# The Effect of Osseodensification Technique on Primary Stability of Dental Implants

**Original Article**

*Aya M. Aly[a], Moustafa Taha[a], Faisal A. Torad[b] and Heba Sleem[a]*

*[a]Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ain Shams University, [b]Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Ciaro University, Cairo, Egypt*

## ABSTRACT

**Purpose:** To evaluate the primary and secondary stability when using densah bur in comparison to conventional drilling technique.

**Methodology:** This experimental study was conducted on four dogs using split-mouth fashion so that each side will receive two implants with two different implant-site preparation techniques. In the study group, Densah Bur was used to osseodesify the osteotomy site where conventional cutting drills were used in the control group. The Peak Insertion Torque was used as an evaluation method of primary stability while the Resonance Frequency Analysis was used for both primary and secondary stability.

**Results:** In this study, we collected our measurements via two methods. First, regarding the Peak Insertion Torque, the primary stability was (41 ± 1.2) in the study group, while in the control group, it was (35 ± 1.3) which reveals that the primary stability of the Densah Bur group outweighs the control group with a *P*-value of (0.003).

Second, concerning the Resonance Frequency Analysis, the primary stability of the study group was (85 ± 2.2) while in the control group, the result was (75 ± 1.16) and the *P*-value of this test (0.0012). On the other hand, the secondary stability was measured by the same device and revealed (85 ± 3.5) of the study group while it shows (71 ± 3.17) in the control group with a *P*-value of (0.005).

**Conclusion:** From the resulted data, this study verified that the use of osseodensification technique would increase primary stability this could be attributed to the enhancement of bone quality and bone-implant contact by preserving the bulk of bone.

**Key Words:** Densah Bur, Dental Implant, Osseodensification, Primary Stability.

**Received:** 05 April 2020, **Accepted:** 20 June 2020.

**Corresponding Author:** Aya Ahmed, Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ain Shams University, Cairo, Egypt, **Tel.:** +20222639083, **Mobile:** +201223169770, **E-mail:** ayam.aly1991@gmail.com.

**ISSN:** 2090-097X, October 2019, Vol. 10, No. 4

## INTRODUCTION

Basically, the success of dental implant depends mainly on adequate achievement of primary stability which can be directly affected by both quality and quantity of the bone of osteotomy site[1]. Henceforth, this article will evaluate the effect of different drilling techniques on the primary stability[2].

Misch in 1988, has classified the types of bone based on macroscopic picture onto: **D1:** Compact cortical bone, **D2:** thick compact to porous cortical bone on the crest and coarse trabecular bone, **D3:** thin porous cortical bone on crest fine trabecular bone, **D4:** fine trabecular bone, **D5:** immature, non-mineralized bone[3]. Later on, several clinical trials have recognized succeeded dental implants in mandible rather than maxilla which can be ought to the higher quality of bone found in the compact bone[2, 4 - 5]. Moreover, poor quality and quantity of bone are the main risk factors for early implant failure. As bone resorption and impaired healing process may be the main cause[6 - 7].

During the last few decades, resonance frequency analysis and peak insertion torque have been considered as the ideal methods of evaluating the primary and secondary stability. By achieving more primary stability, more initial bone-to-implant contact percentage (BIC %) will be gained[8 - 9]. Ottoni et al reported that 20 % increase of survival rate of each implant with each 9.8 Ncm additional torque[10]. Thereafter, several studies have been proposed to evaluate the Osstell device as a method of measuring the resonance frequency analysis. These studies have correlated the resulted resonance frequency analytical values with the histomorphometric analysis of the bone implant contact percentage which can aid in monitoring the bone healing process without intervention[1].

On the other hand, the drilling technique has a crucial factor in achieving primary stability. The conventional technique, as an example, involves extraction of bone during drilling leading to decrease in the amount of left bone. Furthermore, on the microscopic level, those drills release micromotions due to cutting resistance generated

 *DOI: 10.21608/omx.2020.27194.1058*

from bone extraction which will negatively affect the osteotomy geometric shape[11].

