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EVALUATION OF IMPLANT'S PRIMARY STABILITY USING DENSAH BUR VERSUS EXPANDER IN PATIENTS WITH MISSING MAXILLARY PREMOLAR (A RANDOMIZED CLINICAL TRIAL)

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ABSTRACT

Aim: This study aimed to evaluate implant primary stability using Densah bur in comparison with expanders in maxillary premolar area.

Material and methods: This study was conducted on twenty patients. The patients were divided into two equal groups. Each patient received one implant at the edentulous site of missing first or second maxillary premolar. One group received implants after using Densah bur, while the other group received implants after using screw expander. After implant placement, Smart peg was placed on implant and Ostell was used to record ISQ. Implant stability was measured intraoperative and at weeks 2, 4, 6, and 8 for both groups. The collected results were tabulated and statistically analyzed.

Results: The study results showed there was no statistically significant difference between (Expander) and (Densah bur) groups in ISQ reading except at surgery and week two where the highest mean value was found in (Expander) group, while the least mean value was found in (Densah bur) group.

Conclusion: Within the limitation of this study, Densah bur enabled successful implant insertion with acceptable primary stability in the resorbed maxillary premolar area. Moreover, the Densah bur can be used in a faster manner.

KEYWORDS: Atrophic maxilla, Maxillary Premolar, Expansion, Densah bur, Implant stabilit

INTRODUCTION

The proved success of dental implants made them the treatment of choice for replacing tooth loss in its different forms. However, successful dental implant placement requires sufficient bone to be available in three dimensions so that sufficient primary stability is achieved; for long lasting success of the implant, bone thickness covering the implant should be at least 1 - 1.5 mm on buccal and

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palatal sides. This is not very often found, as bone resorption after extraction can reach approximately 50% of the original bone width in under a year.[1,2]

Different procedures have been developed to solve severe bone resorption. These include guided bone regeneration (GBR) as sausage, box, and shell techniques, autogenous inlays and on-lay blocks with/without xenograft particulates, ridge splitting, and distraction osteogenesis. These techniques require the use of bone grafts, membranes, titanium meshes, and screws that increase the cost, even with the use of autogenous bone and blood derivatives. Moreover, they usually require a healing period (6-9 month) before a second surgery for implant placement is done. Complications as dehiscence, infection, donor site morbidity, or even graft failure or rejection are not rare.[3]

More conservative techniques were introduced which involve the use of osteotomes and chisels to expand the atrophied ridge and condense the bone to enhance its density. However, they require the exertion of some force especially in sites with dense cortical bone for which the amount and direction are not fully controllable, thus increases patient's stress and risk of minor head trauma.

As an attempt for non-traumatic bone augmentation screw expanders and thread formers were introduced to allow gradual horizontal expansion of the cortical bone and condensation of the cancellous bone thus increasing stability. This treatment option is reliable, conservative, and economic in time and cost.[4]

Recently, the use of motorized high speed rotary expanders has been presented as an alternative method of expansion and bone conditioning; in a process called Osseodensification.

Osseodensification is a non-excavating implant site preparation technique. It creates dense layer of bone through compaction autografting while expanding the bone at the same time along the entire length of the osteotomy. Maintaining and preserving bone during osteotomy preparation while consistently densifying the osteotomy leads to increased bone to implant contact, and increased primary stability; which is directly related to surrounding bone quality and quantity, which then enhances implant secondary stability, and accelerates healing.

MATERIALS AND METHODS

The study is a randomized clinical trial, parallel design with allocation ratio 1:1. According to sample size calculation, twenty patients who are partially edentulous in the maxillary premolar area were required. The patients were selected from Outpatient Clinic, Faculty of Dentistry, Cairo University according to inclusion and exclusion criteria to assess their eligibility for the study.

All patients included in this study Patients had crestal bone thickness ranging from 4 to 6 mm, The patients were medically free and had no systemic illness or under any medication that could interfere with normal bone healing. Any patients presented with bone pathosis, poor oral hygiene, or active periodontal diseases were excluded.

Intervention

Diagnostic and examination:

A Panoramic x-ray was taken for initial screening of bone and that it is free from any remaining roots or pathosis.

