughout the surgical procedure and are designed to be used with standard surgical engines, to preserve and condense bone at 800-1500 RPM in a counterclockwise direction (Osseodensification), and to precisely cut bone at 800-1500 RPM in a clockwise direction (Cutting Mode). [9]

The **aim** of the present in vivo study is to compare the efficacy of Osseodensification and Conventional implant osteotomy technique in implant site preparation by evaluating CBCT changes in the bone density.

Materials and Methods

The study was conducted in the Department of Periodontology and Implantology in Rajas Dental College ,Tiruneleveli Dt, with approval from the Institutional Review Board. All clinical procedures were performed in accordance with the Declaration of Helsinki .

Inclusion criteria

Nonsmokers,systemically healthy individuals requiring placement of implants for replacement of missing teeth in maxillary posterior region (figure1) with well-healed edentulous site and a healthy overlying mucosa with bony dehiscence

Exclusion Criteria

Patients with a history of smoking and who were unable to perform routine oral hygiene procedures. Patients with psychosis or dental history of bruxism and parafunctional habits and who were contraindicated for periodontal surgery

Study Design

Clinical study was designed to compare the efficacy of OD and Conventional implant osteotomy technique in implant site preparation by assessing bone density changes using CBCT .20 patients with missing maxillary first or second molars were selected based on the inclusion and exclusion criteria**.**They were randomly allotted to 2 groups

Group 1 comprised of 10 Implant osteotomy with Osseodensification technique using Densah Burs (OD)

Group 2 comprised of 10 Conventional Implant Osteotomy using Twist Drills (OC)

Radiographic analysis

The selected patients were explained about the nature and surgical procedure in detail. A preoperative CBCT of the osteotomy site was taken and all density measurement(hounsefield unit) was taken in the buccolingual view of the axial plane by using gray scale bone measuring tool in the NNT software (Newtom GO 2D/3D) at three levels (Apical ,Midcrestal and Crestal) [10,11] (figure 2,3a,3b,3c).

Local anaesthesia was achieved by 2% lignocaine hydrochloride containing 1:80,000 concentration of adrenaline by injecting to the corresponding nerve.

Conventional Implant osteotomy (OC)

After achieving adequate local anesthesia, crestal incisions were placed on the edentulous site with no. 15 blade. The crestal incision was extended to the mid-buccal and mid-lingual crevices of the adjacent tooth. Full-thickness mucoperiosteal flap was elevated using periosteal elevator. Sequential osteotomy drills performed.After performing final osteotomy drill a postoperative CBCT was taken at same position at the same levels. .Implant placed according to the desired width and length of the osteotomy site.(Noris Implant)

Osseodensification Implant Osteotomy

A similar implant-surgical protocol was followed for all cases.Instead of conventional osteotomy burs,osseodensification burs**(** Densah Bur VT2535 ,Versah,) running in a non-cutting counterclockwise (CCW) direction at 1200 RPM (Densifying Mode) was used. Average diameter of 2.3,3.3,4.3 mm was used.(figure 4a,4b,4c,4d). After performing final osteotomy drill a postoperative CBCT was taken at same position at the same levels (figure 5a,5b,5c).Implant was placed

The procedure was completed by repositioning and suturing the surgical flap.All patients were prescribed systemic Amoxycillin 500 mg thrice daily for 5 days, Diclofenac sodium + Serratiopeptidase combination thrice daily for 3 days, and chlorhexidine mouth wash during the post-operative period.

Statistical analysis done by using paired t test

Results

After the sequential osteotomy drills immediate CBCT was taken on crestal ,midcrestal and apical region on both groups .Mean value obtained in post operative crestal region in test group was 427.30 and control group was 389.10. Mean value obtained in post operative mid crestal region in test group was 642.90 and control group was 617.70. Mean value obtained in post operative apical region in test group was 1175.60 and control group was 1050.20.(Table 2).Data obtained showed an increased density of bone in crestal and apical region with statistically significant p value in osseodensification group (test group) compared with conventional osteotomy (control group) (Table 1) .While analyzing the result obtained in pre operative and post operative bone density measurement in control group, there was a decreased bone density in all the three regions from pre operative to postoperative (Table 1).