Several tricks have been done to overcome the bone sacrificing during drilling. Under-sizing drilling technique has shown improvement in early stability of dental implants in terms of clinical and histological evaluation[5, 12]. However, this technique did not improve the bone volume around the implant neither the bone quality[13 - 14].

Recently, Osseodensification has been introduced as a new method of osteotomy site preparation for dental implant. It allows an extremely low plastic deformation of bone using densiyfing bur with minimal heat generation. In 2013, Huwis defined Osseodensification concept as a bone non-extraction technique, Osseodensification had a direct impact on increasing the values of peak insertion torques of the implants compared to cutting drilling which indicates enhancement of initial stability of implant fixture[15 - 16].

This study was aimed to evaluate the effect of osseodensification technique on primary stability in comparison to the conventional drilling technique.

## MATERIALS AND METHODS

The study was conducted on four mature dogs of comparable weight (10 to 15 Kg) with age range from nine months to one year. The dogs were kept in the animal house of faculty of veterinary medicine Cairo University for 6 months.

The grouping was done in a manner where control groups were assigned in the left side while the study group have been assigned in the right side. Among the whole study, two implants were placed in each side whether by conventional or osseodensifying technique.

Extraction of two mandibular premolar teeth bilaterally was performed in the operating room under IV general anesthesia using thiopental and ketamine in addition to subcutaneous 2 % local anesthesia. The surgical sites were left 3 months for complete soft and hard tissue healing (Figure 1).

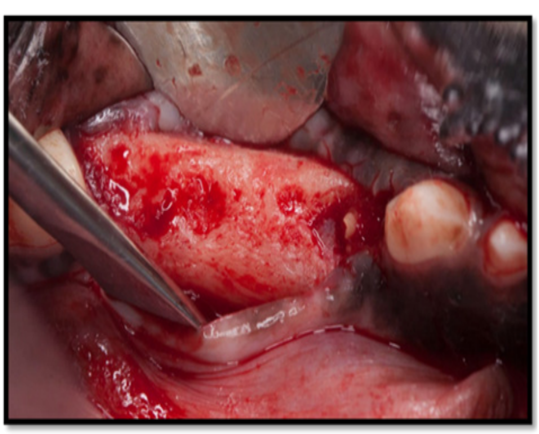

**Figure 1:** An occlusal view of mucoperiosteal flap elevation both buccally and lingually to expose the alveolar ridge.

In the control group (left side), there are 8 implants (3.5 diameter and 8.5 length) were applied successfully, two implants in each dog, by using NEOBIOTECH implant system. The osteotomy sites were prepared by following manufacture instructions (Figure 2).

**Figure 2:** A photograph shows cutting drill insertion to create a primary osteotomy site.

While in the study group (right side), there are 8 implants (3.5 diameter and 8.5 length) were inserted successfully except in the sample no. D the eighth implant was failed, two implants in each dog, by using DENSAH BURS. The osteotomy sites were prepared by following manufacture instructions. The used drills sizes were 2.0, 2.3, 2.5, 3.0, 3.3, 3.5 in order and the drilling was in anti-clock wise direction (Figure 3).

Three months after implant placement, secondary implant stability measurements were taken by (RFA) method.

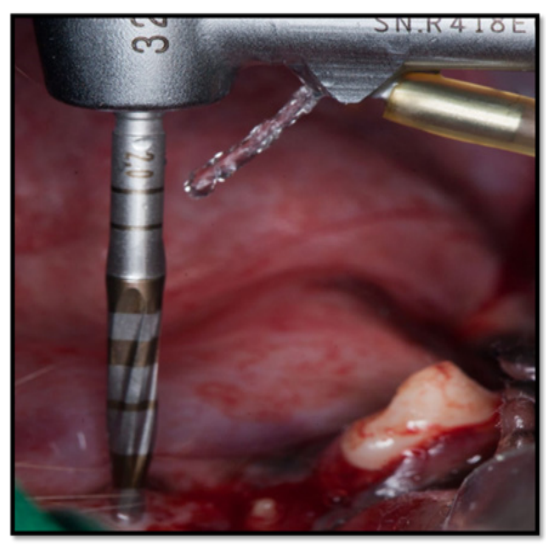

**Figure 3:** A photograph reveals the drilling of an osteotomy site using Densah bur via anti-clock wise technique under copious irrigation.