Primary impression were taken for both arches, followed by facebow record, to produce diagnostic casts and to mount them on an articulator; to evaluate space and the prosthetic position and angulation for the dental implant.

Cone-beam computed tomography (CBCT) was performed. Virtual planning using Blue Sky Bio software (Grayslake, Illinois, USA) involved placing a virtual tooth and a virtual implant, and

measuring the height of bone available until the maxillary sinus, and the width of the bone being of a minimal thickness of 4 mm and mesio-distal space to adjacent teeth of enough space to receive an implant.

Surgical procedure:

All surgical procedures were performed under aseptic conditions. Patients received infiltration local anesthesia (Articaine 4% 1:100 000 epinephrine) at site of implant placement. After anesthesia was achieved, a mid-crestal incision was made using No. 15c blade. A mucoperiosteal elevator was used to reflect the buccal and palatal flaps that were enough to expose the crestal part of alveolar ridge with clear visibility and accessibility. A Lindemann drill of 2.3 mm diameter was used to reach the desired depth at Clockwise drill speed 1000rpm under copious irrigation with sterile saline.

For Expander group

The screw expanders* **Figure 1** were used to expand the osteotomy site. The diameters used were 2.6 mm, 3 mm, 3.4 mm, 3.8 mm in a successive manner. Each expander was screwed until 10 mm of depth was reached as marked on the expander. Each expanders was gently screwed half turn at a time; to allow slow and gradual expansion of the bone **Figure 2**. When necessary, the kit ratchet was used to reach the full depth required **Figure 3**. After the use of the final expander, an implant of 3.9*10mm** was placed with the ratchet driver at a torque ≥30 Ncm.

FOR DENSAH BUR GROUP

The Implant motor was set in an anti-clockwise direction and drilling speed was set at 1000 rpm. Densah Burs*** **Figure 4** were used in increasing diameters of 2.5 mm, 3.0 mm, and 3.5 mm in a

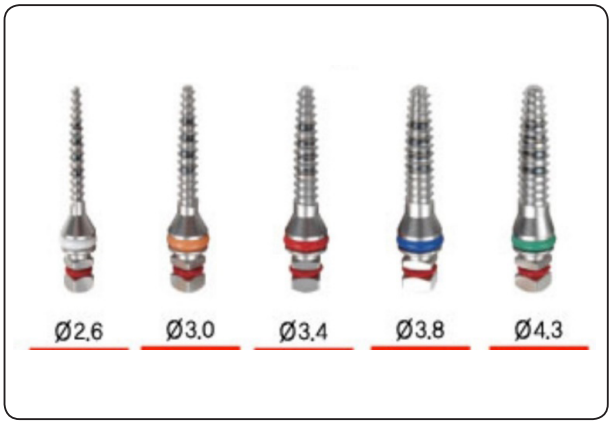

Fig. (1) Screw expanders

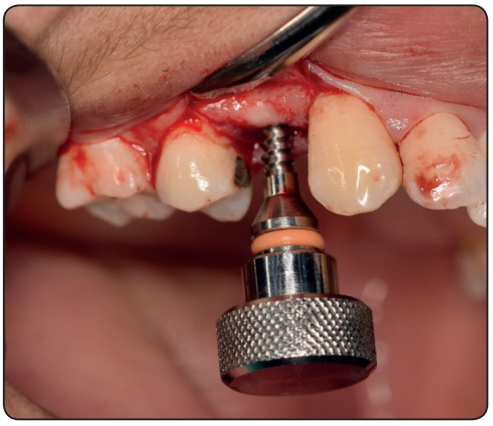

Fig. (2) Screw expanders

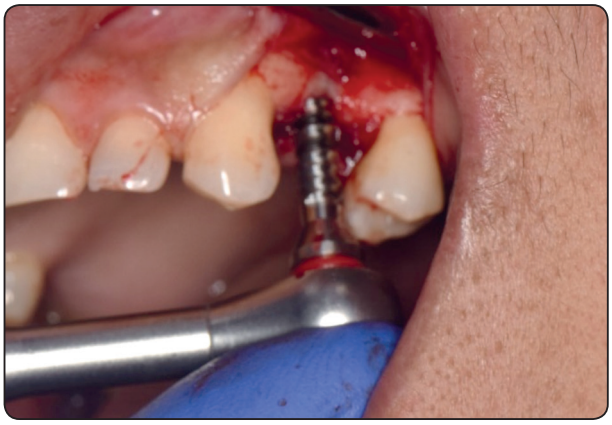

Fig. (3) Expander screwed with ratchet.

