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Effect of One Piece versus Two Piece Mini Implants on Bone Height of Implant Retained Mandibular Overdenture

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Abstract

Severely atrophied mandibles are a common problem within elderly completely edentulous patients. Given their small diameters, long height and self-tapping characteristics, mini-implant retained over-dentures are a valuable treatment option in such patients. Mini-implants are usually once-piece implants, however recently two-piece mini-implants were introduced with aim of addressing angulation problems. The success of the latter has not been thoroughly studied. Crestal bone height measurements are normally used to evaluate implant success. Therefore, this study was conducted to evaluate the effect of one piece versus zero degree two piece ERA mini implants on crestal bone height of implant retained mandibular over-denture. Twelve male, completely edentulous patients ranging between sixty to seventy years old were randomly divided into two groups. Group A: patients were rehabilitated with four one-piece ERA mini-implant retained mandibular over-dentures and upper complete dentures. Group B: patients were rehabilitated with four two-piece ERA mini-implant retained mandibular over-dentures and upper complete dentures. Immediate loading was performed and crestal bone height measurements were conducted using Cone Beam Computed Tomography during loading, six and twelve months following denture insertion. No clinical and radiographic signs of implant failure were observed in both groups. Both groups showed a significant decrease in peri-implant bone height (within the acceptable range; less than one and a half millimeter within first year). The amount of bone loss between both groups during the follow up period was not significant. Due to the insignificant difference in bone loss, the choice between one and two-piece mini-implants narrows down to the surgical protocol. In case guided implant surgery (that eliminate angulation problems) are to be performed, given the simpler procedure one-piece mini-implants might be the treatment of choice. However, when guided surgery is not a viable option, two-piece mini-implants are preferred.

Key Words: Completely edentulous, One piece mini implant, Two piece mini implant, ERA mini implant, ERA attachment, Implant retained mandibular overdenture, Crestal bone loss

Introduction

With the rise of technological and scientific improvements in the dental field, the science of removable prosthodontics has proved great importance in changing patients' quality of life [1,2]. The introduction of implants and their usage in implant retained mandibular overdentures have led to massive improvements in denture retention, stability and masticatory efficiency [3-9]. Also in comparison to fixed prosthesis, they provide easier access for oral hygiene, easy modification of denture base and good aesthetics due to presence of labial flanges. Several studies showed high levels of satisfaction, improved efficiency and high masticatory performances in patients treated with upper complete dentures and lower overdentures [4,5,10-16]. The use of 2 implants to retain a mandibular complete denture has been considered by some as the standard procedure of treating mandibular edentulism [17].

Patients using old dentures for too long or patients suffering from systemic diseases or old age usually have atrophic mandibles with narrow bone width. The placement of standard implants with diameters larger than 3 mm is not possible due to their compromised ridges. In these cases, bone augmentation procedures should be performed to be able to insert standard implants, but these procedures require high degree of surgical skill and have significant side effects and morbidity [17-19]. The use of Mini implants is a unique and simple treatment modality which has been specially designed to support overdentures. They are considered an alternative to

the conventional implant regime and are ideal for thin atrophic ridges and varying bone qualities due to their thin diameters. Mini implants allow for minimally invasive trans-mucosal flapless placement, limit the requirement for hard tissue grafting procedures, are designed for immediate loading and are considered an affordable treatment option [17-20].

Different kinds of abutments have been used with mini implants such as ball and socket, Locators, Era, anatomic abutments for fixed crowns and even splinting bars were added to splint them together [17,18,21-23]. Era attachments used for the retention of overdentures have low supra-crestal heights making them ideal when treating cases with low inter ridge space. Their female portions are fixed to the fixture, while their male portions are fixed to the dentures' fitting surfaces. Due to their short height, less horizontal forces are exerted to the implants and less acrylic needs to be removed from the denture to accommodate them. Era attachments use replaceable nylon matrices with various elasticity, making it possible for the operator to adjust retention according to actual need. All these characteristics make them excellent attachments when using mini implants in the support and retention of mandibular overdentures [21,22].

The minimum number required for support and retention of removable prosthesis may be 6 in maxillary dentures and 4 in mandibular dentures, inserted with a high degree of parallelism (not exceeding 20 degrees) to ensure proper seating of the dentures [24-27]. Mini implants were first introduced as one piece implants that do not have separate

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abutments [17,18,26]. Recently, a new generation of two piece mini implants has been designed to help in solving the angulations/parallelism problems in this technique. Little information exists in the literature about the effect of two piece mini implants on crestal bone levels in comparison to the conventional one piece mini implants. This study was conducted to evaluate which mini implant; one piece or two piece, is less destructive to crestal bone around them.