Discussion

Bone density classification according to Lekholm and Zarb (1985),based on the morphology and distribution of cortical and trabecular bones ,individuated 4 bone quality types .[2]

Poor bone density is common in human upper jaw, especially in elderly patients needing a fixed implant supported rehabilitation. In D3 or D4 bone type, it is difficult to achieve a good implant primary stability because of the poor %BV around the titanium implant surface.Poor bone density (D3-D4) is common in the upper jaw region and in this bone type, it is difficult to achieve a high implant primary stability. If the primary implant stability is inadequate, the early implant failure rate could rise beyond critical levels. Immediate loading protocols are also discouraged in case of poor bone quality or low primary implant stability and longer healing time is needed in these cases, with some disadvantages for the patient.[2]

Standard drills used in implant site osteotomy excavate bone to facilitate implant placement. They produce effective cutting of bone but lack the design capability to create a precise circumferential osteotomy.

OD is a novel biomechanical bone preparation to place a dental implant, using burs (densah burs) which are rotated in reverse at 800 to 1500 rpm. Standard traditional drills remove and excavate bone during implant site preparation. Whereas, the new burs (densah burs) allow bone preservation and condensation through compaction autografting during osteotomy preparation thereby increasing the peri-implant bone density (% BV), and the implant mechanical stability [6]

Meyer EG et al [9]conducted a biomechanical and histological validation study in Porcine tibia, they found that osseodensification creates a densification crust around the preparation site by compacting and autografting bone along the entire depth of the osteotomy.

Stavropoulos A et al [12] identified the presence of autogenous bone fragments in the osseodensified osteotomy sites, especially in the bone of low mineral density relative to regular drills.

In the present study the bone density was measured at three different levels were found a statistically significant change in bone density measurement at apical and crestal region in osseodensification osteotomy sites. OD helped in preserving bone bulk and shortened the waiting period to restorative phase. Greater density of bone in implant osteotomy will definitely make a positive impact in the primary stability obtained.

Frost HM et al [13] reviewed that standard drills extract enough bone to let strains in the remaining bone to reach or exceed the bone micro-damage (MDX) threshold, the bone-remodelling unit (BMU) needs more than 3 months to repair the damaged area, so maintaining bone bulk will enhance healing and shorten the healing period. Densah burs will overcome the bone micro damage and can enhance healing and increasing the stability it preserves bone bulk, so bone tissue is simultaneously compacted and autografted in an outwardly expanding direction to form the osteotomy.[14]

In the current study the conventional drills produce shatters in all the three regions and leads to minimal reduction in bone density comparing pre and postoperative. Trisi et al. [15] an in vivo study found a statistically significant correlation between peri- implant bone density, insertion torque, and micromotion. A significant increase in insertion torque and a concomitant reduction in micromotion was noted with an increase in bone density values.

Use of densah drills in OD led to the formation of undersized osteotomy when compared to conventional drills. It helped improve bone density and will definitely provide a better implant stability.

Limitation of this study is the smaller sample size with lack of histomorphometric analysis. Further studies evaluating other parameters such as secondary stability and long term follow up will help us to arrive at more evidence towards this clinical procedure.

Conclusion

The goal of any periodontal therapy is the preservation of existing architecture rather than meticulous replacement with artificial substitutes. This study provides valuable clinical evidence in favour of Osseodensification using Densah burs in preserving existing bone and providing higher quality of bone density in implant osteotomy sites especially in posterior maxilla.

