EGYPTIAN
DENTAL JOURNAL
www.eda-egypt.org

Vol. 70, 531:541, January, 2024

Print ISSN 0070-9484 • Online ISSN 2090-2360

Fixed Prosthodontics and Dental Materials

Submit Date : 20-12-2023 • Accept Date : 23-12-2023 • Available online: 10-01-2024 • DOI : 10.21608/EDJ.2023.249777.2787

RADIOGRAPHIC EVALUATION OF ALVEOLAR BONE HEIGHT CHANGES AROUND MANDIBULAR IMPLANTS WITH DIFFERENT SURFACE TREATMENTS SUPPORTING MANDIBULAR OVERDENTURE (A SPLIT MOUTH COMPARATIVE STUDY)

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ABSTRACT

Aim: This study was conducted to evaluate bone changes around micro textured acid-washed surface implants and sandblasted and acid-etched surface-treated implants in the mandible of fully edentulous patients.

Materials and methods: Assessment of marginal bone loss around the implant was performed using cone beam radiography. Bone resorption was measured as the distance between the implant-abutment connection and the first implant-bone contact. Implant dimensions, width and length, were used for software calibration to compensate for radiographic magnification. The two installed implants were early-loaded. Marginal bone loss was evaluated during the early loading period after 6w ad 3m months by subtracting bone level values in millimeters of buccal and lingual aspects of each implant from values at base line and averaged .

Results : As a result of these studies, there is no statistically significant difference in bone loss for Implant I (microtextured, acid-washed implant surface treatment) compared to Implant II (Neodent Aqua, sandblasted acid-washed implant surface treatment) However, it was shown statistically that there was a significant difference between the two assessment of bone loss between two periods of 6 W and 3 M.

Conclusion: Based on this discussion, it can be concluded that both implants with different surface treatments have a desirable effect on the alveolar bone surrounding both mandibular implants.

KEYWORDS: Radiographic evaluation , mandibular implants , surface treatment , mandibular overdenture and stud attachments.

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INTRODUCTION

The use of dental implants may provide a mechanical means to maintain and improve complete denture stability and support in damaged dental arches, especially in the mandible. [1]

Implant-supported and immobilized restorations have come a long way in recent decades. However, the patient's economic considerations are an important factor when choosing this prosthetic option, and implants with the desired surface profile will promote better Osseo integration and increased the contact between bone and implant. [2.]

Osseointegration of dental implants is an important key to success. This resembles a direct contact between the bone surface and the implant, developing a stable subclinical union with the bone and maintaining that union throughout function. Various improvements in the surface preparation of dental implants have been introduced in recent decades to improve or accelerate this process, especially in edentulous areas with poor bone quality. [3,4.]

Especially in the dental implant industry, surface treatments are often performed to modify and maintain desirable properties of the base material. Surface area can be increased significantly using appropriate modification, addition or deletion techniques.Surface treatments alter the surface topography and energy, improving wetting, cell proliferation and growth, and promoting osseointegration.[5] .

There are many different surface treatments for dental implants, including titanium and hydroxyapatite (HA) plasma spraying, various types of blasting particles (sand, glass, aluminum oxide), acid etching, anodizing, and intense laser irradiation. [6]

Implant stability reflects the osseointegration of the implant, as certain goals must be achieved during implant placement and healing. Stability can be classified into two types. Primary stability was assessed immediately after implant placement and secondary stability was assessed after peri-implant healing..[7]

However, secondary stability develops as a result of various processes, such as bone deposition and remodeling at the interface of the bone implant, in contrast to primary stability, which is a mechanical phenomenon caused by locking of the implant bone shortly after implant placement. Implant stability was evaluated using a variety of techniques including histological examination, radiography, percussion testing, reverse torque testing, torque resistance testing, frequency instrument analysis and resonance timing (RFA) numbers. Secondary implant stability is influenced by many factors, such as topography, bone quality, and patient factors. [7,8]

MTX is an uncoated micro-textured surface that is coated by sintering the machined titanium implant surface with HA particles, then washed in a non-irritating acid bath and distilled water to remove the residual blasting material. 8

However, surface treatment of the implant surface by acid itched sandblasting causes macro-roughness and micro-scars at the same time. Surface erosion is caused by the action of strong acids on rough surfaces. The process involves spraying successive blasts of large sand particles containing caustic acid. This process increases surface area and surface energy on the implant surface, improving implant placement and osseointegration.8

The advent of dedicated cone beam computed tomography (CBCT) for maxillofacial imaging has revolutionized maxillofacial imagin.Due to the low patient radiation dose and the rapid acquisition of volumetric images in a single scan (only 18 seconds) , the effective dose of CBCT technology is significantly lower than that achieved by other methods.CBCT provides multiple planar images of both jaws in one rotational scan.. [9,10]

CBCT can be used to image maxillofacial structures using various voxel sizes. The voxel size of CBCT is up to 0.125 mm, which is smaller than traditional CT equipment. The smaller the voxel size, the better the image resolution and the higher the radiation dose required. voxels are isotropic (uniform in all directions). Isotropic voxels in CBCT help maintain image quality in all three orthogonal planes (axial, vertical, and horizontal). There are several CBCT systems available on the market. CBCT software provides tools for measuring distance, angle, zoom, grayscale inversion, contrast adjustment, and gamma shift.[11,12]

CBCT is widely used in the postoperative period for dental implants because it can obtain three-dimensional images of bone at a lower radiation dose and higher cost than conventional CT.Several studies have reported the use of CBCT to evaluate peri-implant defects and bone wall appearance. Studies show that 94% of CBCT measurements are accurate to within 1mm.[13,14]

So, the purpose of this study was to evaluate the effect of two different surface treatments of two mandibular implants supporting a mandibular overdenture on changes in alveolar bone height.

MATERIALS AND METHODS

Twelve patients with complete tooth loss (6 men and 6 women) between the ages of 40 and 60 were selected from the Department of Prosthodontics outpatient clinic, Faculty of Dentistry, Cairo University, according to the following criteria: Normal bone and joint relationship, Normal symmetrical face, Last canine extracted at least 6 months old, Sufficient quality and quantity of bones in the foramen, Minimum space between arcs is 12 mm, The width of the keratinized mucosa is greater than 6 mm and no temporomandibular disorders .

However, patients with general contraindications to surgical procedures such as chemotherapy and radiotherapy, patients with metabolic disorders affecting bone integration such as uncontrolled diabetes, osteoporosis, patients on corticosteroid therapy and long-term immunosuppressive therapy, patients with coagulation disorders and on anticoagulant therapy, remaining flabby tissue or knife edge of the ridge, patients with psychological disorders and heavy smoking are excluded from the study.

Complete dentures were constructed for the upper and lower jaws. Dentures are tested for retention, expansion and stability. All necessary adjustments were made and the patient was informed about prosthesis care and follow-up visits. Patients wore the prosthesis for 6 weeks to increase neuromuscular adaptation and make necessary adjustments.

The mandibular prosthesis is duplicated and the contrast gutta percha markers are placed in the intaglio portion of the prosthesis to act as an X-ray stand to precisely define the canine area on the radiograph cone-beam computed tomography (CBCT), to measure the height and width of the previous bone for implantation ,then used as a surgical stent for implant delivery.

Two implants with different surface treatments measuring 3.7 x10 mm were inserted into the mandibular arch. All patients received Zimmer dental TSV MTX,USA Microtextured acid washed implant surface treatment (Group A) on the right side and Neodent helix GM acqua,USA implant surface treatment with sand blasted acid itched (Group B) on the left side. (Fig 1,2)

Two days before surgery, patients were asked to rinse their mouth with Chlorhexidine 0.12% (Antiseptol) (Chlorhexidine Mouthwash, Kahira co. Egypt.) gargle three times a day, oral antibiotic Prescribe 875 mg amoxicillin and 125 mg clavulanic acid. Acid in the form of potassium clavulanate (Augmentin 1g) (Amoxacillin Clavulinic acid, Glaxo-Smith Kline-Becheem, UK) twice a day.

The osteotomy site was prepared according to the drilling sequence provided by the manufacturer's

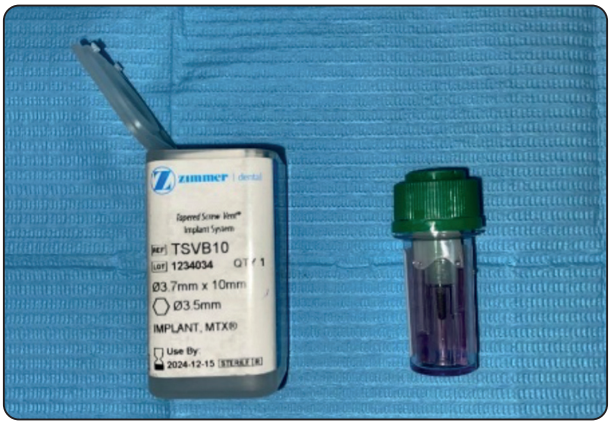

Fig. (1) Zimmer dental TSV MTX,USA Microtextured acid washed implant

Fig. (2) Neodent helix GM acqua,USA implant

surgical kit. A positioning drill is used with an external irrigation tube with a length of 6 mm, followed by a 2.3 mm drill to the working length, a parallel pin is inserted into the osteotomy hole created to fix the angle for the correct body. If possible, any discrepancies are corrected with a subsequent 2.8 mm x 10 mm long drill, a consecutive 3.2 mm drill, then a final 3.8 mm drill. A parallel pin is inserted into the prepared osteotomy on one side to guide the osteotomy on the other side.

The 3.7 x10 mm Zimmer dental TSV MTX,USA Micro textured acid washed implant surface treatment (Group A) was initially manually pressed into the right mandibular opening. While Neodent helix GM acqua,USA implant surface treatment with sand blasted acid itched (Group B) was initially drilled on the left side. The implant installation is then carried out using a torque ratchet until the implant base is flush with the bone surface with a torque of 35N. The healing screw was fixed in place on both implants.

Final complete restorations are loaded as early as 6 weeks after surgery. The healing abutments were removed and the ball abutments were tightened to the implant at 20 N. (Fig 3)

Fig (3) Torqued ball abutmets

The pick up procedures have been done where the prosthesis has been sufficiently relieved opposite to the metal housing of the attachment until the joint is fully guided by an occlusion that matches the opposing arch. A small hole was made lingualy in the cleaned area to allow the acrylic resin used in the impression to escape. A small rubber dam is placed under the spheres to prevent the acrylic from flowing into the undercuts. the acrylic resin was mixed and placed at the areas of the holes then the denture seated in its place (fig4).

The denture removed before complete curing to ensure the transfer of the metal housing into the fitting surface of the denture and also to make sure that no acrylic resin was trapped into the undercut, then the denture reseated again .Once the acrylic has hardened, the denture is removed from the patient's mouth for finishing and polishing (fig5).

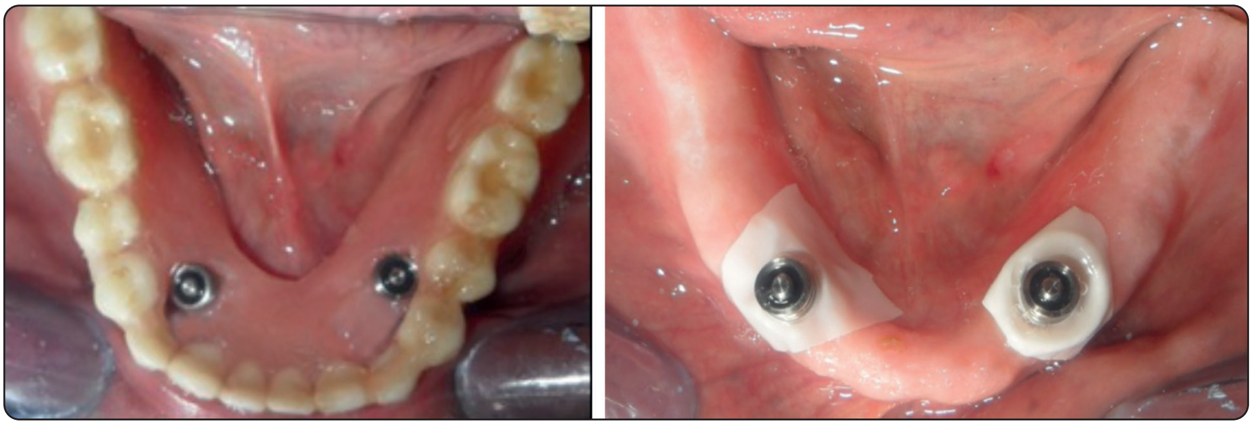

Fig. (4) Pick up procedures

Fig. (5) The final picked up complete denture

The Prosthesis were assigned to the patient and trained to insert and remove the prosthesis in addition to appropriate oral hygiene measures. Patients were scanned and recalled at 6w and 3m for early loading evaluation.

The two installed implants were early-loaded then CBCT scans were performed at 3 and 6 months using Cranex 3D,Soredex Finland CBCT machine using metal artifact reduction algorithm and exposure parameters (field of view 6*8,KvP 90, mA 10 and voxel size 200μm. then data was imported to On Demand 3D software for evaluation of bone loss.

Marginal bone loss was evaluated during the early loading period after 6w and 3m months by subtracting bone level values in millimeters of buccal and lingual aspects of each implant from values at base line and averaged .(fig 6 a and b)

The bone level is considered the distance between implant platform (point A) and first point of implant-bone contact (point B).

Measurements were taken using linear measurement tool on cross sectional images after adjusting the vertical and horizontal axis of the implant fixture with the soft ware vertical and horizontal reference lines for standardization.

All data was collected and sent to the statistician for the analysis required in mean difference and standard deviation.

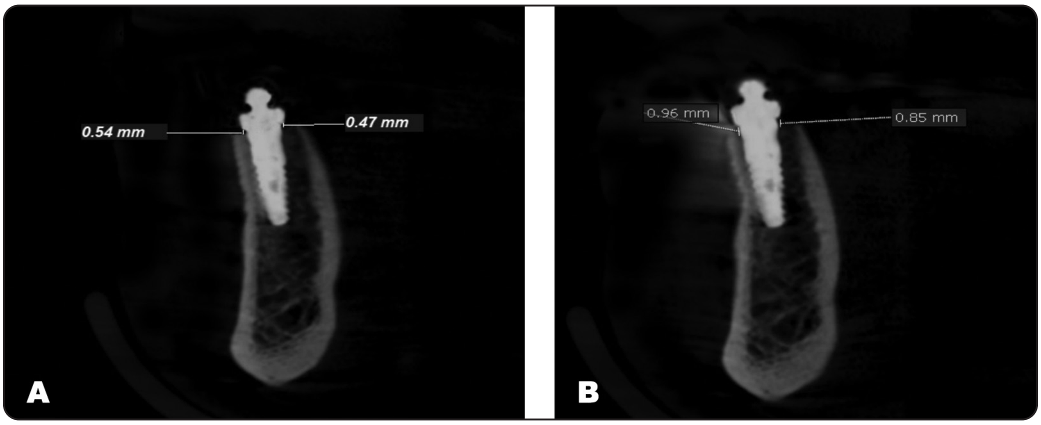

Fig. (6 a) Bone level at 6 weeks (b) bone level at 3 months

RESULTS

The mean and standard deviation for each group for each experiment were calculated. Normality of the data was examined using Kolmogorov-Smirnov and Shapiro-Wilk tests.The data showed a parametric (normal) distribution.several samples t.test

This test was used to compare two groups of her in related samples. An independent samples t-test was used to compare two groups of unrelated samples.

Significance level was set at P ≤ 0.05. Statistical analysis was performed with IBM® SPSS® Statscan version 20 for Windows.

Bone loss:

1) Effect of time:

A) Implant I (Zimmer):

It was revealed that there was a statistically significant difference between the (6 weeks) and (3 months) groups with (p <0.001). The highest mean value was detected at (3m), while the lowest mean value was detected at (6w).

B) Implant II (Neodent)

There was a statistically significant difference between (6 weeks) and (3 months) groups where (p<0.001). The highest mean value was found in (3m), while the least mean value was detected at (6w) group.

2) Effect of implants:

A) At 6 weeks:

There was no statistically significant difference between the (Implant I) and (Implant II) groups (p=0.196).The highest mean value was found in group (implant II) and the lowest mean value was found in group (implant I).

B) At 3 months:

There was no statistically significant difference between the (Implant I) and (Implant II) groups (p=0.055). The highest mean value was found in group (implant II) and the lowest mean value was found in group (implant I). (Table 1), (Fig 7)

TABLE (1) The mean, standard deviation (SD) values of bone loss of different groups.

Variables	Bone loss				
	Implant I (Zimmer)		Implant II (Neodent)		p-value
	Mean	SD	Mean	SD	
After 6w	0.55	0.03	0.57	0.03	0.196ns
After 3m	0.86	0.02	0.89	0.05	0.055ns
p-value	<0.001*		<0.001*		

; significant (p<0.05) ns; non-significant (p>0.05)

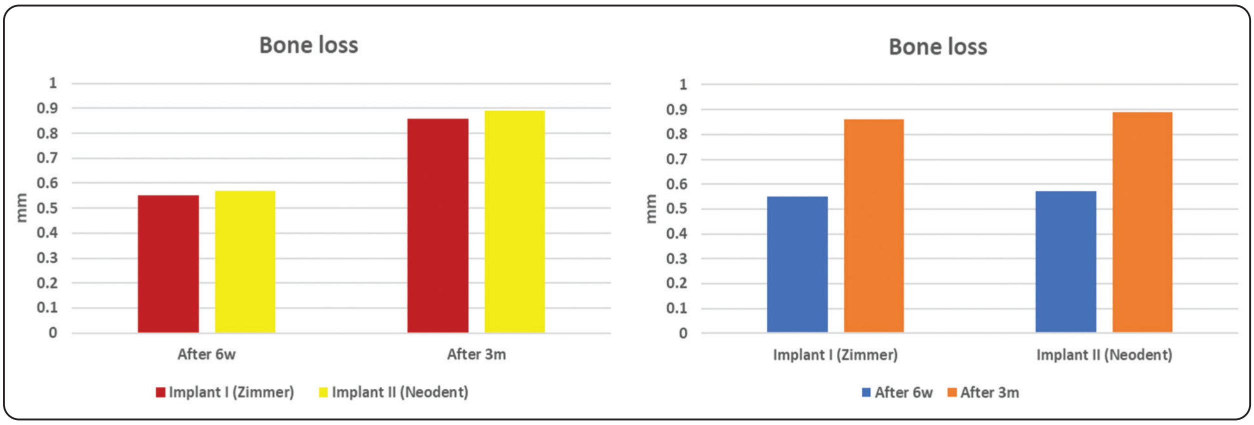

Fig. (7): Bar chart representing bone loss for different groups

DISCUSSION

Implant-supported overdentures are considered a reliable treatment option for the rehabilitation of edentulous elderly patients. Dental implants are one of the most advanced treatment options in the rehabilitation of patients with partial or complete tooth loss. Implants have superior advantages over conventional treatment methods, including bone preservation, adjacent tooth preservation, aesthetics, and durability. Doundulakis et al., reported a cumulative success rate of 94.5% for implants and 100% for dentures.[15,16]

Surface treatment can also be divided into mechanical, chemical and physical processes.

In dental implants, surface treatments are used to modify the surface topography and energy, resulting in improved wettability, cell proliferation and growth, and promotion of osseointegration.[17,18].

The quality of dental implants is determined by their surface condition.Biocompatibility and surface roughness of materials play important roles in good tissue interaction and integration. Goyal et al. observed that increasing roughness increases the surface area of the implant, improving cell migration and attachment to the implant, and improving bone integration.[19]

The literature to date has identified most surface treatment methods that provide good results for dental implants. Coatings have been shown to significantly increase the surface area of the implant. The surface treated with titanium plasma spray has the highest surface roughness value (3.43 ± 0.63 μm) compared to the machined surface (0.15 ± 0.04 μm) 20 (3.43 ± 0.63 μm) compared to the machined surface (0.15 ± 0.04 μm) [20].

Wound healing time was improved using hydroxyapatite (HA) coatings compared to untreated coatings. The behavior of the modified surface in cell culture studies showed that the acid-etched zirconia implant surface showed significant improvement in cell proliferation, except for bone integration and adhesion ability on the first day of culture.[21,22].