## METHODS OF EVALUATION

Insertion torque is the measure of the frictional resistance encountered by the implant while moving forward apically through a rotatory movement on its axis (Figure 4).

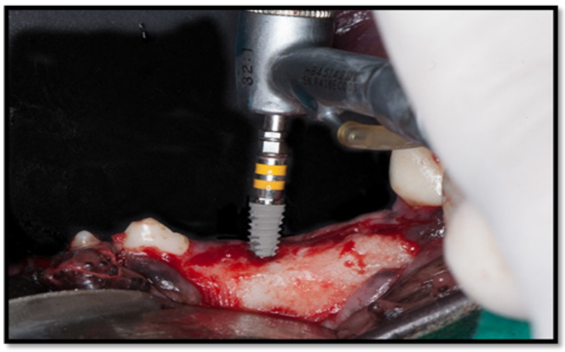

**Figure 4:** Implant insertion using contra angle hand piece which aid in measuring the insertion torque digitally.

Implant insertion torque value (N/cm) recorded during implant placement by using a surgical motor with torque control and an integrated RFA module (Implantmed, W&H,). The Osstell® ISQ was used to measure the implant stability quotient, at the following intervals: immediate postoperatively and 3 months postoperatively (Figure 5).


**Figure 5:** Photograph of the screen of W&H Surgical motor showing the insertion torque measurement from initial insertion to full insertion with peak insertion torque.

## RESULTS

A total of four dogs were included in this study and were numbered as sample A, B, C and D. Each dog jaw was splited so that it includes two implants on each side that had been placed with different implant site preparation methods under general anesthesia. All dogs were closely underwent follow up for six months form extraction day. Two methods have been selected to assess implant stability:

### *Resonance frequency analysis*

#### *Effect of different groups tested at primary assessment*

The primary stability in the study group has a mean value of ISQ 85 ± 2.2 while in control group the mean value of ISQ 75 ± 1.16 with a *P*-value of 0.0012 (Figure 6).

The difference between 2 groups was shown to be statistically significant.

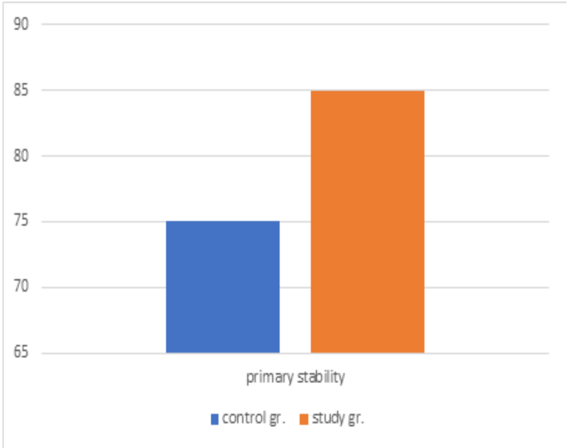


**Figure 6:** Bar chart showing the mean ISQ for different tested groups for primary assessment.

#### *Effect of different groups tested at Secondary assessment*

The secondary stability in the study group has a mean value of ISQ 84 ± 3.5 while in control group the mean value of ISQ 71 ± 3.17 with a P-value of 0.005 (Figure 7).

The difference between 2 groups was shown to be statistically significant.

