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Evaluation Of Implant Stability And Bone Density Following Densah Burs Versus Bone Expanders In Soft Bone: (A Randomized Clinical Trial)

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Abstract:
Background*: This study aimed to evaluate implant primary stability as a primary objective and radiographic bone density as a secondary objective using ossedensification burs in comparison with expanders in maxill.*
Materials and Methods*: In this study, twenty implants were placed in ten patients who had lost teeth between the second right and second left maxillary premolars.The implants were divided into two equal groups. One implant was placed after using ossedensification bur, and the Second implants after using screw expander.Smart pegs were placed on implants after implant placement, and Osstell was used to record ISQ.Stability of both implants was measured intraoperatively and at the 3 and 6 month marks.After implant placement, digital radiographs were taken (using the Soredex digora toto intraoral sensor and holder) for all implants and three and six months later using a software system (ImageJ version 1.46r) for Fractal analysis (FA) of these dental radiographs. A statistical analysis was performed on the data collected.*
Results*: the results showed non statistically significant differences in both groups bone density and primary stability, But both groups showed an increase in bone density and stability after 3 and 6 months.*
The ossedensignication group had a larger FA and bone density at the time of surgery, at three and six months, there was a higher ISQ for the expander group compared to another group at surgery, three months after, and six months after. Bone density negatively correlated with implant stability.
Conclusions *Both expanders and ossedensification burs enable successful implant insertion in a resorbed maxilla with acceptable stability. Additionally, the ossedensification bur can be used more quickly. expander technique was recorded higher implant stability depend on osstel.Higher bone density was recorded in the osteodensification group by fructal analysis.*
Key Word: *Atrophic maxilla; ossedensification ; Expansion ; Implant stability ; Bone density; Fractal analysis*

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I. Introduction

Dental implant placement has become a predictable and routine treatment option for restoring missing teeth and various cases of dentures in the last 30 years. Implant success can be affected by multiple variables and clinical conditions that may play a role, such as local and systematic disease conditions, smoking habits, intravenous medications that affect bone metabolism, and radiation therapy. The importance of local bone quantity and quality during pre-surgical planning should be emphasized, as these factors can directly or indirectly influence bone conditions[1]. Successful implant placement requires sufficient bone volume and quality, as well as adequate upper and lower occlusal relationship. For long-term implant success, at least 1mm of buccal and lingual bone width is needed buccal and lingual to the implant surface [2].

Various surgical augmentation techniques have been described, including lateral augmentation with or without guided bone regeneration (GBR), ridge expansion osteotomy, ridge splitting technique with or without interposition grafting and horizontal distraction osteogenesis[3]**.** An osteotome or manual expander can expand bone to prepare it for dental implants; these are special instruments designed for the preparation of bone. When expanded, they allow immediate placement of implants in narrow ridges and increase bone width for implant placement.[4] It gives a fast and non-traumatic edge expansion; Bone conditioning is also achieved at the implant site by thickening the side walls of the osteotomy; resulting in improved implant stability and osseointegration. [5]The osseointegration process causes bone to form on the Implant surface and contributes to secondary stability between bone and implant. In areas of low bone density, such as the posterior region of the maxilla, inadequate

available bone can negatively affect histological parameters, affecting primary and secondary implantation[6].

This technique is different, highly controllable, fast, and efficient, and it preserves bone during osteotomy preparation, leading to increased primary stability, bone density, and percentage of bone at the implant surface, which speeds up wound healing and enhances osseointegration.[7] [8]The Fractal Analysis is a good method for detecting various diseases affecting the trabecular bone structure. In osteoporosis patients, periodontal disease patients and lactating women, fractal analysis by counting square can evaluate trabecular changes. Trabecular changes caused by circumference have been studied in bone transplanted tissue. Using fractal analysis, we can determine the quality of the bone surrounding the implant. For primary and secondary implant stability, trabecular bone changes can be observed before surgery**.**[9]Primary and Secondary stabilization of dental implants are a critical factor for the success of osseointegration that may be affected by the drilling technique. [10]

Secondary stability arises from bone remodeling and tissue regeneration after implant placement. It is the result of new bone formation around the implant while osseointegration is occurring, arising from bone remodeling and tissue regeneration after implant placement.[11] [12] Implant osseointegration can only be achieved by achieving primary stability, which is achieved by the threads of the implant interlocking with the bone upon insertion, keeping the implant in place. Primary stability is essential for the healing process as it prevents the implants micro-movements during the initial bone remodeling process. [13]

II. Material And Methods

The present study is a randomized clinical trial, parallel design with Allocation ratio 1:1. The study was approved by the ethics committee at Faculty of Dentistry Ain Shams University, and was conducted in the outpatient clinic of periodontology, faculty of Dentistry Ain shams University.

Patient selection:

Twenty implants were placed in 10 patients who had lost teeth from the second right to the second left maxillary premolars

Patient examination:

A full medical history, including previous or current illnesses and prior surgeries, was recorded. Patients with any systemic disease that may affect normal healing or osseointegration, also patients with history of radiation therapy to the head and neck region were to be excluded. Chief complain, cause, and timing of teeth loss was investigated. Patients with history of recent periodontal problems were excluded.

Surrounding teeth were examined to be periodontally free. Inter arch space was examined to be at least 4 mm. Mucosa was examined to detect any inflammation or pathosis. After the clinical examination of patients preoperative intraoral and extra oral photos were taken as records. to evaluate space and the prosthetic position and angulation for the dental implant.

Cone-beam computed tomography (CBCT) was performed. Virtual planning' involved placing a virtual tooth and a virtual implant, and measuring the width of the bone bucco-lingual being of a minimal thickness of 4 mm and mesio- distal space to adjacent teeth of enough space to receive an implant.

Patients were randomly divided into two groups:

- Expander Group: this group will receive implants after expander used in the osteotomy site.
- Osseodensification Group: this group will receive implants after Osseodensification bur was used in the osteotomy site.

Surgical procedures:

All surgical procedures were performed under aseptic conditions.

Patients received infiltration local anesthesia 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 1000 rpm under copious irrigation with sterile saline.

For first group (Expander)

The screw expanders were used to expand the osteotomy site. The diameters used were 2.6 mm, 3 mm, 3.4 mm in a successive manner. Each expander was screwed until 11 mm of depth was reached as marked on the expander.

Each expander was gently screwed half turn at a time; to allow slow and gradual expansion of the bone When necessary, the kit ratchet was used to reach the full depth required **Fig.1** After the use of the final

expander, an implant of 3.5*11 mm³ was placed with the ratchet driver at a torque >30 Nem.

For osseodensification group

The Implant motor was set in an anti-clockwise direction and drilling speed was set at 1000 rpm. Densah Burs were used in increasing diameters of 2.5 mm, 3.0 mm, and 3.5 mm in a 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 11mm of depth was reached as marked on the bur **Fig 3 Fig 4**.After the last bur was used, an implant of 3.5*11 mm' was placed with The ratchet driver. For both groups.

Fig 1: Expander Screw With Ratchet.

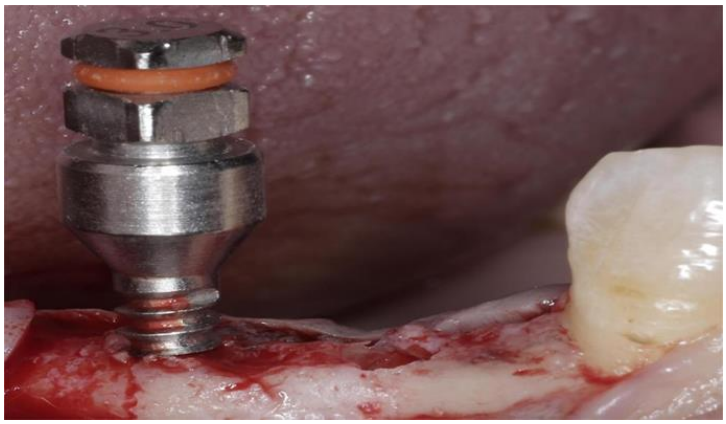

Fig 2: Expander Screw In Osteotomy

Fig 3: Osseodensification Burs

Fig 4: Osseodensification Bur In Osteotomy

Implant Stability:

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 **Fig5** from buccal, lingual, mesial, and distal directions. For each side, three reading were taken and an average was calculated. Then the flap was approximated and sutured.

Osstell was measure primary implant stability immediately post-Operative, secondary implant stability was measure 3 and 6 Months postoperative.

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Fig 5: osstell

Bone density assessment:

All radiographs were digital using (soredex digora toto intraoral sensor and holder). All images were acquired using paralleling technique projection geometry. An intraoral x-ray unit with 70 kvp and 8 Ma. Immediately post- operative and 3,6 months postoperative to evaluate bone density.