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Legends Figures and Tables

Figure 1: Missing tooth in 16

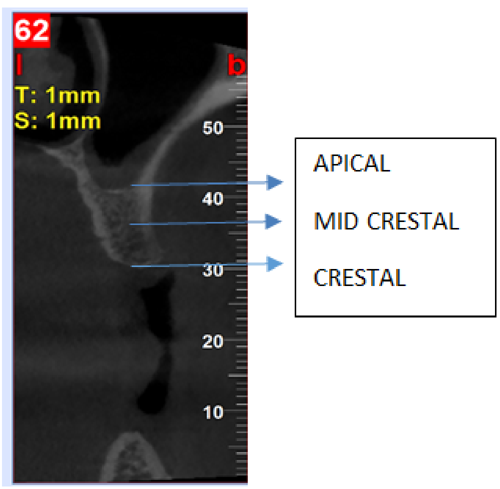

Figure 2: CBCT representation of 3 different bone levels

Figure 3a,3b,3c : Pre operative bone density values (Hounsefield units) at crestal,midcrestal and apical regions

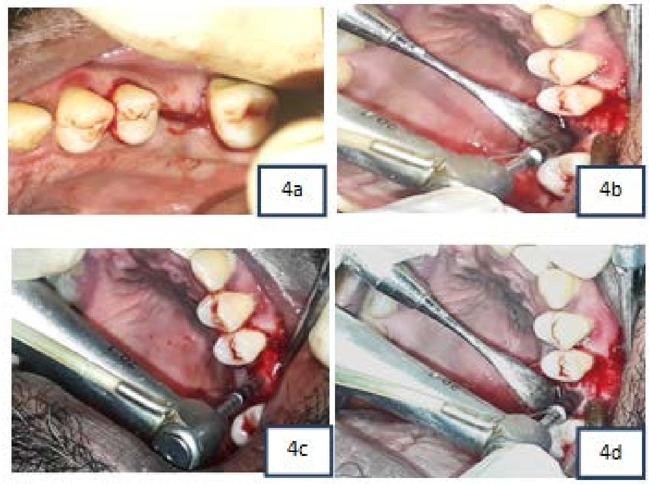

Figure 4a,4b,4c,4d: Osseodensification (Densah burs) implant osteotomy

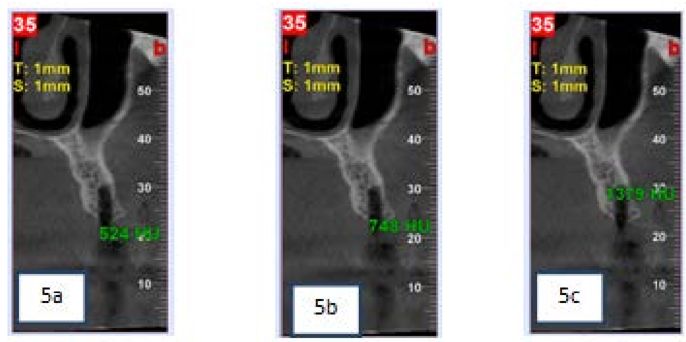

Figure 5a,5b,5c: Post operative bone density values (Hounsefield units) at crestal,midcrestal and apical regions

			N	Mean	Standard Deviation	p-value
Test Group	Crestal	Pre-OP	10	411.20	34.61	0.345
		Post-OP	10	427.30	39.51	
	Mid-Crestal	Pre-OP	10	624.00	99.30	0.680
		Post-OP	10	642.90	102.22	
	Apical	Pre-OP	10	1153.90	148.10	0.743
		Post-OP	10	1175.60	143.18	
Control Group	Crestal	Pre-OP	10	400.70	31.67	0.434
		Post-OP	10	389.10	33.18	
	MidCrestal	Pre-OP	10	636.50	106.54	0.705
		Post-OP	10	617.70	111.90	
	Apical	Pre-OP	10	1112.20	125.09	0.259
		Post-OP	10	1050.20	112.49	
p-value based on Independent-t-Test, * = $p < 0.05$ (Statistically Significant)						

Table 1: Pre and post operative bone density values at three different levels

		N	Mean	Standard Deviation	p-value
Crestal Post-OP	Test Group	10	427.30	39.51	0.031*
	Control	10	389.10	33.18	
Mid Crestal Post-OP	Test Group	10	642.90	102.22	0.605
	Control	10	617.70	111.90	
Apical Post-OP	Test Group	10	1175.60	143.18	0.043*
	Control	10	1050.20	112.49	
p-value based on Independent-t-Test , * = $p < 0.05$ (Statistically Significant)					

Table 2 : Post operative statistical values of test and control group