Materials and Methods

Patients' selection

Patients eligible for the study were male patients, completely edentulous with age ranging between 60 to 70 years and for whom a decision had already been made to incorporate dental implants for the treatment of complete edentulism. Following Misch [28] rules of bone classification patients with bone density ranging from 850-1250 HU (D2) and bone height and width more than 15 mm and 4 mm respectively in the anterior region of the mandible (Division A) were included in the study. Exclusion criteria included severe maxilla-mandibular skeletal discrepancy, clenching habits, bruxism, temporomandibular joint disorders, smoking, history of head and neck radiation and systemic disorders that may prevent surgery, affect bone quality or contribute to bone resorption [29]. Following this criteria twelve qualified patients were chosen and motivated to the treatment. To fulfil the predetermined criteria, clinical and radiographic examinations as well as laboratory investigations were carried out for all patients.

Prosthetic procedure

Complete dentures were fabricated for all patients prior to implant installation to assure ideal implant placement in harmony with osseous anatomy, denture esthetics and abutment connection. Upper and lower primary impressions were taken for all patients using alginate (Tropicalgin normal setting, Zhermack Clinical, 45021 Badia Polesine, Rovigo, Italy) in stock trays. Next, upper and lower special trays were border traced using medium body rubber base (Speedex Medium surface activated, Coltène/Whaledent AG Feldwiesenstr. Altstätten/Switzerland) and secondary impressions were taken using light body rubber base (Speedex Light surface activated, Coltène/Whaledent AG Feldwiesenstr. Altstätten/Switzerland). Master casts were poured and occlusion blocks were fabricated on them. Centric occluding relation was recorded following the conventional wax wafer technique and mounting was performed on semi-adjustable articulator (Bio-Art A7plus articulator, Bio-Art Equipamentos Odontologicos Ltda c 2012, Rua Teotônio Vilela, 120 CEP 13568-000 Jardim Tangará São Carlos - SP). Setting up of teeth was done according to modified lingualized occlusion using modified teeth (Acrostone acrylic teeth, Vitamisr lab, Egypt). Waxed up dentures were tried in the patients' mouths, then flaked and processed into heat cure acrylic resin (Acrostone, Heat Cure, Acrostone dental factory, Egypt under exclusive license from WIW, England). Laboratory remounting was performed before finishing the dentures and occlusal discrepancies were adjusted. Any necessary adjustments were carried out to eliminate occlusal interference and the dentures were delivered to the patients. Follow up

visits were performed 24 and 72 hours post-delivery to ensure patients comfort and do any adjustments required. Following dentures placement and patients' adaptation, the mandibular dentures were duplicated in clear acrylic resin (Vertex Rapid Simplified; Vertex-Dental BV, Zeist, The Netherlands) to act as a surgical guide for implant positioning in the interforaminal region. Also to assure proper implants installation beneath the planned position which was determined by ideal denture contour and esthetics (Figure 1).

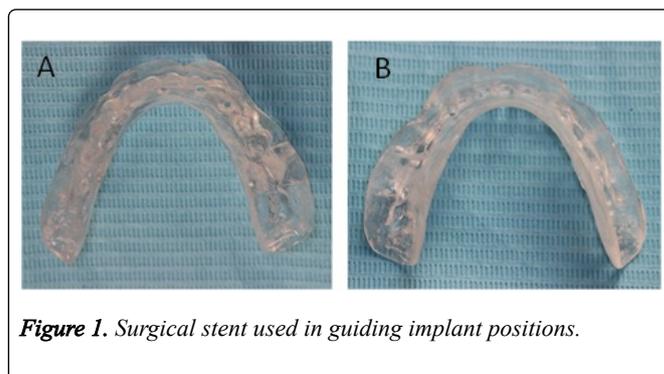


Figure 1. Surgical stent used in guiding implant positions.

Surgical procedures

All patients were randomly divided into two equal groups:

Group A: Six patients received 4 one piece Sterngold Era Mini implants (Machined, 0 degrees, micro. Sterngold ImplaMed, USA) 2.2 mm diameter, 13 mm length (Figure 2) equidistantly in the inter-foraminal region of the mandible.

