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EFFECT OF TWO DIFFERENT DRILLING TECHNIQUES ON THE SUPPORTING STRUCTURES OF POSTERIOR MAXILLA IN IMPLANT RETAINED PARTIAL DENTURES

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ABSTRACT

Background: Osseodensification has been introduced as a novel method for osteotomy site preparation for root form dental implants. It allows for a low plastic deformation of bone using a set of universally compatible densifying burs.

Objective: This study was aimed to evaluate the effect of two different drilling techniques (Osseodensification using Densah™ burs and conventional extractional drilling) on the marginal bone height changes of the posterior maxilla in implant retained partial dentures.

Materials and methods: This is a split-mouth study where eight patients with Kennedy Class I maxillae were selected and each patient received an implant on the right side using osseodensification (Group I) and an implant on the left side using conventional drilling (Group II). The second stage was started after 16 weeks and removable partial dentures that were retained by ball abutments fitted to the implants were constructed. Serial, standardized digital periapical radiographs were taken at 6 and 12 months to assess marginal bone height. All data were collected, tabulated and statistically analyzed.

Results: Six months after prosthetic loading, the mean amount of the measured marginal bone height changes was found to be 0.675±0.089mm and 0.7625±0.206mm for group I and group II, respectively. From six to twelve months after loading, the mean amount of the measured marginal bone height changes was found to be 0.475±0.167mm and 0.65±0.207mm for group I and group II, respectively. Twelve months after loading, the mean amount of the measured marginal bone height changes was found to be 1.15±0.239mm and 1.4125±0.253mm for group I and group II, respectively. The difference between the two groups was found to be not statistically significant $p<0.05$.

Conclusion: Although osseodensification drilling technique showed better results regarding bone height changes around dental implants than the conventional technique, both drilling techniques are reliable for creating osteotomies for implant placement.

KEYWORDS: Densah, Osseodensification.

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INTRODUCTION

Partial edentulism is when one or more, but not all the teeth, are missing in a dental arch. Usually, this loss is caused either by dental caries, periodontal pathologies, trauma or pathologic lesions. Many studies have claimed that dental caries and periodontal pathologies were the main causes of tooth loss specially in younger patients.[1]

Partial posterior maxillary edentulism is one of the more frequently encountered problem in dental medicine, significantly more prevalent than mandibular edentulism. 20% to 30% of adult partially edentulous population older than 45 years of age are missing maxillary posterior teeth on one side, and around 15% of this age group are missing maxillary dentition in both posterior regions.[2]

Removable partial dentures with distal extensions are still vastly used in the rehabilitation of Kennedy Class I and Class II partially edentulous patients as these partial dentures significantly improve the stomatognathic functions. However, there is a clear association between distal extension removable partial dentures and alveolar bone resorption, higher caries incidence and they are not totally psychologically accepted by the patients.[3]

It has been documented that the patients who received implants in conjunction with removable partial dentures had fewer prosthetic complications, improved masticatory efficiency, fewer surgical procedures and improved esthetics at a much lower cost than other treatment modalities.[4]

Quality of life and satisfaction of patients with removable partial dentures, especially the distal extension removable partial denture, have been improved by the introduction of the implant-supported removable prostheses. It is considered a minimally invasive procedure that does not affect the implant success.[5]

Osseodensification has been introduced as a novel method for osteotomy site preparation for root form dental implants. It allows for a low plastic deformation of bone using a set of universally compatible densifying burs with minimal heat generation.

This technique was presented to be used with specially designed burs that are used to enhance bone density as they expand the osteotomy site. These contemporary burs permit bone conservation and condensation by compaction autografting along with osteotomy preparation.[6]

The configuration of the Densah™ bur allows it to perform a non-cutting function, with its negative rake angle numerous lands. It is composed of a cutting chisel edge and a tapered shank; thereby, when it penetrates deep into the bone, it widens the osteotomy, and smoothly compacts the peripheral bone walls. This design makes the bur able to push the bone chips and debris towards the implant bed instead of removing them.[7]

After comparing the osseous densification technique with the conventional drilling technique, Huwais et al., confirmed that both primary implant stability and the amount of bone at the implant surface are increased in the osseous densification technique.[8]

The quantity and quality of the alveolar bone are commonly evaluated by imaging techniques. After the surgery, it is important to evaluate the health of the implant, which includes assessing the changes in both quality and quantity of the bone, and measuring the crestal bone loss, which is a result of osseointegration. All are tested by imaging methods.[9]

Digital radiography produces images that are as accurate in diagnosis as those of conventional radiography. Faster image production with less radiation exposure is offered by digital radiography.[10]

So, this study was conducted to evaluate the effect of the osseodensification technique on the marginal bone height changes and whether it has an advantage over the conventional drilling technique or not?

