ASDJ
AINSHAMS DENTAL
JOURNAL

AIN SHAMS DENTAL JOURNAL
Official Publication of Ain Shams Dental School
Des. 2019 - Vol. XXII

Management of low bone density site with osseodensification versus conventional bone expanding prior to dental implant placement Clinical and Radiographic study

Ahmed M. Aboelnaga, Mahmoud T. Eldestawy**, Hazem M. Mandour*** and Hussein R. Mohammed*****

Abstract

Background: The effective bond between an implant and its surrounding bone is depending upon various mechanical factors.surgical techniques can help to reduce the time of rehabilitation for patient when excellent primary stability is the primary prerequisite In cases where the quality of the bone is Type 3 or 4, the need to increase the amount of bone tissue that will be in contact with the surface of the implant becomes essential to achieve excellent primary stability, this study was to evaluate the rule of biomechanical properties of osseodensification (OD) as a novel osteotomy preparation technique, to be used by the surgeon safely and efficiently in region with low density and having a layer of compacted bone at the implant interface.

Methods: Twenty dental implants units (non submerged tissue levels,simple line implants) were inserted in Twenty Patients with missed teeth and low bone density in maxilla were divided into two groups, first group Ridge Expansion : The dental implant site was prepared using conventional motor driven ridge expander, the second group Counter-clockwise osseodensification : The dental implant site was prepared using CCW osseodensificatin drilling with Densah Bur. RFA reading was carried out two directions perpendicular to long axis of implant and parallel to long axis of implant at base line ,3 and 6 months for clinical implant stability evaluation while The bone density values were recorded in Hounsfield units (HU). post-operative CBCT scan was

** Department of Periodontology, Faculty of Dental Medicine, Al Azhar University, Cairo, Egypt*
*** Department of Periodontology, Faculty of Dental Medicine, Al Azhar University, Cairo, Egypt*
**** Department of Periodontology, Faculty of Dental Medicine, Al Azhar University, Cairo, Egypt*
***** Department of crown and bridge, Faculty of Dental Medicine, Al Azhar University, Cairo, Egypt*

obtained at base line after implant insertion and 6 months.

Results: clinical evaluation showing there was a statistically significant change in ISQ through all periods which OD group showed a higher mean ISQ value than Bone Expander group . While radiographic evaluation of bone density showed: Pre-operative; there was no statistically significant difference between bone density measurements in the two groups. Immediate and 6th months; there was a statistically significant difference between bone density measurements in the two groups. Osseodensification group showed a higher mean bone density than Bone Expander group.

Conclusion: The use of osseodensificatin drilling with Densah Bur demonstrated superiority when compared to bone expander, more significant improvement was noted in all the tested parameters.

Implant stability as a critical role in successful out come of oral implant is either primary or secondary in incidence, Primary or mechanical implant stability is the initial interlocking between alveolar bone and implant body at the time of insertion, while secondary implant stability refer to the biological fixation of implant body due to continues bone apposition on implant surface and ends by remodeling of this bone on implant surface. It has been mentioned that implant stability at the time of surgery is a crucial factor to achieve the implant osseointegration. And this successful osseoint- egration has been found to influence by a numerous factors, as proposed by Albrektsson et al.; these include the surface topography, material properties, geometry, surgical technique, and in particular the patient's bone status, in which the implant success would depends on an exquisite balance of these factors(1).

Regarding to bone status, Implant primary stability is affected by the density of the host bone(2). The bony structure of human jaw bone is irregular in shape and size due to a non-uniform modeling during embryo-genesis and early life. The mandible shows a thicker cortical and denser trabecular bone when compared with the maxilla, while the trabecular in posterior parts in both arch are recognized to have lower density and thickness(3-4). The prospective clinical studies reviewed that total failure rate of implant stability is associated more with defect in bone quality surrounding the implant site(5). This observation emphasize the promise of bone structural analysis needs in each dental implant surgery, especially in the thinner maxilla, where primary stability may show a challenge to achieve.

According to characteristic anatomical feature of jaw bone dental, implants inserted at the posterior region of the maxilla showed to exhibit the lowest success rates(6,7). This mainly due to the thin cortical plate and the low density of trabecular bone present. In addition several studies reported that, trabecular bone has only a minor influence on the implant stability compared to the marginal compact bone(8,9).

During the past decades, and in atrial to solve this problem, many surgical techniques have been developed to increase the primary stability of an implant when placed in areas of low density bone.

Originally it was suggested that the stage of bone tapping should be omitted, especially in cases of low density bone(10).

Many studies confirmed the compaction of trabeculae is an effective method to increase the primary stability of an implant(11,12). According the their results they concluded that the bone condensing technique can be recommended as an alternate in surgical approach for implant site preparation in areas of reduced bone density to achieve greater implant stability. On the other hand, other studies(13,14) reported that the increased periimplant density gained by the osteotome technique does not ensure greater BIC and so, does not improve implant primary stability. The explanation given is that trabecular fractures that accompany the bone condensation procedure trigger a prolonged period of healing and bone resorption preventing the implants to achieve superior secondary stability.

A technique that has been to developed

allows a traumatic preparation of implant sites is by eliminating the use of a surgical mallet(15). This procedure is based on the use of ridge expansion system which includes a bur kit and instruments known as motor driven bone expanders.he thread pattern of expanders has been designed to compact the bone laterally as the instrument advances into the osseous crest. This system allows expansion and preparation of implant sites in Type II and III bone, as well as compaction of Type IV bone.

Osseodensification is a novel biomechanical bone preparation technique used to place a dental implant, Through burs (densah burs) rotated in reverse at 800 to 1500 rpm, not like the Standard traditional drills which remove and excavate bone during implant site preparation, but the new burs (densah burs) allow bone preservation and condensation through compaction auto grafting during osteotomy preparation to increase the peri-implant bone density, and the implant mechanical stability.

The rational behind this process is the establishment of densification of bone that will be in immediate contact to the implant and results in higher degrees of primary stability obtained due to physical interlocking between the bone and the implant, with faster new bone growth formation due to osteoblasts nucleating on instrumented bone that is will be in close proximity with the implant (16).

Because it is important to figure out the potentials of different surgical technique in management of low bone density in posterior site of maxilla, the primary objective of the present study was to evaluate the clinical implant stability at different time period with both surgical techniques, The secondary one was to figure out the radiographic change in bone density around dental implant.

1 MATERIALS AND METHODS

1.1 Patients

Twenty dental implants units (non submerged tissue levels,simple line implants) were inserted in twenty patients 9 males and 11 females (age range 28-48 years) with missed teeth and low bone density in maxilla. This patient were recruited from the Department of Oral Medicine, Periodotology, Oral Diagnosis and Oral Radiology, Faculty of Oral and Dental Medicine, (Boys,Cairo) Al-Azhar University.

Figure 1 Preoperative clinical photograph for edentulous sites.

1.2 Patient grouping

The study was designed as a prospective interventional randomized controlled study. Included patient was randomly divided into two equal group according to surgical technique performance to: Group I(Ridge Expansion),The dental implant site was prepared using conventional motor driven ridge expander . while Group II(Counter-clockwise osseodensification) which dental implant site was prepared using CCW osseodensificatin drilling with Densah Bur.

Preoperative assessment of all patients was carried out including history taking, clinical examination and radiographic examination.

Study casts were created for evaluation of edentulous areas and occlusion, cone beam computed tomography (CBCT) scans were done.

All subjects were received initial periodontal therapy consisted of prophylaxis, supra and subgingival scaling, subgingival debridement if needed, and polishing. They were instructed in proper plaque control measures and advised to use teeth brushing and interdental cleaning devices.

1.3 Surgical protocol

Pre-surgical mouth rinse was carried out with 0.12% chlorhexidine digluconate rinse,while povidone iodine solution were used to perform the extra oral antisepsis. After administration of local anesthesia (Articaine 4% with 1:100000 epinephrine), and flap procedure(Para-crestal incisions and full thickness flaps were reflected exposing the alveolar ridge) .

Ridge Expansion group:

Motor-driven expanders begin with the use of pilot drill at speed of 700 to 800 rpm with irrigation creating an osteotomy of 1.5 mm in diameter. The 1.8mm and 1.8/2.6 mm bur was subsequently use at 50 rpm without irrigation, followed by no.1 and no.2 expander. The torque setting of the surgical motor was 15 to 20Ncm. Once the sufficient resistance was encountered, a manual expander with ratchet was utilized to creating osteotomy of 4.3mm in diameter.