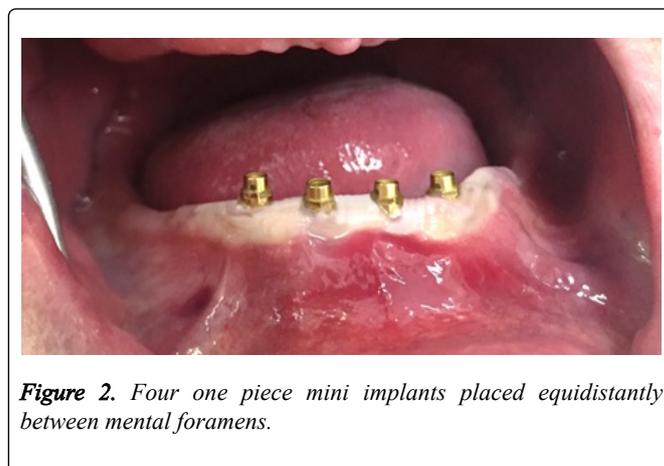


Figure 2. Four one piece mini implants placed equidistantly between mental foramina.

Group B: Six patients received 4 two piece Sterngold Era Mini implants (Machined, Angle Correction 0 degrees, Micro. Sterngold ImplaMed, USA) 2.2 mm diameter, 13 mm length (Figure 3) equidistantly in the inter-foraminal region of the mandible.

Flapless surgical technique was performed to the patients. Using the round bur drill, 4 marks were made in the mandible guided by the stent. The surgical stent was then removed from the patient's mouth, and using a 2.2 mm Countersink Drill with copious saline irrigation at a speed of 1000 RPM, the 4 osteotomy sites were prepared in a vertical direction and parallel to each other with the aid of paralleling posts. Implants were then inserted into their osteotomy sites using finger ratchet until moderate resistance was felt, then complete insertion was performed using hand ratchet.



Figure 3. Four two piece implants placed equidistantly between mental foramens.

Dentures were then relieved at implants sites and tissue conditioning material (GC Gold Label Glass Ionomer, GC CORPORATION, Tokyo, Japan) was added to the fitting surfaces to enhance denture usage by the patients.

Pick-up procedure

All patients were recalled 10 days after implants insertion (immediate loading).

For group A: Micro Overdenture Metal Jackets with black Fabrication Male nylon (pick up male nylons) were clicked on top of the fixed micro ERA female.

For group B: the Micro ERA female 0° were clicked and cemented on top of the mini implant fixtures using glass ionomer cement (GC Gold Label Glass Ionomer, GC CORPORATION, Tokyo, Japan), then the Micro Overdenture Metal Jackets with black Fabrication Male nylon (pick up male nylons) were then placed in their places above the female parts.

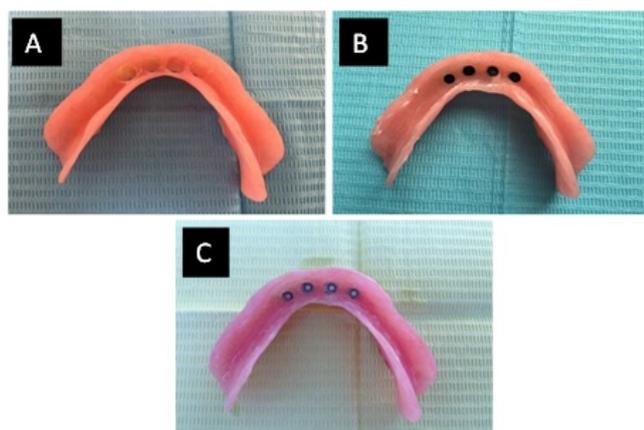


Figure 4. Pick-up stage (A) holes created in the fitting surface of the lower denture to accommodate the metal jackets (B) pick up conducted using black fabrication male nylons (C) replacing black fabrication male nylons with the white male nylons.

The mandibular overdenture base was relieved to accommodate the newly inserted attachments (Figure 4A). The denture was tried in the patient's mouth to ensure complete seating. Any undercuts were blocked out using Liquidam (Liquidam, soft tissue isolation, Discus dental,

LLC. Los Angeles, CA, USA). Lingual escape holes were opened to allow for escaping of excess pick up material and ensure proper seating of the denture on the tissues. Methyl methacrylate free self-curing rebase material (Tokuyama Rebase II Fast, Tokuyama Dental Corporation, Japan) was added to the relieved areas for direct pick-up of the male component of the ERA attachments (Figure 4B). The black Fabrication Male Nylons in the Micro Overdenture Metal Jackets were then replaced with the white male nylons (Figure 4C). Necessary adjustments were performed to the dentures to ensure proper occlusion and denture finishing. Patients were recalled 24 and 72 hours after insertion for any needed adjustments.