MATERIALS AND METHODS

This study was accepted by the board of the Oral and Maxillofacial Prosthodontics Department and the ethics committee of the Faculty of Dentistry, Ain Shams University.

Eight patients were selected from the out-patient clinic of the Oral and Maxillofacial Prosthodontics Department, Faculty of Dentistry, Ain Shams University. The inclusion criteria for this study involved patients who were: (1) Aged from 30 to 55 years old. (2) Kennedy Class I maxillary arch where the last standing abutment is the first premolar, opposed by a fully dentate mandible. (3) A minimum of 11 millimeters of bone below the floor of the maxillary sinus and a minimum of 6 millimeters of buccolingual width. (4) Sufficient inter-arch space (12mm) to accommodate the implant overdenture. (5) Good oral hygiene.

The exclusion criteria: (1) Patients with bone or mucosal diseases. (2) Patients receiving chemotherapy or radiotherapy. (3) Heavy smokers. (4) Patients with uncontrolled metabolic disorders such as diabetes mellitus. (5) Patients with parafunctional habits. (6) Patients with conditions that might complicate the treatment, such as: severe gag reflex, limited mouth opening, TMJ problems, fearful patients.

Setting of acrylic teeth[*] using sticky wax following the curvature of the arch was performed on the diagnostic cast to visualize the final position of the artificial teeth then a vacuum sheet of clear acrylic resin was pressed on the casts of the patient to fabricate a stent. Drops of flowable composite resin were attached to the acrylic stent at the planned implant positions to serve as radiographic markers during the construction of the radiographic stent.

A cone beam computed topography (CBCT) radiograph was taken for the maxillary arch while each patient was wearing the radiographic stent, the planned future positions of the dental implants were detected and then a surgical stent was made by drilling channels through the radiographic stent in the planned implant positions.

Tapered, self-tapping, threaded, two-piece, titanium dental implants[**] that are 4.2 mm in diameter, and 10 mm in length were selected.

The surgical stent was placed in the patients' mouth guided by the remaining teeth anterior to the edentulous space and the pilot drill was used to drill through the channel, mucosa and cortical plate to mark the site of the osteotomy at the distal marginal ridge of the upper first molar.

A 15C blade[***] was used to make sulcular incisions around the first premolars and crestal incisions distal to the first premolars to the second molar region reaching the bone crest and a sharp mucoperiosteal elevator was used to reflect the full thickness of the mucoperiosteum and the covering mucosa to expose the alveolar ridge for ideal visibility.

I. For Group I (using Densah™ burs):

The pilot drill was used to reach the desired depth (aided by the laser markers) in a clockwise manner (Cutting mode) with copious irrigation. The drill speed was 800 rpm. A paralleling pin was used to confirm the angulation of the osteotomy and compare it to the long axis of the neighboring teeth. The Densah™ burs were sequentially used to widen the osteotomy to reach its final diameter. The (VT 1828) 2.3 mm bur was used, followed by the (VT 2838) 3.3 mm bur. These burs were used in a counterclockwise manner (Densifying mode) at a speed of 800 rpm with copious irrigation. Whenever the haptic feedback of the bur was

* Acrylic teeth, Acrostone Dental, Egypt

** VITRONEX Elite Implant System, Italy

*** Kiato Carbon Steel, Kehr Surgical Private, Kanpur, India encountered pushing the drill out of the osteotomy, pressure was modulated with a pumping in and out motion until reaching the desired depth as recommended by the manufacturer. (Fig. 1) Copious and continuous irrigation is highly recommended during osseodensification so a syringe containing cooled saline was used in conjunction with the saline coming out of the saline tube attached to the handpiece. A high suction unit was used to quickly flush out the used saline. The sterile vial containing the dental implant was opened and the implant was picked up using the finger driver then inserted in the osteotomy through clockwise rotation. The torque ratchet was then used until the implant platform was submerged 0.5 mm below the bone crest all around. The screwdriver was used to secure the implant cover screw in position.