Counter-clockwise osseodensification group

Osseodensification was utilize by the use of pilot drill then using Densah™ Bur VT1828 (Versah™, LLC) running in a non-cutting counterclockwise (CCW) direction at 1200 RPM (Densifying Mode) with a bouncing motion to expand the osteotomy. Sequential use of Densah™ Bur VT2535 running in a non-cutting CCW direction at 1200 RPM (Densifying Mode) with a bouncing motion was utilize to expand the osteotomy to a 3.3. Then use of Densah™ Bur VT2838 running in a non-cutting CCW direction at 1200 RPM (Densifying Mode) with a bouncing motion was utilize to expand the osteotomy to a 3.5 mm diameter .Then use of Densah™ Bur VT3545 running in a non-cutting CCW direction at 1200 RPM (Densifying Mode) with a bouncing motion was utilize to expand the osteotomy to a 4 mm diameter .

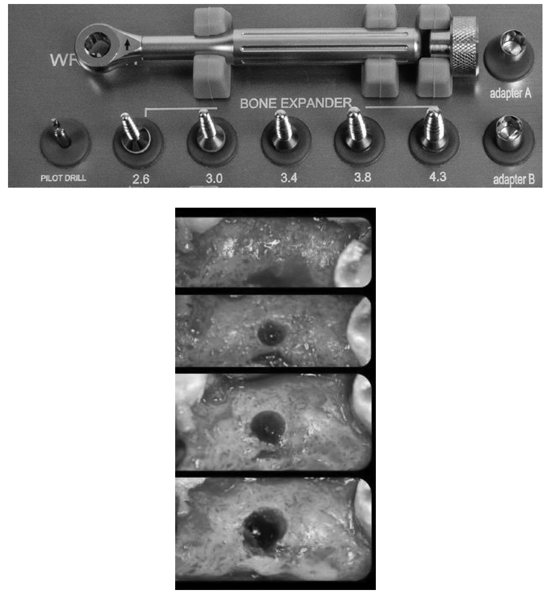

Figure 2: Clinical photograph for ridge expansion case showing: bone expander kit, sequential increase of osteotomy site width

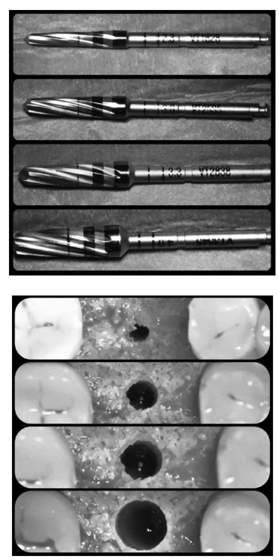

Figure 3: Clinical photograph for counter-clockwise osseodensification case showing: Densah Burs, sequential increase of osteotomy site width

The implants used in this study was T6 bone level implant by nucleoss were between 3.5 to 4.8 mm in diameter, implant insertion was performed according to manufacturer’s instructions. Non submerged installation procedures were performed. and flaps were closed by interrupted sutures using 3″0″ Vicryl.

1.4 Post-operative follow-up

Patients were asked to follow oral hygiene instructions, and asked not to bite upon or use the surgical site for the initial 3 weeks. A soft diet was recommended throughout the remaining healing period (3 months), Suture removal was performed after 8-10 days. At 3 months, a definitive abutment level impression was made and acrylic restorations were cemented to the abutments.

Clinical evaluation: RFA (by Osstell Inc. W&H Dentalwerk, Burmoos, Salzburg, Austria) reading was carried out two directions perpendicular to long axis of implant and parallel to long axis of implant at base line ,3 and 6 months.

Radiographic evaluation: Bone density was measured at the crest, 3 mm from crest, 6 mm from crest and at the apex, both on the buccal and palatal aspect for all the designated implant sites. The bone density values were recorded in Hounsfield units (HU). post-operative CBCT scan was obtained at base line after implant insertion and 6 months under the similar preoperative conditions .

1.5 Statistical evaluation

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level.

2 Results

The mean age of Osseodensification group was 38.70 ± 5.15 years while in Bone expander group was 40.20 ± 4.70 years. There was no statistically significant difference in the two groups regarding to the mean of age.

Osseodensification group had 4 males and 6 females, while Bone expander had 5 males and 5 females. There was no statistically significant difference between gender distributions in the two groups.

Descriptive statistics of ISQ (table 1)

In OD group the mean ISQ was 87.30± 2.75 at base line, after 3 months was 79.50 ± 3.21 and after 6 months was 86.40± 3.50. Descriptive statistics of ISQ in Bone expander group the mean ISQ was 70.60± 2.99 at base line, after 3 months was 63.80± 3.22 and after 6 months was 69.30 ± 2.58.

At base line, after 3 months and after 6 months; there was a statistically significant difference between ISQ in two groups which OD group showed a higher mean ISQ value than Bone Expander group .

Descriptive statistics of Bone density (table 2) The mean bone density of Osseodensification group was 426.0± 48.46 Pre-operative, 611.30 ± 57.13 at base line Immediate post implant insertion and 670.10 ± 56.20 at 6th months. While the mean bone density of bone expander group was 435.50± 68.35 Pre-operative, 490.70 ± 73.85 at base line Immediate post implant insertion and 525.95 ± 74.89 at 6th months.

Pre-operative; there was no statistically significant difference between bone density measurements in the two groups. While immediate and 6th months; there was a statistically significant difference between bone density measurements in the two groups. Osseodensification group showed a higher mean bone density than Bone Expander group.

Table (1): Comparison between the two group during different time periods according to ISQ

	ISQ						p1
	Baseline		3 months		6 months		
	Mean	±SD	Mean	±SD	Mean	±SD	
Osseodensification	87.30	2.75	79.50	3.21	86.40	3.50	<0.001*
pBaseline			<0.001*		0.284		
Bone expander	70.60	2.99	63.80	3.22	69.30	2.58	<0.001*
pBaseline			<0.001*		0.006*		

p1: p value for Post Hoc Test (adjusted Bonferroni) for ANOVA with repeated measures for comparing between different periods

pBaseline: p value for comparing between baseline and each other period in each group

*: Statistically significant at $p \leq 0.05$

Table (2): Comparison between each group during the different time periods according to bone density

	Bone density						**p**
	Pre-operative		**Immediate**		**6th month**		
	Mean	**±SD**	**Mean**	**±SD**	**Mean**	**±SD**	
Osseodensification	6.0 42	48.46	611.30	57.13	670.10	56.20	<0.001*
Sig. bet. periods	$p_1<0.001^*, p_2<0.001^*, p_3<0.001^*$						
Expander	435.50	68.35	490.70	73.85	525.95	74.89	<0.001*
Sig. bet. periods	$p_1<0.001^*, p_2<0.001^*, p_3=0.002^*$						

p: p value for Post Hoc Test (adjusted Bonferroni) for ANOVA with repeated measures for comparing between different periods

p1: p value for comparing between Pre-operative and Immediate

p2: p value for comparing between Pre-operative and 6th month

p3: p value for comparing between Immediate and 6th month

*: Statistically significant at $p \leq 0.05$

3 Discussion

Degree of implant stability may also depend on the condition of the surrounding tissue. When an implant is placed in the posterior maxilla, it can be difficult to obtain a high and satisfactory primary stability, where the bone quality (density) is poor in this region, as in the case of native bone . When the bone has been partially or fully regenerated, the bone quality tends to further decrease(17-19) . In the present study twenty implants were inserted in twenty patients : Ten dental implant sites were prepared by using conventional motor driven ridge expander and the other ten dental implant sites were prepared by using CCW osseodensificatin drilling with Densah Bur. These implants were clinically and radio-graphically evaluated, to examine implant stability and surrounding bony density.

Clinical evaluation of implant stability was carried out by using ISQ at base line,3 and 6 months. According to the result of implant stability mentioned above, at base line, after 3 months and after 6 months; there was a statistically significant difference between ISQ in both groups. These results showed to be in agreement with Huwais and Meyer(20) study who reported that osseodens- ification in implant preparation increase primary stability. Therefore, The present study can support the hypothesis that osseodensification technique increase the primary stability due to creating a crust of increased bone mineral density around the osteotomy site which lead to high insertion torques. While the relatively slight elevation in temperature associated with this technique can avoided by irrigation and a bouncing surgical method used(21).