Radiographic evaluation

Marginal bone height change around the implants was evaluated by taking three Cone Beam Computed Tomography (Scanora 3Dx, Sordex, Finland); at the time of loading, after 6 months and 1 year of loading. Patients were instructed to remove their dentures before imaging. They were seated in an up-right position in the middle of the chair, back pushed against the back rest. The head support was adjusted to level the angle of the patients' heads. The temple supports of the machine were adjusted towards the patients so that they were positioned on both sides of their heads and closed to grip them, preventing patient movements. Patients were then instructed not to move during the exposure time (20 seconds). After exposure, the 3D image appeared on the computer screen display, the head support was opened and the patients were dismissed.

Image analysis

The mesial, distal, buccal and lingual, marginal bone height around implants were evaluated using the linear measurement system of the software (Ondemand 3D) supplied by the cone beam. From the coronal plane, the distal and mesial marginal bone height around the implants was evaluated. First a line was drawn horizontally tangential to the apex of the implant and perpendicular to its long axis.

Two lines were then drawn tangential to the mesial and distal surfaces of the implants, parallel to each other and extending from the highest level of alveolar crest to the horizontal line (Figure 5A). Similarly, buccal and lingual bone levels were calculated by using sagittal cross-sectional views (Figures 5B-5E). Average readings of the four surfaces at each interval were calculated and tabulated for statistical analysis. The measurements were carried out at loading, 6 and twelve months after loading. The marginal bone loss was obtained for two intervals. This was done by calculating the difference in bone height between the reading at 6 months and loading time for the first interval, and the difference between the readings at 12 months and the loading time for the second interval. All data was collected, tabulated and statistically analysed.

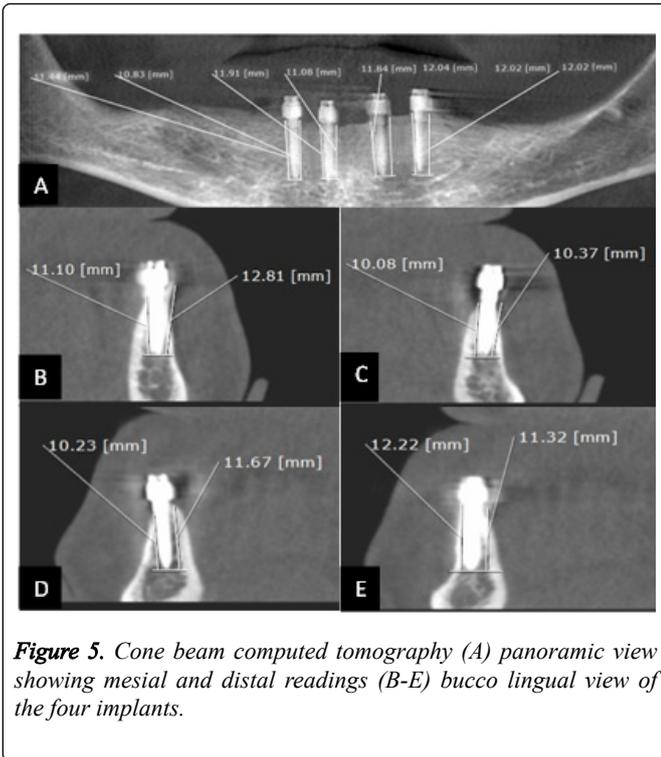


Figure 5. Cone beam computed tomography (A) panoramic view showing mesial and distal readings (B-E) bucco lingual view of the four implants.

Statistical analysis

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). All data showed parametric distribution. Numerical data were presented as mean, median, standard deviation (SD), minimum, maximum and 95% Confidence Interval (95% CI) values. Repeated measures ANOVA test was used to compare between bone heights measurements in the two groups as well as to study the changes by time within each group. Tukey's test was used for pair-wise comparisons when ANOVA test is significant. Student's t-test was used to compare between amounts of bone loss in the two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM (IBM Corporation, NY, USA), SPSS (SPSS, Inc., an IBM Company) Statistics Version 20 for Windows. The study results are represented in (Figures 6 and 7).