Image Analyses

The Fractal Dimension FD was calculated for each implant at two regions of interest (ROIs): mesial and distal to the implant.FDs were calculated using the box-counting method described by White and Rudolph [14] via an image software system (ImageJ v.1.46r software, two rectangular ROIs (100 x 50 or 100 x 40 pixels) were selected for each implant, one mesial to the implant and one distal to the implant Mean values of the two ROIs, one each mesial and distal to the implant **Fig 6**, were used to calculate the FD for each implant.In this procedure, several grids of reduced size (box size) were placed on the ROI and the number of boxes containing pixels was counted for each grid. Updike SX, Nowzari H. Fractal analysis of dental radiographs to detect periodontitis-induced trabecular changes. J Periodontal Res 2008; 43(6):658-64.The mean gray level, trabecular area, perimeter, and the number of terminal points were measured from the transformed image.

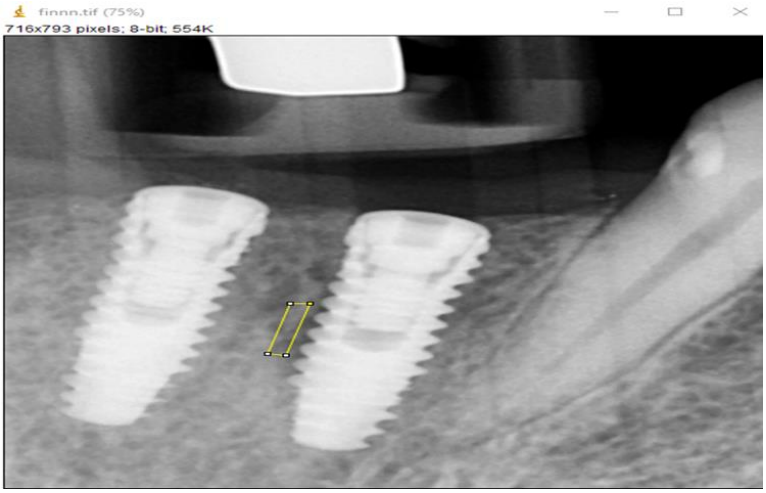

Fig 6: Digital periapical image demonstrating the ROIs used to calculate the FD.

III. Result

Bone density by fractal analysis

Time	Groups	Mean	Std. Dev.	Difference				t	P value
				Mean	Std. Dev.	C.I. lower	C.I. upper		
0 months	Expander	103.48	15.31	-9.20	9.11	-28.33	9.94	-1.01	.326 ns
	Osseodensification	112.68	24.39						
3 months	Expander	108.27	14.60	-9.30	7.51	-25.07	6.47	-1.24	.231 ns
	Osseodensification	117.57	18.71						
6 months	Expander	104.42	11.26	-9.73	6.49	-23.36	3.91	-1.50	.151 ns
	Osseodensification	114.14	17.16						

Significance p≤0.05, ns=non-significant, C.I.: 95% confidence interval

Expander group recorded (103.48±15.31) at 0 months, (108.27±14.6) at 3 months and (104.42±11.26) at 6 months. The difference between the 3 observation times was not statistically significant (p=0.717)

Osseodensificationgroup recorded (112.68±24.39) at 0 months, (117.57±18.71) at 3 months and (114.14±17.16) at 6 months. The difference between the 3 observation times was not statistically significant (p=0.859)

Implant stability by Ostell

Time	Groups	Mean	Std. Dev.	Difference				t	P value
				Mean	Std. Dev.	C.I. lower	C.I. upper		
0 months	Expander	58.70	11.86	6.00	6.58	-7.82	19.82	.91	.374 ns
	Osseodensification	52.70	17.09						
3 months	Expander	65.20	5.27	2.50	3.03	-3.87	8.87	.82	.421 ns
	Osseodensification	62.70	8.01						
6 months	Expander	64.40	4.25	.30	2.64	-5.25	5.85	.11	.911 ns
	Osseodensification	64.10	7.19						

Significance p≤0.05, ns=non-significant, C.I.: 95% confidence interval

Expander group recorded (58.7±11.86) at 0 months, (65.2±5.27) at 3 months and (64.4±4.25) at 6 months. The difference between the 3 observation times was not statistically significant (p=0.152)

Osseodensification group recorded (52.7±17.09) at 0 months, (62.7±8.01) at 3 months and (64.1±7.19) at 6 months. The difference between the 3 observation times was not statistically significant (p=0.076)

Correlation between density and implant stability

Pearson correlation test revealed a weak negative correlation between bone density and implant stability. This correlation was not statistically significant in expander group (p=0.145) and Osseodensification group (p=0.61)

IV. Discussion

Discussion of Methodology:

