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COMPARATIVE EVALUATION OF OSSEODENSIFICATION VS. TRADITIONAL TECHNIQUE FOR DENTAL IMPLANTS PLACEMENT IN POSTERIOR MAXILLA USING RESONANCE FREQUENCY ANALYSIS AND BONE DENSITY MEASUREMENT

Ahmed Samir Bahgat Saleh [1*], Ayman Fahim Hegab [2], Samy Saeed El Naas [3]

ABSTRACT

Objectives: posterior maxillary region exhibits low bone density that affects implant stability placed using conventional drilling protocol. The present study aimed to assess implant stability and bone density of densah bur osseodensification drilling in maxillary posterior region.. **Subjects and Methods:** sixteen implants were inserted for 8 patients aged between 32 and 45 years old with posterior maxillary single or multiple missing teeth. Implants were randomly divided into two equal groups: **Group (I) (n=8):** implant bed was prepared using densah burs, and **group (II) (n=8):** implant bed was prepared using conventional drills. The patients were evaluated clinically and radiographically preoperatively, immediately post-implantation and 6 months postoperatively. Clinical evaluation using Resonance frequency analysis (RFA) for implant stability. Radiographic evaluation was achieved by CBCT to measure bone density. **Results:** for implant stability, there was a statistically significant difference between both groups in primary and secondary stability. For bone density, there was a statistically significant difference between both groups in all intervals. **Conclusions:** using osseodensification protocol by densah burs improves osteotomy preparation in maxillary alveolar bone with low density, densah burs show higher primary implant stability values and improves bone density around dental implants.

KEYWORDS: Osseodensification, densah durs, implant stability, RFA

INTRODUCTION

Nowadays, osseointegrated dental implants have become the gold standard therapy to restore missing teeth. Osseointegration (OI) is an ankylotic relationship between two interfaces, respectively, the surface of implant and the surrounding bone. The success of dental implant healing is influenced by its primary stability [(1)].

Establishing good primary stability is necessary for bone formation, osseointegration, and increased bone-implant contact, which in turn affects the secondary stability of the implant [(2)]. the most important factor that determines the stability of a dental implant is the quality and quantity of the surrounding bone tissue[(3)].

1. Masters Candidate, Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine (boys, Cairo)
2. Professor and head of Oral and Maxillofacial Surgery department, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University.
3. Lecturer of Oral and Maxillofacial Surgery department, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University.

• ***Corresponding author*:** ahmedsamie1993@gmail.com

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Dental implants inserted at the posterior maxillary region have lower success rates due to poor bone quality (type IV)[4] in the area, resulting in low primary implant stability and less favorable outcomes [5].

Many surgical protocols have been advanced to improve the primary stability of an implant placed in low-density bone, These include the use of osteotomes for bone condensation, undersized implant bed preparation, and bi-cortical fixation[6].

A promising protocol, called osseodensification (OD), has been developed that creates a condensed autograft bone layer at the periphery of the implant bed with the aid of specially designed burs rotating in a clockwise and anti-clockwise direction [7].

Conventional drills excavate bone during implant site preparation, while osteotomes may cause trabeculae micro-fractures that prolong remodeling time and delay secondary implant stability [8].

In contrary to conventional drills, OD is a non-extraction protocol with burs specially designed to increase bone density by expanding the osteotomy. These burs incorporate the benefits of osteotomes with the speed, tactile sensation, and precision of drilling procedures [9].

In OD protocol the bone can be preserved and condensed through compaction autografting during osteotomy preparation, which increases bone volume percentage (%BV), peri-implant bone density, and implant mechanical stability [10].

Despite the fact that many studies conducted on animal models have demonstrated a favorable outcome of OD over conventional drilling protocols, its clinical effect on stability and bone density around implants installed in low-density bone is not clear[11–15]. The present study was conducted to evaluate the validity of using OD to enhance implant stability in posterior maxilla.