Results

Both groups showed a statistically significant decrease in marginal bone height. The mean value of marginal bone heights measured during loading, after six and twelve months for group A were 11.89 ± 0.31 , 11.38 ± 0.28 and 10.96 ± 0.20 mm respectively and for group B were 12.04 ± 0.42 , 11.32 ± 0.17 and 10.93 ± 0.11 mm respectively (Figure 6). However, when comparing marginal bone loss between the two groups, no significant difference was observed. The mean difference of marginal bone height for group A and B was 0.51 ± 0.11 mm and 0.72 ± 0.10 mm respectively for the first interval and 0.93 ± 0.09 mm and 1.11 ± 0.14 mm respectively for the second interval (Figure 7).

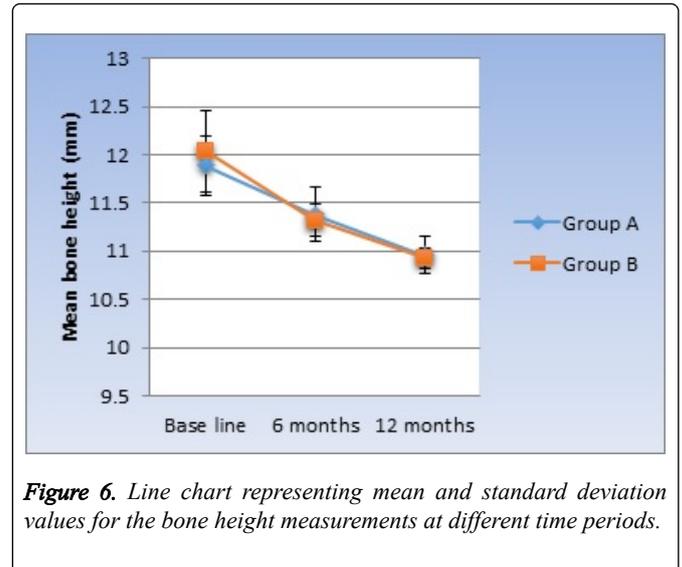


Figure 6. Line chart representing mean and standard deviation values for the bone height measurements at different time periods.

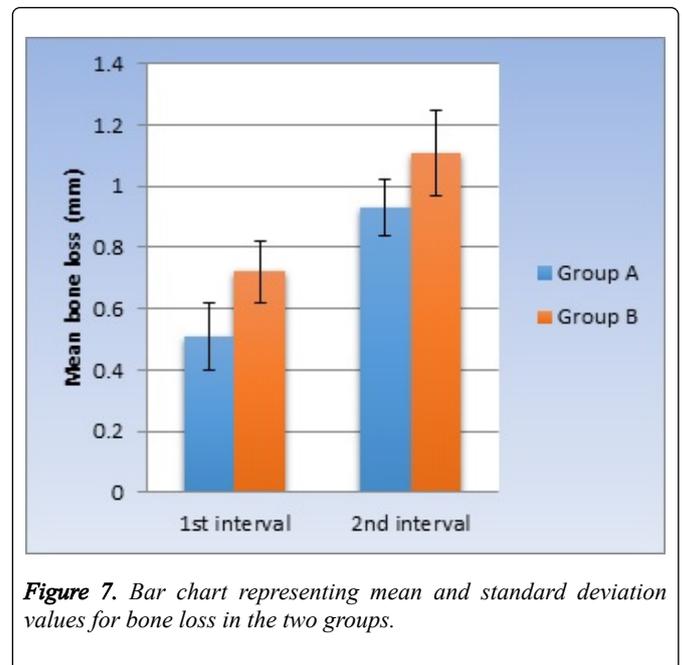


Figure 7. Bar chart representing mean and standard deviation values for bone loss in the two groups.

Discussion and Conclusion

The absence of clinical and radiographical signs of inflammation and infection around the implants, as well as the results of this study confirm the success of both groups since according to longitudinal studies, average alveolar ridge resorption adjacent to implants of approximately 1.2 mm to 2.0 mm at the end of the first-year and 0.1 mm annually were reported [2]. This also agrees with the findings of Cox and Zarb [30]. WHO stated that mean crestal bone loss reaching 1.6 mm is accepted as a radiographic sign for implant success during the first year of implant loading. This amount of peri-implant bone loss might be due to surgical trauma, bone osteotomy and healing process. