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Original Article

Osseodensification Versus Conventional Drilling Technique on The Bone Height Changes of Implant Retained Maxillary Overdentures (Split-mouth Study)

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I. INTRODUCTION:

The success of implants has been demonstrated over time, making them the treatment of choice for restoring missing teeth in a variety of ways. Successful dental implant placement requires an adequate quantity of bone thickness covering the implant to ensure primary stability, which is crucial for the long-term effectiveness of the implant,. Additionally, maintaining adequate bone mass and density is crucial in locations with low bone density, such as the maxilla, to achieve the necessary bone to implant contact and create a biomechanically stable implant.(1)

Restoration the maxillary edentulous arch with implants is more exciting than the mandibular one due to biomechanical, esthetic & anatomic considerations. Maxillary bone density is often quality type D3-D4, as opposite in the mandible, that more commonly as quality type D2-D3. (2)

The drilling technique has a critical factor in providing the primary stability. Conventional extraction technique employed a standard drill to dig the bone and simplify implant placement. Although, they produce effective cutting of bone but the design competence to create a precise circumferential osteotomy is poor , this primes a minimize of torque during implant insertion , contributing to the potential for non-integration of the implant and poor primary stability (3)

For the preparation of implant sites, a method utilizing a specially created densifying bur was suggested in 2015. It was asserted that this bur would increase bone density at the drilling site.(4) Implant insertion torque is increased by densification of the osteotomy site walls because bone is crushed into open marrow spaces during the Osseo densification process .(5) The cutting chisel and tapering shank of the densifying bur enable it to gradually expand the diameter as it is carried deeper into the osteotomy. Additionally, there are two rotation orientations that can be used while drilling: clockwise (CW) and counterclockwise (CCW). The clockwise drilling direction is best for higher-density bone, while the CCW rotation direction is more effective at the densification process .(6,7)

Osseo densification is an innovative bio-mechanical site preparation technique. It allows low plastic deformation owing to its non-extraction site preparation method, which preserves the bone to augment the host. The taper design tolerates the surgeon to control pressure and irrigation, as long as providing a unique real-time haptic feedback that makes the densifying bur spontaneous for every skilled implant surgeon. Moreover, It develops a multi-

fluted densifying bur technology (Versah™, LLC) that produces and expands a pilot hole without digging significant amounts of bone tissue through a exceptional, highly controllable, fast, and efficient procedure with minimal heat elevation. (8-11)

Due to the elastic strain and bone's ability to bounce back, densah bur osteotomies were also discovered to have a smaller diameter than traditional osteotomies. This roughly tripled the amount of bone that was readily available at the implant location. In the Osseo densified osteotomy sites, particularly in bone with poor density in comparison to standard drills, histomorphological research revealed autologous bone chips.(12-14)

The various parameters influencing the stability of the implant are clearly shown by radiographic evaluation. Cone Beam Computed Tomography (CBCT) has recently risen to the top among all radiography modalities as, the usage of CBCT has several advantages .(15,16) CBCT is the most effective and accurate method to determine the bone loss at different levels and services in the early recognition of bone loss surrounding implants in addition to providing data about the peri-implant tissue and the extent of marginal bone loss .(17,18)

So, this study was promoted to compare between Osseo densification drilling technique and conventional one regarding bone height changes around implant in implant retained maxillary overdenture.

II. MATERIALS AND METHODS

Ten patients were selected from the outpatient clinic of the Prosthodontics Department, Faculty of Dentistry, Cairo University to share in this study. All patients were ranged between the ages of 50-65. Inclusive criteria were: U-shaped alveolar arches, patients with completely edentulous upper and lower ridges, with the maximum of 6 months from last tooth extraction before implant placement, sufficient bone quantity in the pre-maxillary region of the maxilla with a minimum length of 14 mm and 5mm width, Angle class I ridge relationship, adequate inter arch space. Exclusion criteria were included: Patients suffering from temporomandibular joint disorder , neuromuscular disorders, heavy smokers, Un-controlled diabetes with HbA1C value higher than 7% and patients receiving radiotherapy or chemotherapy.

All patients were restored by implant supported maxillary over denture by installing 4 implants (2 in the lateral region, and 2 in the first premolar region) and mandibular complete denture.

Upper and lower complete dentures were fabricated to all the patients following the same basic principles. A radiographic stent was fabricated by duplication of the upper complete denture into a heat cured acrylic resin. Cone beam computed topography (CBCT) scan was produced for the maxillary arch to evaluate bone dimensions at the proposed implants site.

Four implants were inserted in the maxilla for each patient with spilt mouth design. The groups were enrolled as follow:

Group I: Two implants were installed in the right side of the maxillary arch using Osseo densification drilling technique

Group II: Two implants were installed in the left side of the maxillary arch using conventional drilling technique

Implants (Vitronex implant system, Italy) tapered, self-tapping, threaded, two-piece, implant with 11.5 mm lengths and 3.7 mm diameter were used. Infiltration anesthetic solution was taken. The radiographic radiographic stent was modified to act as surgical stent. Surgical stent was placed in patient's mouth then the pilot drill used to drill through the mucosa and mark the osteotomy site through the cortical plate of bone at the marked implant site. Three- line trapezoidal incision was made and a full thickness mucoperiosteal flap was reflected.

For group I (Osseo densification technique):

- A pilot drill was used to the chosen depth (Clockwise drill speed 800-1500 rpm with copious irrigation).
- The narrowest Densah bur (VT 1525) 2.0mm was used (Counterclockwise drill speed 800-1500rpm) after the drill motor was reversed. Fig1
- Successive drilling using large drill in diameter (VT 2535)3.0mm was utilized until complete the drilling.
- When the haptic feedback of the bur pushing up out of the osteotomy was reached, pressure was controlled with a pumping motion until attainment the desired depth.
- Irrigation was supported using internal and external irrigation with saline.
- The implant was installed in the osteotomy site and the finger driver was rotated clockwise.
- Complete the procedure until the implant was fully seated by using ratchet wrench then cover screws were inserted.

For group II (conventional technique):

- Implant osteotomies were drilled following the standard protocol. The pilot drill was used to continue drilling through the marked osteotomy site at speed 1000 RPM associated with copious irrigation
- The drill 2.8 mm in diameter followed by finally 3.4 mm drill at 800 rpm speed were used to allow osteotomy preparation.
- The implant was installed in the osteotomy site and rotated clockwise using the finger driver
- The ratchet wrench was utilized until the implant was fully seated with its all threads covered then cover screws were inserted. Fig 2

The suturing of the mucoperiosteal flap was done in continuous lock pattern (4-0 prolene3 suture material) using curved triangular cross-sectional needle.

After seven days, sutures were removed, and the denture was relieved and lined by soft liner. Then, the denture was finished, polished, and delivered to the patients.

The second exposure stage was done after 4 months later, and the ball abutments (Ball abutment -SPI) were applied and secured to the implant fixture . Fig 3a

During the pick-up of the metal housings, the block- out shim was modified and adapted to each abutment in order to block out the undercut areas gingival to the ball abutments, then the metal housings were positioned in place. All the areas in the upper denture opposing to ball attachment were detected , marked and relieved on the fitting surfaces of the denture. Chair-side pick-up of the metal housings was done using hard denture lining material (Duralay). The lining material was applied into the recesses of the denture base and the denture was fully seated in the patient's mouth. The patient was directed to close gently in centric relation until complete curing of the hard denture liner was happened. Excess acrylic resin was removed. Recall appointments were arranged for inspection and evaluation of the prosthesis and to complete any needed adjustments. Fig 3b

Radiographic evaluation

The linear measurement system supplied by the cone beam computed tomography was used to evaluate marginal bone height change around the implants. A ruler in the software was utilize to measure the bone height from the apex of the implant to crestal bone in contact with the implant.

By the end of each follow up appointment (at time of insertion ,6-months then after 12-months of the prosthesis insertion) , the marginal bone loss was measured by

calculating the difference in bone height at that interval from the base line measurement.

III. RESULTS

The Data analysis were performed using Statistical Analysis Systems. SPSS software (version 13.1: SPSS Inc) was used. Probability values ≤0.05 to indicate significant relationships between variables. Shapiro-Wilk tests was used to evaluate data normality and presented normal distribution. Data were tabulated using means and standard deviations.

Independent t-test was used to compare between the two groups. Paired t-test was also used to study the changes by time in each group. the Comparison between both groups were completed and the results were shown in table (1).

The average mean value of marginal bone height changes measured from prosthetic

Loading to twelve months after implant loading for group I was found to be 1.01 ± 0.125 mm .

Statistical analysis of the data revealed significant difference during follow up period.

The average mean value of marginal bone height changes measured from prosthetic loading to twelve months after implant loading for group II was found to be 1.115 ± 0.137 mm. Statistical analysis of the data showed statistically significant difference during follow up period.