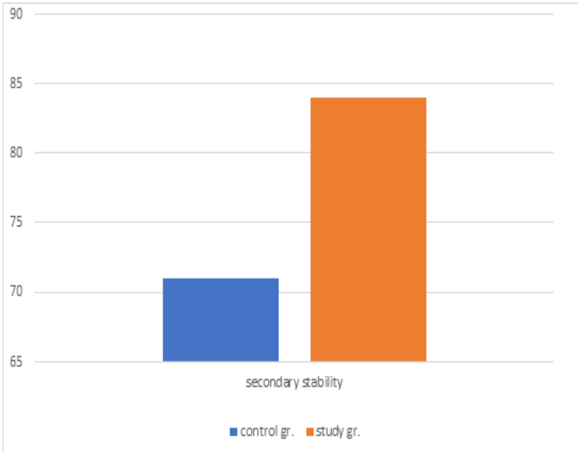


**Figure 7:** Bar chart showing the mean ISQ for different tested groups for Secondary assessment.

### *Peak Insertion Torque (PIT)*

The primary stability in the study group has a mean value of (41 ± 1.2) while in control group the mean value of (35 ± 1.3) with a *P*-value of 0.003 (Figure 8).

The difference between 2 groups found to be statistically significant.

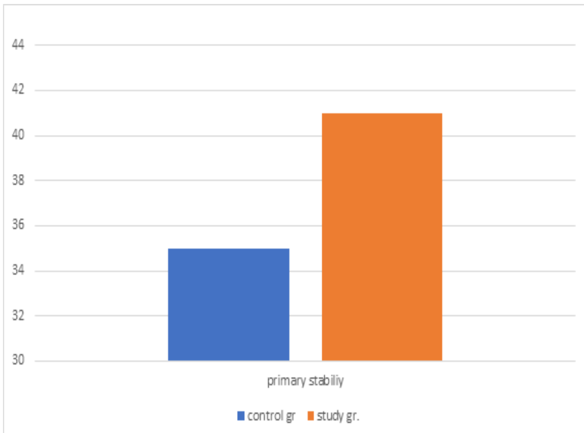


**Figure 8:** Bar chart showing the mean PIT for different tested groups for primary assessment.

## DISCUSSION

This study was designed to compare between the effect of both osseodensification and conventional drilling techniques on the primary and secondary stability of the implants using peak insertion torque and resonance frequency analysis as methods of assessment.

Primary stability depends mainly on increase the frictional surface between implant fixture and bone of osteotomy site by enhancing the quality of bone in addition to increase bone volume percentage (BV %). Therefore, increasing of primary stability is usually followed by acceleration of the osseointegration process[17, 6 and 7].

A split mouth design on dogs was chosen for this study which allowed a non-biased comparison between the types of drills within each sample providing a similar healing potential with similar immunological and microbiological conditions[18 - 19].

We insisted to use dogs rather than any other animal because of many advantages including bone size, body weight, and bone quality when compared to humans. Moreover, they are similar to human beings in terms of formation of secondary osteons, epiphyseal fusion after maturity, comparable intra-cortical remodeling activity and age-associated bone loss[20 - 22].

Primary stability plays a crucial role in establishment of a reliable, long-term osseous anchorage of an implanted device. This is why we focused on evaluating the primary stability by two different methods of assessment and compare them with each other and we have reached a conclusion that the osseodensification, as a drilling technique, is reliable and can guarantee higher primary stability that the conventional drilling technique.

Regarding the results of resonance frequency analysis that has been obtained by osstell device, the osseodensifying drills recorded statistically significant difference in RFA than the extraction drills which indicates that the osseodensification technique has a direct effect on primary stability. On the other hand, the RFA outcomes after three months showed statistically significant difference in the study group in comparison to the control group. These results recommended that osseodensifing drills enhance the osseointegration process where Huwais has concluded that the two techniques were similar to each other.