Regarding to radiographic evaluation which carried out by using CBCT before surgery, at base line immediate after implant insertion and 6 month after implants insertion.At base line; there was no statistically significant difference between bone density in both groups. While at base line immediate after implant insertion and after 6 months; there was a statistically significant difference between bone density which was higher in OD group that investigated in bone expander group.

It has been mentioned that bone can be preserved by two ways: compaction of cancellous bone due to viscoelastic and plastic deformation, and compaction auto-grafting of bone particles along the length and at the apex of the osteotomy. The philosophy of OD technique, can be explained by the bur which runs counter to the outcome of bone drilling, and so healthy bone well be maintained, especially in regions where the density is already compromised. In the present study, the OD technique lead to redistribute bone material on the osteotomy surface through plastic deformation using slide of flutes across the surface of the bone with a compressive force less than the ultimate strength of the bone. Since fresh, hydrated trabecular of bone is of ductile material, it has a good capacity for plastic deformation. The irrigation fluid and fluid content of the bone can help this process by creating a lubrication film between the two surfaces to reduce friction and more evenly distribute the compressive forces(22). Therefore, the osseodensification technique lead to increase the density of cancellous bone after implant placement. This was attributed to the compression of bone trabeculae that occurred simultaneously with burs counter act and implant placement, and so offered compression stability to the implant. After six months, the result also showed that the bone density values were increase than those recorded in the per-operative measurements.

It is known that cancellous bone stiffness and strength are proportional to bone mineral density(23), With reduced bone mineral density, there is a higher risk that the remaining bone will reach or exceed the bone micro damage threshold. If micro damage does occur, the bone remodeling unit may require 3 or more months to repair the damaged bone area(24). Accordingly it was evident that significant difference in both ISQ and radiographic bone density in the two group was obtained; finding agree with those findings previously reported in other studies(20,25,26,27).

4 Conclusion

Within the limitations of the present study we can conclude That both treatment modalities osseoden- sification and bone expander were successful in the placement and stability of dental implants in the maxilla. The use of osseodensificatin drilling with Densah Bur demonstrated superiority when compared to bone expander, more significant improvement was noted in all the tested parameters.

REFERENCES

1. Albrektsson T, Branemark P, Hansson H. Osseointegrated titanium implants. Requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. Acta Orthop Scand. 1981;52:155–170.

2. Trisi P, De Benedittis S, Perfetti G, Berardi D. Primary stability, insertion torque and bone density of cylindric implant ad modum Branemark: is there a relationship? An in vitro study. Clin Oral Implants Res, 2011;22:567-70.

3. Ulm C, Kneissel M, Schedle A, Solar P, Matejka M, Schneider B,et al. Characteristic features of trabecular bone in edentulous maxillae. Clin Oral Implants Res 1999; 10: 459-67.

4. Park H, Lee Y, Jeong S, Kwon T. Density of the alveolar and basal bones of the maxilla and the mandible. Am J Orthod Dentofacial Orthop 2008;133: 30-37.

5. Jaffin R, Berman C The excessive loss of Branemark fixtures in type IV bone: a 5-year analysis. J Periodontol 1991;62: 2-4.

6. Wakimoto M, Matsumura T, Ueno T, Mizukawa N, Yanagi Y, Dessel J,et al. Bone quality and quantity of the anterior maxillary trabecular bone in dental implant sites. Clin Oral Implants Res 2012;23: 1314-9.

7. Fugazzotto P, Wheeler S, Lindsay J. Success and failure rates of cylinder implants in type IV bone. J Periodontol 1993;64:1085-7.

8. Trisi P, Berardini M, Falco A, Podaliri Vulpiani M. New OD Implant Site Preparation Method to Increase Bone Density in Low-Density Bone: In Vivo Evaluation in Sheep. Implant Dent, 2016;25:24-31.

9. Lopez C, Alifarag A, Torroni A, Tovar N, Diaz-Siso J. OD for enhancement of spinal surgical hardware fixation. J Mech Behav Biomed Mater, 2017;69:275-81.

10. Lahens B, Neiva R, Tovar N, Alifarag A, Jimbo R, Bonfante E. Biomechanical and histologic basis of OD drilling for endosteal implant placement in low density bone. An experimental study in sheep. J Mech Behav Biomed Mater, 2016;63:56-65.

11. Kim S, Lee H, Choi Y, Heo S, Lee C, Kim K,et al. Effect of anodized oxidation or turned implants on bone healing after using conventional drilling or trabecular compaction technique: Histomorphometric analysis and RFA. Clin Oral Implants Res, 2006;17:644-50.

12. Marković A, Calasan D, Colić S, Stojčev-Stajčić L, Janjić B. Implant stability in posterior maxilla: bone-condensing versus bone-drilling: a clinical study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2011;112:557-63.

13. Buchter A, Kleinheinz J, Wiesmann H, Kersken J, Nienkemper M. Biological and biomechanical evaluation of bone remodelling and implant stability after using an osteotome technique. Clin Oral Implants Res, 2005;16:1-8.

14. Nkenke E, Lehner B, Fenner M, Roman FS, Thams U. Immediate versus delayed loading of dental implants in the maxillae of minipigs: follow-up of implant stability and implant failures. Int J Oral Maxillofac Implants, 2005;20:39-47.

15. Anitua E. Ridge expansion with motorized expander drills. Dental Dialogue 2004;2:3-13.

16. Jimbo R, Tovar N, Marin C, Teixeira H, Anchieta R, Kurihara H,et al. The impact of a modified cutting flute implants design on osseointegration. Int J Oral Maxillofac Surg. 2014;43(7):883-8.

17. Thoma D, Haas R, Tutak M, Garcia A, Schincaglia G. "Randomized controlled multicentre study comparing short dental implants (6 mm) versus longer dental implants (11–15 mm) in combination with sinus floor elevation procedures. Part 1: demographics and patient-reported outcomes at 1 year of loading," Journal of Clinical Periodontology. 2015 ;42(1):72–80.

18. Mangano C, Sinjari B, Shibli J. "A Human clinical, histological, histomorphometrical, and radiographical study on biphasic HA-Beta-TCP 30/70 in maxillary sinus augmentation," Clinical Implant Dentistry and Related Research.

19. Goiato M, Dos Santos D, Santiago J,Moreno A, "Longevity of dental implants in type IV bone: a systematic review," International Journal of Oral and Maxillofacial Surgery. 2014;43(9):1108–16.

20. Huwais S, Meyer E. OD: A novel approach in implant preparation to increase primary stability, bone mineral density and bone to implant contact. Int J Oral Maxillofac Implants. 2017;32(1):27-36.

21. Augustin G, Davila S, Mihoci K, Udiljak T, Vedrina D. Thermal osteonecrosis and bone drilling parameters revisited. Arch Orthop Trauma Surg 2008; 128:71–77.

22. Loh N, Tam S, Miyazawa S. A study of the effects of ball burnishing parameters on surface roughness using factorial design. J Mech Working Tech 1989;18:53–61

23. Ciarelli M, Goldstein S, Kuhn J, Cody D, Brown M. Evaluation of orthogonal mechanical properties and density of human trabecular bone from the major metaphyseal regions with materials testing and computed tomography. J Orthop Res 1991; 9:674–682.

24. Frost H. A brief review for orthopedic surgeons: Fatigue damage (microdamage) in bone (its determinants and clinical implication. J Orthop Sci 1998; 3:272–281.

25. Trisi P, De Benedittis S, Perfetti G, Berardi D. Primary stability, insertion torque and bone density of cylindric implant ad modum Branemark: Is there a relationship?An in vitro study. Clin Oral Implants Res. 2011;22:567-70.

26. Piatelli A, Ruggeri A, Franchi M, Romasco N, Trisi P. An histologic and histomorphometric study of bone reactions to unloaded and loaded non-submerged single implants in monkeys: a pilot study. J of Oral Implantology 1993;19(4):314-20 .

27. Hoshaw S, Brunski J,Cochran G. Mechanical loading of Branemark implants affects interfacial bone modelling and remodelling. Int J Oral Maxillofac Implants 1994;9:345-60.