The results showed that, there was statistically in-significant difference in the marginal bone height loss between the two studied group during the follow up period . After six months, there was reported the least bone loss around the implants in group I. the mean difference of bone height changes was (0.4±0.097) and (0.460±0.0119) for group I & II respectively. While from six to twelve month, the mean difference of bone height changes was (0.61±0.174) and (0.655±0.219) in group I & II respectively

IV. DISCUSSION:

Dental implants have been considered the best treatment option for the prosthetic replacement in the completely edentulous patients. However, management of the edentulous maxilla could exist a lot of problems due to the atrophy that happens after extraction of the teeth. This process remains throughout life due to lack of stimuli (disuse atrophy). [19]

Patients participating in this study were precisely selected, examined, and organized to avoid any factor that may unfavorably affect the results of the study. All patients had motivated for prosthodontic treatment and for preserving the oral and denture hygiene maintenance. Hence, they responded regularly to the frequent recall appointments .[20]

Patients were selected with age range from 50 to 65 years to avoid the effect of age changes on the condition of the residual ridge, oral mucosa, muscle tone and temporo-mandibular joint.[21]

Patients have been totally edentulous for at least 6 months before implant insertion to avoid the period of bone remodeling which occurs after tooth extraction.[22] Patients with adequate interarch space were selected, they should have not less than 11 mm from the crest of the ridge to the occlusal plane (5 mm for the ball of the implant and its housing and the remaining 6 mm for the denture base and denture teeth) as it was necessary to accommodate the abutments and the denture base without affecting the vertical dimension of occlusion or disrupting the occlusal plane.[23]

Standard clinical and laboratory steps were followed for the fabrication of the dentures for all patients. Also, the same materials were used in order to eliminate any factor that might affect the results of this study.[24]

Customized radiographic acrylic stent was constructed and a cone beam computed tomography was taken to all patients with the radiographic stents to mark the planned implant positions in the radiograph and evaluate

available bone height and width in these positions.[25]

It was planned to install four implants in anterior maxilla two in position of the lateral incisors and two in position of the first premolars. This study is a split mouth study as two implants were inserted in the right side with Osseo densification technique and two implants were inserted in the left side with conventional drilling technique, this was done to standardize the results and to skip the variables that was found between the patients.[26]

Implants were positioned in anterior maxilla due to extension of the maxillary sinus to avoid augmentation and sinus floor elevation surgeries. While the trapezoid distribution is preferred to prevent rotation of the overdenture around the anterior implants and to increase the anterior-posterior spread of the implants.[27]

The full thickness flap was reflected to expose the surgical field by making three- line trapezoidal incision to allow good visual access. Irrigation with saline solution was used during drilling of implant sites. This reduces the high temperatures that can be generated during drilling the implant osteotomies to satisfactory levels.[28]

For group I, drilling technique was installed with CCW direction with speed of 800-1500 rpm, as indicated by the protocols set by Huwais.[5] Using OD drills with copious amounts of irrigation fluid during drilling provides lubrication between the bur and bone surface and eliminates overheating.[29]

The two-stage surgical protocol was used in this study may attribute to obtain soft-tissue coverage over the implant and maintaining a minimal load applied on the implant for four months that also, decreases the bacterial infection, avoid apical migration of the oral epithelium along the body of the implant, permits time for proper osseointegration, and lastly , reduces the risks related to early implant loading during bone remodeling period . [30]

The metal housings were fitted on the ball abutments. The area of undercut below the metal housing was blocked using O Ring to prevent the pick-up material from engaging the abutment. The fitting surface of the denture was relieved to make room for the metal housing. Denture was seated and checked for any interference and the occlusion was verified. The direct pickup technique used rather than the indirect technique in order to avoid the possible errors that may occur with the indirect technique.[31]

After one-year follow-up period, the marginal bone height changes for both groups were within the acceptable range of implant success & showed statistically significant difference. This may be due to surgical trauma, establishment of biologic width, the presence of a micro-gap at the implant-abutment interface, occlusal overload, or implant neck design[32]The results was in accordance with previous studies which stated that dental implants have some degrees of unavoidable bone loss following implant installation and loading. An early peri-implant bone loss of 1.5 mm may occur during the healing phase and the first year in functional loading at the crestal area of implants, followed by an average annual bone loss of 0.2 mm thereafter. [33,34]

Although the results of this study showed less bone height changes in group I than group II but this difference was statistically insignificant during all the follow-up periods. This may be due to the creation of osteotomies by osseodensification technique without the removal of existing bone will preserves the collagen and bone mass which promote revascularization, that is essential for the formation of new bone and bone remodeling. [35]

The result of this study was coincided with another study which states that there is no statistical difference in the bone height changes between osseodensified sites using Densah™ burs compared to conventional osteotomy sites. However, the buccolingual width of the residual bone was increased after osseodensification and remains in the increased dimension for at least six months.[36]