Regarding the peak insertion torque values, the results revealed quite agreement with Lahens *et al* 2016[23] where osseodensification samples were found to be increased significantly in peak insertion torque when comparing with the results of control group.

Trisi *et al*, has conducted an in-vivo animal study, using the iliac crest of sheeps to insert twenty implant devices. Ten 3.8 mm × 10 mm implants were inserted in the left side using the standard drilling method (control group). Ten 5 mm × 10 mm implants were inserted in the right side (test group) using the densah burs. The outcome proved that no implant failures were observed after 2 months of healing, significant increase of ridge width and bone volume percentage (approximately 30 % higher) was detected in the test group in addition to significantly better removal torque values and micromotion under lateral forces (value of actual micromotion) were recorded for the test group in respect with the control group[24].

Huwais et al, performed an in-vivo animal study, three preparation techniques have been included in the study. There were standard drilling with rotary bur, extraction drilling with Densah® bur and osseodensification with Densah® bur rotating in reversed, noncutting direction (total sites = 72). The results concluded that bone mineral density increased around periphery and bottom of OD holes, bone particles autografted into walls and bottom creating smoother OD holes in addition to bone–implant contact (BIC) was increased to 3 times for OD versus SD[25].

A recent histologically-based study, done in 2018 by Slete et al, using standard drills, summers osteotomies and osseodensification. This study has reached a conclusion that the resulted bone implant contact percentages from each technique were 16 - 17 %, 40 - 42 % and 60 - 62 % respectively. Moreover, the bone volume percentage surrounding implant fixture reported its highest value with OD technique. Hence, osteotomy preparation can influence both BIC and percentage of bone around the implant[26].

## CONCLUSION

Having manifested the previous results in terms of Primary and secondary stability outcomes, we have reached a conclusion that by utilizing the osseodesification as a method for osteotomy site preparation would improve the quality of bone and subsequent enhancement of initial stability at time of placement.

On the contrary, the cutting drills would extract bone alongside the osteotomy walls which subsequently will lead to decrease quantity of bone with no positive change in the quality of bone.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## REFERENCES


1. Rasmusson L, Meredith N, Cho I-H, Sennerby L. The influence of simultaneous versus delayed placement on the stability of titanium implants in onlay bone grafts: a histologic and biomechanic study in the rabbit. International journal of oral and maxillofacial surgery. 1999; 28 (3): 224 - 31.

2. Javed F, Ahmed HB, Crespi R, Romanos GE. Role of primary stability for successful osseointegration of dental implants: Factors of influence and evaluation. Interventional Medicine and Applied Science. 2013; 5 (4): 162 - 7.

3. Misch CE. Contemporary implant dentistry. Implant Dentistry. 1999; 8 (1): 90.

4. Jacobs R. Preoperative radiologic planning of implant surgery in compromised patients. Periodontology 2000. 2003; 33 (1): 12 - 25.

5. Shalabi MM, Wolke JG, De Ruijter AJ, Jansen JA. A mechanical evaluation of implants placed with different surgical techniques into the trabecular bone of goats. Journal of Oral Implantology. 2007; 33 (2): 51 - 8.

6. Jaffin RA, Berman CL. The excessive loss of Branemark fixtures in type IV bone: a 5-year analysis. Journal of periodontology. 1991; 62 (1): 2 - 4.

7. Herrmann I, Lekholm U, Holm S, Kultje C. Evaluation of patient and implant characteristics as potential prognostic factors for oral implant failures. International Journal of Oral and Maxillofacial Implants. 2005; 20 (2).

8. Trisi P, Perfetti G, Baldoni E, Berardi D, Colagiovanni M, Scogna G. Implant micromotion is related to peak insertion torque and bone density. Clinical oral implants research. 2009; 20 (5): 467 - 71.

9. Capparé P, Vinci R, Di Stefano DA, Traini T, Pantaleo G, Gherlone EF, *et al.* Correlation between initial BIC and the insertion torque/ depth integral recorded with an instantaneous torque-measuring implant motor: an in vivo study. Clinical implant dentistry and related research. 2015; 17: e613 - e20.

10. Ottoni JMP, Oliveira ZFL, Mansini R, Cabral AM. Correlation between placement torque and survival of single-tooth implants. International Journal of Oral and Maxillofacial Implants. 2005; 20 (5).

11. Wiggins K, Malkin S. Drilling of bone. Journal of biomechanics. 1976; 9 (9): 553 - 9.

12. Shalabi MM, Wolke JG, De Ruijter AJ, Jansen JA. Histological evaluation of oral implants inserted with different surgical techniques into the trabecular bone of goats. Clinical oral implants research. 2007; 18 (4): 489 - 95.

13. Tabassum A, Meijer GJ, Walboomers XF, Jansen JA. Evaluation of primary and secondary stability of titanium implants using different surgical techniques. Clinical oral implants research. 2014; 25 (4): 487 - 92.

14. Campos FE, Gomes JB, Marin C, Teixeira HS, Suzuki M, Witek L, et al. Effect of drilling dimension on implant placement torque and early osseointegration stages: an experimental study in dogs. Journal of Oral and Maxillofacial Surgery. 2012; 70 (1): e43 - e50.

15. Huwais S. Fluted osteotome and surgical method for use. US2013 / 0004918. US Patent Application. 2013; 3.

16. Huwais S. Enhancing implant stability with osseodensificationdA case report with 2-year follow-up. Implant Practice. 2015; 8: 28 - 34.

17. Romanos GE. Bone quality and the immediate loading of implants—critical aspects based on literature, research, and clinical experience. Implant dentistry. 2009; 18 (3): 203 - 9.

18. Romanos GE, Aydin E, Locher K, Nentwig GH. Immediate vs. delayed loading in the posterior

mandible: a split-mouth study with up to 15 years of follow-up. Clinical oral implants research. 2016; 27 (2): e74 - e9.

19. Cannizzaro G, Leone M, Ferri V, Viola P, Gelpi F, Esposito M. Immediate loading of single implants inserted flapless with medium or high insertion torque: a 6-month follow-up of a split-mouth randomised controlled trial. Eur J Oral Implantol. 2012; 5 (4): 333 - 42.

20. Sommer NG, Hahn D, Okutan B, Marek R, Weinberg A-M. Animal Models in Orthopedic Research: The Proper Animal Model to Answer Fundamental Questions on Bone Healing Depending on Pathology and Implant Material. Animal Models in Medicine and Biology: IntechOpen; 2019.

21. Pearce A, Richards R, Milz S, Schneider E, Pearce S. Animal models for implant biomaterial research in bone: a review. Eur Cell Mater. 2007; 13 (1): 1 - 10.

22. Wancket L. Animal models for evaluation of bone implants and devices: comparative bone structure and common model uses. Veterinary pathology. 2015; 52 (5): 842 - 50.

23. Lahens B, Neiva R, Tovar N, Alifarag AM, Jimbo R, Bonfante EA, et al. Biomechanical and histologic basis of osseodensification drilling for endosteal implant placement in low density bone. An experimental study in sheep. journal of the mechanical behavior of biomedical materials. 2016; 63: 56 - 65.

24. Trisi P, Berardini M, Falco A, Vulpiani MP. New osseodensification implant site preparation method to increase bone density in low-density bone: In vivo evaluation in sheep. Implant dentistry. 2016; 25 (1): 24.

25. Huwais S, Meyer EG. A Novel Osseous Densification Approach in Implant Osteotomy Preparation to Increase Biomechanical Primary Stability, Bone Mineral Density, and Bone-to-Implant Contact. International Journal of Oral and Maxillofacial Implants. 2017; 32 (1).

26. Slete FB, Olin P, Prasad H. Histomorphometric comparison of 3 osteotomy techniques. Implant dentistry. 2018; 27 (4): 424 - 8.