SUBJECTS AND METHODS

I. Ethical consideration:

The study was approved by the ethical committee at the Faculty of Dental Medicine (Boys - Cairo)Al-Azhar University with ethical code 693 / 1584. All patients were informed about the aim and protocol of the study and signed the Al-Azhar University informed consent form, which contained all information about the surgical procedure and post-operative follow-up.

II. Study design:

It is a randomized controlled clinical study.

III. Sample size calculation:

To study the influence of densah burs on implant primary stability and peri-implant bone density, independent t-tests were used for comparison. According to a previous study by Kothayer (2020[16], a total sample size of 16 implants (8 in each group) was sufficient to detect: an effect size of 1.1, and a statistical power (1-β error) of 0.8, using a two-sided hypothesis test. Significance level (α error) 0.05 for data.

IV. Study setting and population:

The study included 8 patients (3 males and 5 females) aged between 32 and 45 years. Patients were selected from the Outpatient Clinic of the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Boys, Cairo, Al-Azhar University. All patients satisfied the eligibility criteria.

V. Eligibility criteria.

Inclusion criteria:

Single or multiple missing teeth in the maxillary posterior region. The patient's age is ≥18 to 45 years old including both genders.

Exclusion criteria:

Any signs of infection or pathological condition at theproposed implant site, any local limitation that

interferes with implant placement like inadequate inter- ridge distance or insufficient vertical height that needs sinus lift procedure, any drug that could compromise the healing of bone like long-term corticosteroids, hormone replacement or Bisphosphonates, history of any uncontrolled systemic disease which could affect implant surgery or healing. Current radiation therapy or less than 6 months after radiation therapy affecting the orofacial zone, heavy Smokers, and inability or unwillingness to return for follow-up visits

VI. Patient grouping:

All patients were randomly divided into two groups:

Group (I) study group: the implant bed was prepared using densah burs

Group (II) control group: the implant bed was prepared using conventional drills.

VII. Preoperative evaluation:

Clinical evaluation: of the patient including medical and dental history and a complete intra-oral and extra-oral examination were carried out for each patient.

Radiographic evaluation

- ***Preoperative panoramic radiographic view:***

For screening of patients before inclusion in the study, presence of any pathological lesion, proximity of ridge crest to the maxillary sinus floor, estimate the available bone height for proper selection of implant length, and the divergence of the root adjacent to the operative area for proper implant angulation.

- Cone beam computed tomography (CBCT) (kodak 9500, Carestream Health, Inc. USA) using (**Blue Sky Plan 4 software**) for evaluating Bone density. by Hounsfield units (HU), alveolar bone dimensions, and dimensions of the implant to be installed.

VIII. Surgical intervention

Before the surgery, the patients were asked to rinse with Hexitol (Chlorhexidine 0.12% mouthwash) for about 1 minute, this was followed by circumoral scrubbing by gauze soaked in Betadine (Povidone-Iodine solution) and draping with sterile surgical drapes.

Local anesthesia -Articaine (4%) with Epinephrine (1:100,000)- was used for all procedures using local infiltration into buccal and palatal mucosa of the planned surgical field. After achievement of profound anesthesia, a mucoperiosteal flap was designed, incised, and elevated, the osteotomy sites were prepared differently according to each group;

Group (I) study group

Using densah burs based on the implant length selected for the site, pilot drills of densah bur (1.7 mm) were inserted to the desired depth (drill speed 800 rpm with copious irrigation in clockwise direction). Based on the implant diameter selected for the site, preparation continued in densification mode through the sequential stepped drilling with the densah burs (drilling speed 800 rpm with copious irrigation in a counter-clockwise direction) to the appropriate length and diameter planned from CBCT. **(Figure 1)**

Group (II) control group

Using conventional drills, based on the selected implant length and diameter for the site of implantation, preparation proceeded in bone extraction -cutting- mode through sequential stepped clockwise drilling speed of 800 rpm with copious irrigation according to the manufacturer's recommendations.

The implant was installed for both groups into the osteotomy site with 1 mm sub-crestal level.