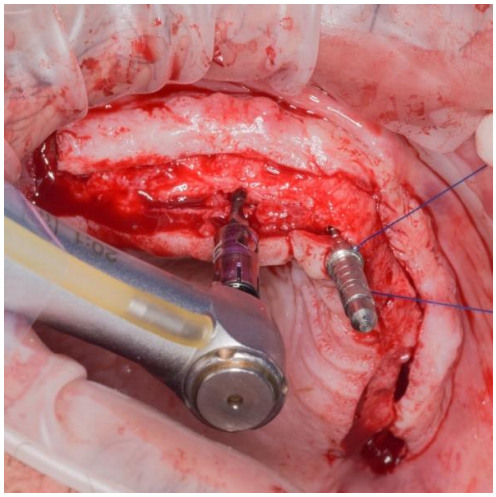

Fig. (1): Narrowest drill (VT1525) in anticlockwise direction

Fig. (2): Four implants fully seated in the prepared osteotomies

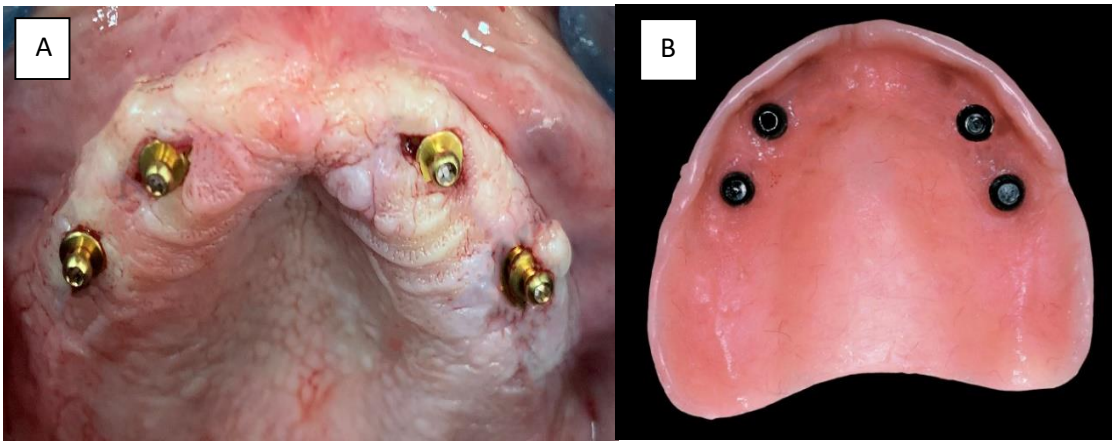

Figure (3): A-Ball abutments screwed& B- Metal housing & O-ring picked up in the denture

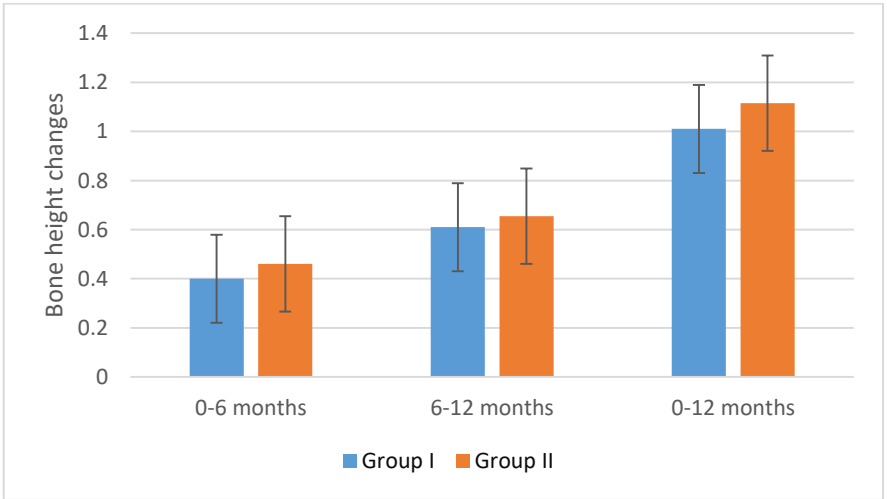

Fig. (4): Bar chart showing mean of bone height changes in the two studied groups

Table (1): Mean ± standard deviation (SD) of bone height changes for the two studied groups

***; significant ($p \leq 0.05$)**

Time	Group I		Group II		P value
	Mean	SD	Mean	SD	
0-6 months	0.4	0.097	0.460	0.119	0.088
6-12 months	0.61	0.174	0.655	0.219	0.476
0-12 months	1.01	0.125	1.115	0.137	0.061
P value	<0.0001*		0.0012*		

V. CONCLUSIONS

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

Although Osseo densification drilling technique (Densah burs) showed better results regarding bone height changes around dental implants than conventional technique, both drilling techniques are reliable for creating osteotomies for implant placement.

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