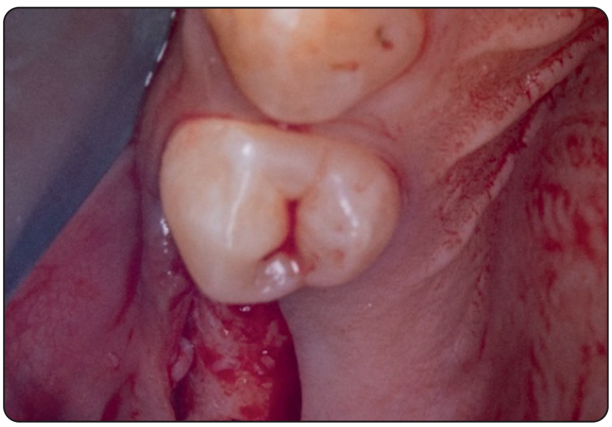

Fig. (1) Final osteotomy

II. For group 2 (conventional drills):

The pilot drill was used to reach the desired depth (aided by the drill stopper) in a clockwise manner with copious irrigation. The drill speed was 1000 rpm. A paralleling pin was used to confirm the angulation of the osteotomy and compare it to the long axis of the neighboring teeth. Sequential drilling was performed using progressively larger diameter drills following the pilot drill (twist drill 2.4/2.8, twist drill 2.8/3.2, then twist drill 3.2/3.8). All the drills were used in a clockwise manner at a speed of 1000 rpm while the drill stoppers were used to reach the desired depth. The sterile vial containing the dental implant was opened and the implant was picked up using the finger driver then inserted in the osteotomy through clockwise rotation. The torque ratchet was then used until the implant platform was submerged 0.5 mm below the bone crest all around. The screwdriver was used to secure the implant cover screw in position.

A 10 ml disposable plastic syringe was used to irrigate the surgical site before the flap was repositioned in its former position overlying the implant and the ridge. Then a continuous with lock pattern using 4-0 non-resorbable monofilament polypropylene suture material* was used to secure the mucoperiosteum in its original position.

After a 16-week period, the patients were recalled. Infiltration local anesthesia was administered and the implant positions were determined using the tip of a probe with the aid of the surgical stent used during the surgery. A small incision using a 15C blade was made on top of the implants to expose the cover screws. A screwdriver was used to remove the cover screw and attach a ball abutment of a suitable dimension then a periapical radiograph was taken to ensure that the ball abutment was fully seated.

A vitallium removable partial denture was fabricated using the conventional steps. After occlusion was adjusted, the black pick-up O-ring was placed inside the metal housings and they were seated on the ball attachment then the removable partial denture was inserted inside the patient's mouth with pressure indicating paste in the area that would receive the metal housing to verify the absence of any contact with the housing.

The undercuts of the attachment were blocked using gingival barrier material and rubber dam

* Assut Sutures, Assut Medical Sarl, Pully-Lausanne, Switzerland

sheets* then the pick-up space was filled with hard pick up material** and the removable denture was seated inside the oral cavity. Complete seating of the partial denture was verified then the patient was instructed to maintain light occlusal pressure in the centric occlusion position while the resin polymerizes. The pick-up resin was then trimmed and polished.

The black pick-up O-ring was removed and replaced with a resilient nylon cap before the patient was instructed on how to place and remove the denture properly as well as the necessary home care instructions. (Fig. 2)

Fig. (2) Final prosthesis

Marginal bone height assessment:

The GXS-700 digital intraoral sensor*** was used for the acquisition of the digital intraoral radiographs and the subsequent assessment of the marginal bone height changes. Serial standardized periapical radiographs were taken and collected on the same day of loading and at every follow up appointment (6 and 12 months). Bone height was measured mesial and distal to every implant abutment using the linear measurement system of the software ruler.

Customized bite blocks were fabricated using addition silicon impression material**** of putty consistency by folding a piece of putty around the bite piece of the sensor holder before it was inserted in the patient's mouth making sure the sensor was kept parallel to the area of interest during setting of the impression material. (Fig. 3)

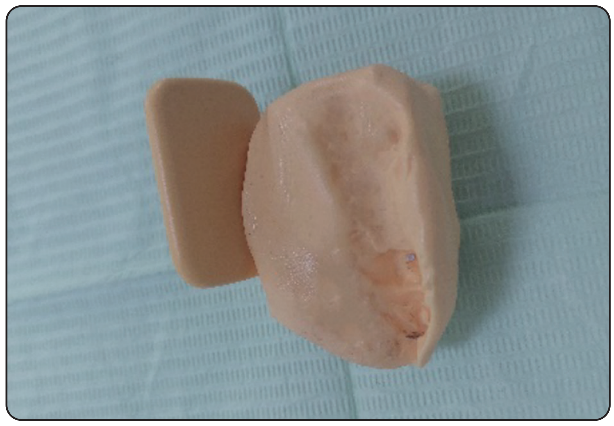

Fig. (3) Customized bite block for standardization of x-rays

The dental X-ray unit***** was operated at 70 Kv and 7 mA for 0.56 seconds, these exposure parameters were standardized for all the patients during each follow up visit. The sensor was placed in the designated place of the sensor holder and the customized bite blocks were placed around the bite piece. The assembly was placed inside each patient's mouth then it was connected to the aiming ring using the positioning bar to aid with the alignment of the x-ray tube.