The goal of this study was to determine whether primary stability is crucial to predictability in healing and osseointegration. Patients were selected, treatment plans were developed, surgical procedures were performed, and the final restoration was constructed considering factors affecting osseointegration on both a systemic and local level. According to **Shadid, R** patients were evaluated to ensure they had no history of debilitating diseases.[15]A minimum bone width of 4-5 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, maintaining the integrity of the bone plate without cracks is crucial for using either the Densah bur or the expander. [16]As a non-invasive alternative to guided bone regeneration, expanders were used in this study to increase ridge width for implant placement by expanding the narrow ridge simultaneously with implant placement, the narrow ridge can be expanded effectively gradual force is provided in a controlled manner as the expanders are initially tightened by finger pressure and then by ratcheting. To allow for bone expansion without stress, half turns should be made with a half-minute interval between them.[17] There was a second group of participants who used the Densah bur based on the suggestion made by its members. Huwais, the inventor of Oscodensification, developed a method using a 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." According to Lahens, this hypothesis is supported by his research. [17]0ssedensification burs combine the speed and tactile control of standard drills with the advantage of expanders.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. [18]

Currently, primary stability can be measured through insertion torque (IT), Periotest, or resonance frequency analysis (RFA) using ISQ. With the ISQ, implant stability can be monitored during the healing period, from primary to secondary implant stability. [19] A higher amount of bone mineralization is indicated by the increase in the fractal dimension in CBCT radiography and conventional radiography. This suggests a significant increase in the quality of the bone surrounding the implant is in line with the increasing bone structure measured by fractal analysis. [20]

Discussion of Results

Implant stability by osstell:

We noticed an increase in stability after 3 and 6 months compared to immediately after surgery.

The study overall showed no significant difference in the implant's primary stability in both groups. This is consistent with the result of **Mahmoud et al** .[21] Osseodensification using a Densah bur was found to have little effect in improving the primary stability of implants in a recent study. [22]The stability of implants placed after conventional drilling versus implants placed after osteodensification was also not significantly different in an invitro study. [19] The results of this study supported the use of expenders to increase the implant stability, which is in keeping with Pikos ma et al 2019 in them in vivo study that demonstrated that expanders use can provide adequate bone width allowing that the implant bed is created by condensation. [23]

Bone density by fractal analysis (FA):

We observed an increase in bone density for both groups after 3 and 6 months compared to immediately after surgery.The ossedensigication group had a larger FA and bone density at the time of the surgery and at three and six months.The study overall showed no significant difference in the bone density in both groups, it also supports the results of a recent study that demonstrated osseodensification (OD) using Densah burs increased peri-implant bone density.[22]This study supported the use of OD techniques for increasing bone density in areas with low bone density, which is consistent with what (**Huwais and Meyer, 2017**) [8] found in their animal study that showed that OD produces a compaction autografted bone along the entire depth of an osteotomy, especially at its apical part. It increases mineral bone density around the perimeter and the apical portion of the osteotomy. **Huwais et al. (2018)** [18]**,** in a 5-year retrospective clinical study, also found that the OD technique results in increases in bone density through compression autografting and facilitates crestal sinus augmentation. As for the expander group, there was an increase in bone density, which supports what was found by [24]. The FD values decreased immediately after the operation and increased gradually according to the time lapse and this is consistent with .[25]The increase in FD in conventional radiography compared to previous studies indicates a higher amount of bone mineralization as a result, the Enhance implant stability and mineral bone density around the periphery of the osteotomy as well as compact autografted bone along its entire depth, particularly at its apical end. Increasing bone structure measured by fractal analysis seems consistent with the significant increase in the quality of the bone surrounding the implant this supports the results of a study conducted by

Ozturk A et al 2023. [20]Correlation between density and implant stability:

The establishment of osseointegration is a dynamic process that involves bone tissue modeling and remodeling and this physiologic drop of implant stability during the early osseous healing period is associated with resorption of bone in contact with the implant surface which is evident during the first weeks of healing, During the transition from mechanical anchorage to biological attachment, implant stability is replaced with newly formed viable bone, which represents a transition from primary stability to secondary stability.[26] As a result, measuring implant stability during the healing period can provide an objective assessment of stability changes that are critical for determining implant loading.The study overall showed no significant difference in the implant's primary stability and bone density in both groups. Osseodensification may have caused high strains at the implant interface, which in turn caused microfractures that delayed secondary stability, explaining the negative correlation between bone density and implant stability, or we achieved bone density with expanders and OD, but it was fake, it did not wear off with time, but decreased and new bone formed.

V. Conclusion

Both expanders and osseodensification burs enable successful implant insertion in a resorbed maxilla with acceptable stability. the osseodensification bur can be used more quickly.The expander technique demonstrated higher implant stability, as measured by Osstell. Higher bone density was recorded in the osseodensification group by fractal analysis.

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