IX. Implant primary stability measurement:

Immediately after the insertion of the dental implant, a metal rod was attached to the implant

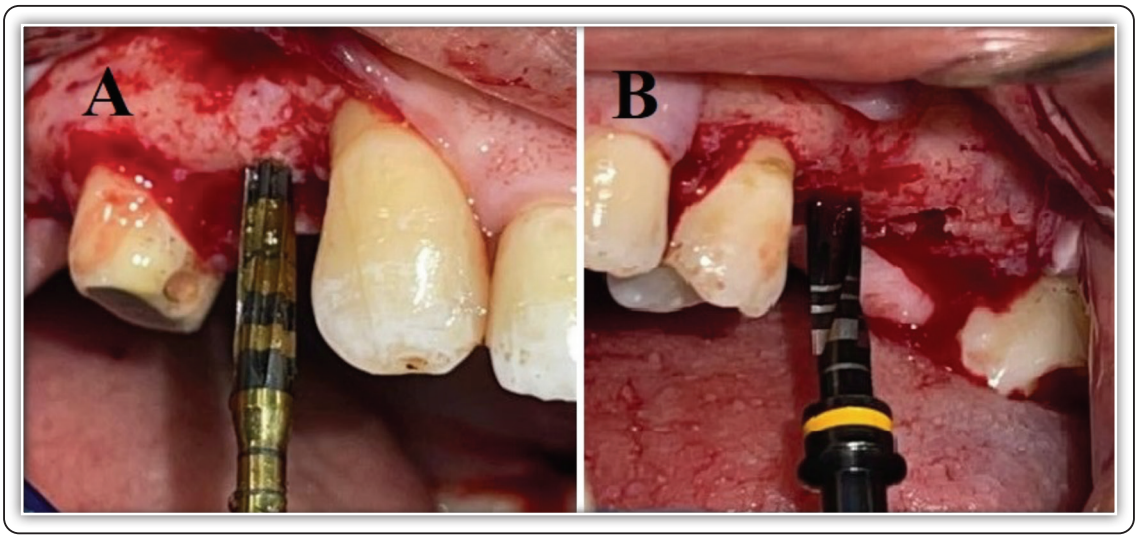

FIG (1) Clinical photograph for drills A) densah bur, B) conventional drill

with a screw connection and Ostell® was conducted to measure baseline implant stability. The measurement was recorded as primary stability then a cover screw was screwed in after removing the metal rod. Surgical flap repositioning and sutured using 3/0 silk.

X. Postoperative care and medications:

Regular postoperative instructions were given to the patients, and postoperative medications were prescribed. The patients were instructed to attend for the follow-up 7-10 days postoperatively for suture removal and checkup.

XI. Postoperative assessment:

- ***Clinical evaluation:***

At 6 months postoperative during implant exposure and abutment fixation, implant stability using Ostell® was recorded. The implant stability was measured using Ostell® in the same manner described in the first surgery measurement. Implant stability was recorded as secondary stability. All patients were referred to the Department of Prosthodontics to complete their prostheses.

- ***Radiographic evaluation:***

All patients were examined radiographically preoperatively, immediately post-surgical, and six months after implant placement by CBCT for assessing postoperative bone density changes around dental implant (HU) using Blue Sky Plan 4 software.

XII. Statistical analysis:

Statistical analysis was performed using a commercially available software program Statistical Package for the Social Sciences (SPSS Chicago, IL, USA). Numerical data was described as mean and standard deviation or as median and range as appropriate according to the normality of the data. The level of significance will be set at $P < 0.05$.

RESULTS

The total number of patients in this study was 8 received 16 dental implants. The sample was divided into two groups; **group I** osteotomy prepared using densah burs including 8 implants (n = 8) and **group II** osteotomy prepared using conventional drills including 8 implants (n = 8). Neo-biotic implant system was used for all patients with a diameter ranging from 4 to 4.5 mm, while the length ranged from 10 to 11.5 mm.

During the course of the study, implant healing was uneventful. All 16 implants remained stable and showed no sign of pain, suppuration, or peri-implant infection throughout the study.

Implant stability:

Implant stability was measured immediately as primary stability and at 6 months postoperatively as secondary stability using RFA by Osstell device, as described in table (1).

For **group I,** the primary stability Mean ± SD value was (79.00±4.44) ISQ, and the secondary stability Mean ± SD was (82.13±3.40) ISQ with a statistically insignificant difference in RFA value between the two intervals.

For **group II,** the primary stability Mean ± SD value was (71.00±7.63) ISQ, and the secondary stability Mean ± SD value was (79.13±1.96) ISQ with a statistically significant difference in RFA value between the two intervals.

TABLE (1) Descriptive statistics of implant stability in each studied group in all evaluation intervals.

Implant Stability	Group 1	Group 2	"t"	Probability
	Mean±SD	Mean ± SD		
Primary	79.00 ±4.44	71.00±7.63	2.562	0.011*
Secondary	82.13 ±3.40	79.13±1.96	2.163	0.024*
"t"	1.642	3.091		
Probability	0.072 NS	0.009*		

In comparing both groups, there was a statistically significant difference in primary and secondary implant stability.

Bone density:

Bone density was evaluated for patients of both groups preoperatively, immediately post-surgical, and six months after implant placement, as described in table (2).

Regarding **group I,** the Mean ± SD values of pre-operative, immediate postoperative, and 6 months postoperative bone density were (246.50 ± 55.53), (430.53 ± 81.84) and (457.88 ± 51.30) respectively. There was a statistically significant difference in peri-implant bone density between preoperative and immediate postoperative intervals. But, between immediate postoperative and 6 months postoperative intervals the statistical difference was insignificant.

Regarding **group II,** the Mean ± SD values of pre-operative, immediate postoperative and 6 months postoperative bone density were (287.31±29.65), (341.00±41.17) and (396.94±32.88) respectively. There were statistically significant differences in peri-implant bone density in all intervals.

In comparing both groups, there was a statistically significant difference between both groups in all intervals except preoperatively where the difference was statistically insignificant.

TABLE (2) Descriptive statistics of bone density in each studied group in all evaluation intervals

Bone Density	Group 1	Group 2	"t"	Probability
	Mean ± SD	Mean ± SD		
Preoperative	246.50±55A	287.31±29.6 A	1.83	0.089 NS
Immediate post-operative	430.53±.84 BC	341.00±41.2 B	2.76	0.008*
Preop-Imm	p =0.001*	p = 0.015*		
6 Months postoperative	457.88±51.3C	396.94±32.8 C	2.832	0.007*
Imm-6 Month	p = 0.667 NS	p = 0.011*		
F	25.551	19.733		
Probability	0.00000	0.00000		

DISCUSSION

Choosing a convenient surgical technique for implant placement is crucial. Traditional osteotomy preparation is known as a subtractive approach that involves cutting and removing bone tissue from the implant site[1]. On the other hand, the OD drilling technique developed by Huwias[17] allows for the expansion of the drilling site. This is accomplished by using a specially designed drill with several negative rake angles, which act as non-cutting edges, and four or more lands that compact the bone smoothly along the osteotomy when operating in a CCW direction[18].

In the current study, two independent and different surgical techniques were performed and compared. sixteen implant fixtures were inserted in (8 patients) divided equally into two groups. In group I (densah)-implant site prepared by densah burs - the male patients were 4 (50%) and female patients were 4 (50%) and in group II (conventional)-implant site prepared by conventional drills the male patients were 3(37%) and female patients were 5 (63%). However, there were no statistically significant effects of sex on the obtained results in both groups.

The age of all patients enrolled in the study ranged between 32 – 45 years. The age ranged between 32– 45 with a mean age of 39.88 ± 4.61 years for group I (densah) and between 34 – 45 years with a mean age of 40.25 ± 4.68 years for group II (conventional), however, there were no statistically significant effects of age on the obtained results in both groups.

The outcome analysis of the present clinical study assessed the patients clinically in terms of implant stability and radiographically in terms of bone density. The primary and secondary (6-month post-operative) implant stability was assessed using the RFA technique. The RFA technique was developed by Meredith in 1996 [19] via the Osstell ISQ system.

The present study found that using densah bur drilling resulted in significantly higher primary implant stability compared to the conventional drilling technique. This improvement is thought to occur because the densah bur technique preserves bone in two ways: first, by compacting cancellous bone through plastic deformation, and second, by autografting bone particles at the apex and length of the osteotomy.

The findings of the current study align with the research conducted by Barberá-Millán et al.[20] which concluded that the osteotome technique (OD) enhances the primary stability (PS) of dental implants in low-density bones. This conclusion was drawn based on implant insertion torque and RFA measurements, in comparison to the implants inserted using the under-drilling (UD) technique.

In the other hand study performed by Atef et al.[21] comparing densah and conventional drills stated that regarding primary stability there was no statistically significant difference between the two groups regarding PS

In the current study concerning 6-month postoperative implant stability, each group showed a remarkable increase in ISQ values that were measured at immediate post-operative. However, there were no significant differences in values between both studied groups.

An increase in ISQ values for SS is considered an indication that the OI process is gradually being gained at the implant-bone interface.

SS is affected by the quality and quantity of bone at the bone-implant interface. OD leads to increased bone at the implant surface by increasing bone mineral density in the peri-implant area. This explained why the SS of implants placed by densah bur drilling was slightly higher than conventional drilling.

This is in accordance with Ibrahim et.al.[22] who found a significant increase in PS of the

OD technique in comparison to the conventional technique. Also, SS at 4 months post-implant placement had significant improvement for the side prepared with the OD group.

Bone density is an important factor that reflects the bone quality and affects the initial stability and survival rate of the implants. CT technology has become an essential tool in oral implantology as it is the most widely used method for assessing bone quantity and quality during dental implant planning[23]. A study designed by Razi et al.[24], showed a strong correlation between HU in CT scans and the voxel grayscale in CBCT and suggested that the voxel value in CBCT can be used for the estimation of bone density.

The posterior maxillary region was chosen as the study area in this study because all patients there had low bone density values in this region, which ranged from 151 to 318 HU. There was no discernible difference in the preoperative CBCT bone density values between the two groups. These results were consistent with a previous study by Sogo et al. [25] that found that the majority of the posterior maxilla's bone fell into either D4 (150-350 HU) or D3 (350-850 HU) categories based on Misch's classification.

In the current study immediate postoperative CBCT, there was a significant increase in the bone density values in the densah group (430.53 ± 81.84) compared to the conventional group (341.00 ± 41.17) These results were in agreement with a study by Slete Frederic B [8] which compare the histomorphometric structure of osteotomy preparation through conventional extraction drilling (CD), Summers osteotomes (SO), and OD. and It stipulated that the trabecular bone around the implant appeared denser and more consistent in distribution through OD preparation compared to other methods. This was evident both laterally and apically to the implant body. The OD method also produced fine bony autogenous graft particles throughout the compacted trabeculae.

In the current study, it was found that 6 months after the surgery, the densah group showed a significant increase in bone density values (457.88±51) compared to the conventional group (396.94±32.88). These findings are consistent with a split-mouth study conducted by Aloorker S, et al. [26] in the posterior maxilla which concluded that **"**The bone density adjacent to the implant significantly increases after ossedensification, and the density remains relatively high for 6 months, facilitating primary stability and eventual optimal integration.".

CONCLUSIONS

Within the limitations of the present study, it could be concluded that:

Osseodensifiction is considered to be a valid technique for dental implantation in the posterior maxilla. Densah burs show a remarkable positive effect on preserving alveolar bone surrounding the implant bed which in turn gives rise to higher primary stability values and improves bone density around dental implants.

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