Images were analyzed using the Cliniview software to evaluate changes in the crestal bone height mesial and distal to each implant. Linear measurements in millimeters were taken at each follow up visit using the linear measurement system tool integrated in the software. (Fig. 4)

* Sanctuary dental dam, Wellkang Ltd, Derry, Northern Ireland

** DuraLay self-cure acrylic-pink, Reliance Dental Manufacturing LLC, Alsip, USA

*** GXS 700, GENDEX, USA

**** Elite HD+ a-silicone, Zhermack S.p.A, Badia Polesine, Italy

***** VARIO^DG intraoral x-ray unit, Dentsply Sirona Inc, North Carolina, USA

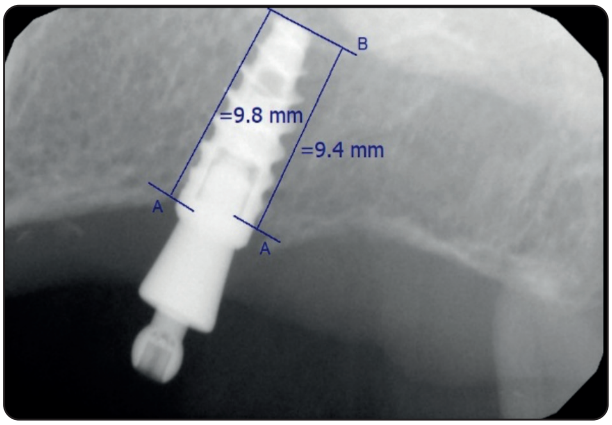

Fig. (4) Linear measurement of bone height changes

For each implant, the measurements were obtained using the following steps: (1) Two lines were drawn horizontally, one mesial and one distal, at the highest level of the alveolar crest parallel to the horizontal plane and perpendicular to the long axis of the implant (A-mesial, A-distal). (2) One line was drawn tangential to the apex of the implant parallel to the previous lines (B). (3) Parallel lines extending from (A) to (B) were drawn and measured in mm. The same sequence was performed for all implants. (4) The sum of the bone height mesial and distal was obtained and divided by two to obtain the average bone height at each appointment (loading, 6 months and 12 months follow up).

Statistical Analysis:

Statistical analysis of all the collected data was performed using Statistical Package for Scientific Studies (IBM SPSS)* Version 26 for Microsoft Windows and charts were generated using Microsoft Excel 2016.

Independent t-test was used to compare the results between groups. Probability value of $p \leq 0.05$ was considered statistically significant.

* SPSS, IBM Co, New York, USA

RESULTS

To compare between the mean amount of marginal bone height changes in both two studied groups during the follow-up periods, independent t-test was performed.

Six months after prosthetic loading, the mean amount of the measured marginal bone height changes was found to be 0.675 ± 0.089 mm and 0.7625 ± 0.206 mm for group I and group II, respectively. The difference between the two groups was found to be not statistically significant $p< 0.05$.

From six to twelve months after loading, the mean amount of the measured marginal bone height changes was found to be 0.475 ± 0.167 mm and 0.65 ± 0.207 mm for group I and group II, respectively. The difference between the two groups was found to be not quite statistically significant $p< 0.05$.

Twelve months after loading, the mean amount of the measured marginal bone height changes was found to be 1.15 ± 0.239 mm and 1.4125 ± 0.253 mm for group I and group II, respectively. The difference between the two groups was found to be not quite statistically significant $p< 0.05$. (Fig. 5)

TABLE (1) Average mean values (mm), standard deviation (SD) and p-value of marginal bone height changes in the studied groups during follow-up period.

Time Interval	Bone Height Changes (Mean ± SD)		p-value
	Group I (Densah™)	Group II (Conventional)	
Loading to 6 months	0.675±0.089	0.7625±0.206	0.2895
6 months to 12 months	0.475±0.167	0.65±0.207	0.0838
Loading to 12 months	1.15±0.239	1.4125±0.253	0.0658