* MCT Bone Expander kit
** DENTIS Co. OneQ.
*** Versah LLC.

successive manner and under copious irrigation with sterile saline.

When the haptic feedback of the bur was encountered, pressure was modulated by a pumping motion in and out of the osteotomy until 10mm of depth was reached as marked on the bur **Figure 5**. After the use of the final expander, an implant of 3.9*10 mm^2 was placed with the ratchet driver at a torque ≥30 Ncm.

Fig. (4) Densah burs.

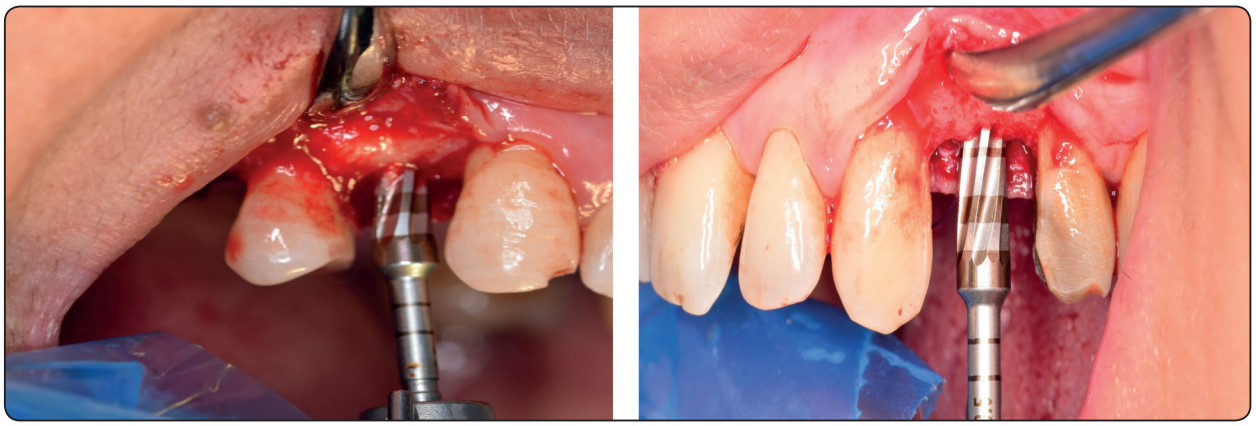

Fig. (5) Densah bur in osteotomy in different patients.

For both groups

After implant placement, the integrity of the buccal bone was examined for any cracks. The Smart peg* corresponding with the implant system was placed on the implant and Osstell** device was used to measure ISQ from buccal, lingual, mesial, and distal directions. For each side, three reading were taken and an average was calculated. A healing collar was placed on the implant, then the flap was approximated and sutured*** around healing collar**.**

Patients were instructed to take an antibiotic after surgery (Amoxicillin/Clavulanic acid 1gm) every 12 hours for a week and to start non-steriodal anti-inflammatory drug (NSAID) every 8 hours for 2-3 days; to control the possible post operative pain and edema. Antiseptic mouthwash was also continued 3 times daily for 14 days. The patients were informed with the next appointment date so that the sutures were to be removed after 1 week. The patient were scheduled for follow up visits every two weeks for a period of two months were ISQ measurements were recorded.

* Osstell Smartpeg Type 11, Art no. 100372.
** Osstell IDX.
*** AssuCryl PGA Synthetic absorbable.

RESULTS

Effect of time:

Densah bur group:

There was a statistically significant difference between (0weeks), (2weeks), (4weeks), (6weeks) and (8weeks) groups where ($p<0.001$).

A statistically significant difference between (8weeks) and each of (0weeks), (2weeks), (4weeks) and (6weeks) groups where ($p=0.001$), ($p<0.001$), ($p<0.001$) and ($p=0.021$).

Also, a statistically significant difference was found between (2weeks) and (6weeks) groups where ($p=0.001$).

No statistically significant difference was found between any other pair. The highest mean value was found in (8weeks) followed by (6weeks), (0weeks) and (4weeks) groups, while the least mean value was found in (2weeks) group.

Expander group:

There was a statistically significant difference between (0weeks), (2weeks), (4weeks), (6weeks) and (8weeks) groups where ($p=0.010$).

A statistically significant difference between (0weeks) and each of (2weeks), (4weeks), (6weeks) and (8weeks) groups where ($p<0.001$).

Also, a statistically significant difference was found between (2weeks) and each of (4weeks) and (8weeks) groups where ($p=0.035$) and ($p=0.001$).

A statistically significant difference was found between (4weeks) and each of (6weeks) and (8weeks) groups where ($p=0.013$) and ($p=0.001$).

A statistically significant difference was found between (6weeks) and (8weeks) groups where ($p<0.001$).

The highest mean value was found in (0weeks) followed by (8weeks), (2weeks) and (6weeks) groups, while the least mean value was found in (4weeks) group.

Effect of groups:

0 weeks: There was a statistically significant difference between (Densah bur) and (Expander) groups where ($p=0.001$).The highest mean value was found in (Expander), while the least mean value was found in (Densah bur).

2 weeks: There was a statistically significant difference between (Densah bur) and (Expander) groups where ($p=0.031$).The highest mean value was found in (Expander), while the least mean value was found in (Densah bur).

4 weeks: There was no statistically significant difference between (Densah bur) and (Expander) groups where ($p=0.353$). The highest mean value was found in (Densah bur), while the least mean value was found in (Expander).

6 weeks: There was no statistically significant difference between (Densah bur) and (Expander) groups where ($p=0.449$). The highest mean value was found in (Densah bur), while the least mean value was found in (Expander).

8 weeks: There was no statistically significant difference between (Densah bur) and (Expander) groups where ($p=0.842$).The highest mean value was found in (Densah bur), while the least mean value was found in (Expander).

DISCUSSION

Discussion of Methodology

This study was planned on the assumption that primary stability is crucial for predictable healing and osseointegration. Factors affecting osseointegration either systemically or locally were taken in consideration during patient selection, treatment planning, surgical procedure, and construction of the final restoration. The selected patients were with proper general appraisal and no medical history of debilitating diseases to avoid the adverse effect of systemic disorders on the healing process and osseointegration.[5,6]

General contraindications for implant surgery were applied during patient selection as metabolic, collagen disorders, hematological disorders, cardiac circulatory diseases, osseous metabolic disturbances, and patients under current medications as corticosteroids, immune suppressive drugs, and long antibiotic therapy that would affect osseointegration.[7]

Maintenance of good oral hygiene is very important for the healing process, prognosis, and results of the study. As such heavy smokers and patients with periodontal diseases were excluded.[8]

Patients with para-functional habits as clenching, bruxism or deep over-bite were excluded to avoid extra load and undesirable forces on the implants to avoid inaccuracy of the results.[9]

All patients had a CBCT performed for evaluating both residual alveolar ridge thickness and height. Patients with crestal bone width of less than 4 mm and bone height less than 11 mm were excluded.[10]

A minimum bone width of 4 mm was required, in which there had to be at least 1 mm of cortical bone both buccal and palatal, and at least 2 mm of cancellous bone. This was advocated to ensure proper soft tissue support, avoid resorption of the facial bone wall when blood supply is decreased, and minimize the risk for peri-implant soft tissue recessions. And to be able to use either the Densah bur or the expander while maintaining the integrity of the bone plate without cracks.[4,11]

A crestal incision and full flap reflection was necessary to visually assess the bone in case of cracks or fracture. Moreover it would provide better accessibility and irrigation to avoid bone overheating and lower cutting efficiency of drills.[12]

In the present study the expanders were used as they provide a non invasive alternative to guided bone regeneration to increase the ridge width for implant placement. It allows expansion of the narrow ridge with simultaneous implant placement at time of expansion. It provides gradual force in a controlled manner; as the expanders are tightened initially using finger pressure then a ratchet is used. There should be only half a turn at a time with a waiting time of about half a minute between each half turn to allow for bone expansion without stress.[4]

Despite that the use of expanders does not require bone grafting in most cases, fracture or crack of the buccal plate of bone may occur during expansion thus affecting implant stability.[13]

In the second group the Densah bur was used as it was proposed by its inventor Huwais that Osseodensification using Densah bur preserve, and condense bone through compaction autografting, he also claimed that it increased the insertion torque, bone-to-implant contact, and accordingly resulted in increased primary stability when compared to conventional drilling.[14] This hypothesis has been confirmed by the work of Lahens who reported a significantly higher bone-to-implant contact for Densah bur.[15] Additionally, it was shown that the use of Densah bur allows the insertion of wider implants diameters in narrow edentulous ridges, with consequent increase in bone volume to reach 30% of the original ridge dimensions.[16] Thus the Densah bur has the advantages of expanders combined with the high speed of standard drills and their tactile control. The drilling process using Densah burs can be either clockwise (CW) or counterclockwise (CCW) and is performed at high speeds 800-1500 rpm. The counterclockwise drilling direction is utilized in bone with low-density, while the clockwise drilling direction is better for high density bone. [17]

Since the implants to be placed in our study are in the maxillary premolar area; which is an area of soft low density bone, we resorted to a CCW direction for drilling with speed of 800-1500 rpm, as indicated by the protocols set by Huwais. Unlike the conventional drills, the Densah drills have tapered flutes with a negative rake angle. This angle design may cause overheating and lower cutting efficiency.[17] Thus in this study, extra care was made

by reflecting flap and use of copious irrigation to counteract overheating by providing access for external irrigation during osteotomy preparation. Also the drills used were sharp and not used with excessive drilling speed or pressure.[12]

The expansion process was attributed to the high speed rotation of the bur in a pumping motion, while irrigation fluid is present in the osteotomy; thus creating a hydrodynamic wave that causes plastic deformation of the bone (expansion). The relative atraumatic osteotomy preparation - densifying mode- enables the inner walls of the osteotomy to spring back. Thus, the OD osteotomies diameters are narrower than conventional osteotomies prepared with the conventional burs of the same diameter. This subsequently generates increased biomechanical energy for bone-to-implant contact.[17,18]

Nowadays, the commonly used tests to measure primary stability are insertion torque (IT), Periotest and resonance frequency analysis (RFA) by means of ISQ.[19] The ISQ allows for the monitoring of the progress of the implant stability during healing period, from primary to secondary implant stability[20], while the insertion torque can evaluate implant stability at time of implant insertion only. Studies that compared the Osstell and the Periotest in determining the actual implant stability, showed that both methods are useful but the Osstell being more accurate than the Periotest.[21,22] A finite element study investigating both devices reviled that Periotest values had good correlation with implant stability only when there was no bone loss.[23] Also a study proved the Osstell to be more sensitive when detecting changes in the implant stiffness, and to be more reliable than the Periotest.[24]

Discussion of Results

The results obtained from this study showed that there was an increase in the implants primary stability with time in both groups after a decrease in the first two weeks; this may be due to remodeling processes of the pre-existing bone. With time, the implant's stability tends to increase, as new bone apposition onto the implant surface occurs and the establishment of secondary stability. However, a large decrease in ISQ values act as warning that would indicate a problem at the bone-implant interface.[25,26]

The expander group had a larger ISQ at the time of the surgery and at the second week, which supports the claims that the expanders when used in soft bone like that of the maxilla; condense bone thus improving its density and resulting in an increase in primary stability of implant.[4,27,28] Also studies investigated the validity of RFA and concluded that the ISQ values were affected by the bone characteristic, implant depth, implant diameter and surface characteristic of implant. However, some cautioned about reliability of RFA and questioned its values.[29]

The study overall showed no significant difference in the implants primary stability in both groups. This may be explained by the fact that Osseodensification caused high strains at bone implant interface; causing micro fractures that extended resorption period thus to delaying secondary stability. This finding supports the results of a recent study that reported that Osseodensification using Densah bur increased the density of the peri-implant bone, but had little effect in improving implants primary stability.[30] Another invitro study also showed no significant difference in stability between the implants placed after conventional drilling and implants placed after Osteodensification.[31]

CONCLUSION

The current research demonstrated that both the expander and the Densah bur enable successful implant insertion with acceptable primary stability in a resorbed maxillary premolar area. Moreover, the Densah bur can be used in a faster manner.

It is therefore recommended that more invivo studies to be performed on the Osseodensification concept using Densah bur.

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