Titanium is the material of choice for dental implants because its properties meet important requirements such as good biocompatibility, corrosion resistance, high durability, relatively low modulus of elasticity, and good machinability. [23, 24]

Furthermore, surface modifications are used on implant surfaces, mainly to improve wettability, cell-implant adhesion and adhesion, cell proliferation and integration, and thus healing and treatment time. Therefore, much research has been conducted to improve the surface modification of existing implants to achieve the desired biological response. [25]

The surface topography was also treated by acid etching or sandblasting of the surface, to achieve a better topography and therefore a better roughness. Among its mechanisms, the roughness of titanium implants is considered as one of the important parameters influencing the speed and quality of osseointegration.[26.]

Another method of roughening the surface is sandblasting. This involves injecting particles of ceramic or quartz material under pressure onto the surface of the implant.Materials such as sand, hydroxyapatite, aluminum oxide, and TiO_2 granules are commonly used for these purposes. [27, 28].

Grit blasting surface treatment is always followed by an acid etching surface treatment to remove the residual blasting particles. Hence, the grit blasting has been considered as one of the means to embed surface contaminants on the substrates. Surface micro hardness of zirconia particles on titanium surface via blasting was found to be far larger than a controlled polished titanium surface particles.[29]

Aparicio et al.also performed sandblasting with aluminum oxide. Particle sizes ranging from 425 to 600 μm were used to achieve high surface roughness values in the range of 4.15 ± 0.26 μm. A study by Bacchelli et al. The conducted in vivo study revealed that the surfroughness of deposited titanium treated with commercially pure Ti was the highest at 8.55 ± 0.78 μm, followed by ZrO_2 spray which improved the osteogenic ability. This indicates that sandblasting also plays an effective role in creating an optimal surface roughness for dental implants, promoting osseointegration and improving bone healing around the implant.[30]

However, sandblasting, rough etching, and acid etching (SLA) are other surface treatments that cause surface erosion by applying strong acids to the blasted surface. This treatment combines blasting with coarse sand particles and continuous acid etching to achieve macro-roughness and micro-pitting, increasing surface roughness and improving osseointegration. [31,32].

They also found that implants treated with sandblasting and subsequent (HCl and H_2SO_4) promoted osseointegration during the healing phase and showed significant improvement. Regarding biological activity. Additionally, biological evaluation was performed by Kim et a., found that human osteoblasts grow faster on ALS surfaces, providing more space for cell attachment and proliferation. [33,34]

Cho and Jung found the presence of large voids (about 5μm to 20 μm in diameter) and micropores (about 0.5 μm to 3 μm in diameter) on the SLA surface, indicating an increase in surface roughness and an increase in surface area. Therefore, SLA-treated surfaces are believed to be helpful in improving tissue integration and cell proliferation..[35]

These findings coincide with the results of our study that showed that both implants with different surface treatments exhibited minimal bone loss detected at the first evaluation at 6 w(insignificant difference), however the amount of bone loss increased with time period from 6w to 3 m (significant difference) which may be attributed to the early loading of the installed implants with the mandibular overdenture.

However, clinical and experimental studies have shown that osseointegration can be achieved with early and immediate loading protocols.The clinical results of early-loading implants to support mandibular dentures have been compared with early- and immediate-loading protocols, showing high success rates with similar results. [37,38].

Early studies have proposed preloading protocols for implant-supported maxillary dentures that were developed based on the use of a particularly rough titanium surface [39,40.]

Early implant loading of mandibular dentures (1 week to 2 months) is recommended without affecting implant success rates.[41.42,43]

Assessing the degree of marginal bone loss is an important criterion for implant success.44.Various studies have presented data on marginal bone loss associated with long-term results of implant-supported mandibular prostheses. Factors that influence these clinical outcomes include smoking, history of periodontitis, bone mass, and length of follow-up.[45].

In this study, CBCT was used to assess bone loss, as CBCT has high diagnostic accuracy in detecting peri-implant bone defects and is considered a useful and reliable tool for diagnosing peri-implant bone loss.[46.]

Additionally, Hilgenfeld et al., Sirin et al. and Cool et al.have been reported the high sensitivity in the detection of various peri-implant defects using CBCT. [47,48,49].

A metal artifact reduction algorithm was used in the CBCT scan because it has been reported to improve the detection accuracy of artificially created dehiscence near the implant. [50]

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