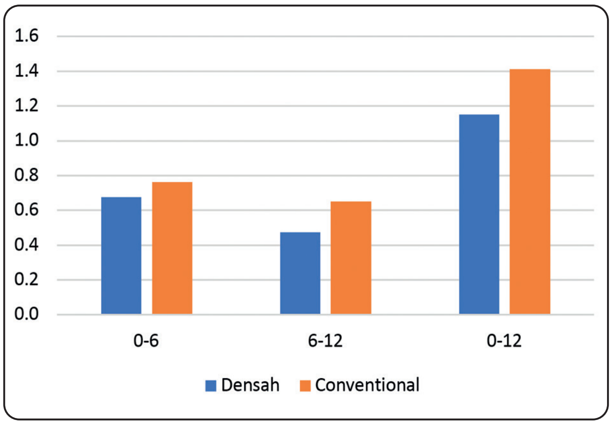

Fig. (5) Compare between marginal bone height changes in both two studied groups

DISCUSSION

A split-mouth study design was followed as it has the advantage of removing a lot of inter-patient variability from the estimated treatment effect, and hence requires fewer subjects than a parallel-group trial with the same power.[11]

Specific implant dimensions were chosen to increase the implant surface area that contacts the bone. These dimensions were 4.2 mm in diameter and 10 mm in length. A Higher risk of failure was encountered in implants less than 10 mm in length.[12]

Both the clockwise and the counterclockwise drilling directions can be used, all at high-speed, from 800 to 1500 rpm. The clockwise direction is used in areas of high bone density, while the counterclockwise direction is better utilized in areas of low bone density. In this study, a drilling of counterclockwise direction was used with a speed of 800-1500 rpm, as suggested by the protocols set by Huwais.[8]

This study presents the two-stage surgical protocol, as it was established that maintaining a soft-tissue barrier over the implant and reducing the load to which it is subjected results in fewer bacterial infections, minimal apical migration of the epithelium along the implant body, more time for osseointegration, and fewer risks in bone remodeling than in immediate-loading techniques, so a period of 16 weeks was waited before exposing the implants.[13]

Standard clinical and laboratory steps for the construction of the partial dentures were performed for all the patients. The same materials were used to eliminate as many factors as possible that may affect the results.[14]

The indirect pick-up technique possesses some possible errors that could result from the dimensional changes of impression materials, faulty impression technique, improper storage, laboratory errors. Thereby, the direct pick-up technique was utilized to avoid such errors through utilizing the black pick-up O-ring for the pick-up as it possesses the least retention to facilitate the pick-up procedure before choosing the suitable nylon cap.[15]

For a precise evaluation of the crestal bone level changes over the follow up appointments, an accurate tool that would yield similar measurements regardless of the examiner was required. So, the GXS-700 system was employed to perform the radiographic evaluation in this study.[16]

All the patients that participated in this study successfully achieved osseointegration of implants placed on both sides. The success of these implants was decided through regular clinical check-ups and follow-up periapical radiographs to ensure the absence of implant mobility, peri-implant radiolucency, persistent pain, discomfort or infection as well as patients' satisfaction regarding function, retention, and esthetics of their appliances.

This success could be attributed to proper case selection, adequate implant planning and selection of proper implant dimensions in proportion to the existing supporting structures, proper implant installation and angulation, and following strict oral hygiene measures.[17]

At the end of the one-year follow-up period, the marginal bone height changes for both studied groups were within the acceptable range of implant success as the mean amount of the measured marginal bone height changes was found to be 1.15 mm and 1.4125 mm for group I and group II respectively. As previous researches have 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 occurs 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.[18]

The previously stated bone loss may be due to surgical trauma, establishment of biologic width, lack of completely passive fit of the superstructures, the presence of a micro-gap at the implant-abutment interface, occlusal overload, or implant neck design.[19]

For both groups, the bone height changes during the follow-up periods within every group have proven to within the same range (0.22 ± 0.55 mm to 2.5 ± 2.7 mm in the first year for implants supporting removable partial dentures) that was shown in a systemic review by Saravi et al, in which 42 studies were selected for evaluation to compare the marginal bone loss around implants used to support fixed and removable prostheses.[20]

Osseodensification has yielded better results regarding the marginal bone height changes, which may be attributed to the significant increase of ridge width and bone volume percentage (%BV) around the implants placed with osseodensification techniques as illustrated by Trisi et al[21], the unique design of the Densah Bur consisting of four tapered flutes with a large negative rake angle allowing compaction autografting to occur[8] as well as the decrease in temperature during implant site preparation with osseodensification technique.[22]

However, in agreement with Aloorker et al (2022)[23] and Al Ahmari et al (2022)[24] the results of this study showed that there was no statistically significant difference in marginal bone height changes between the two groups in the six months', the six to twelve months', and the twelve months' follow-up periods.

The previously mentioned researches state that there is no statistical difference between the crestal bone levels between osseodensified sites using Densah™ burs when 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.

CONCLUSION

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

Although osseodensification drilling technique showed better results regarding bone height changes around dental implants than the conventional technique, both drilling techniques are reliable for creating osteotomies for implant placement.

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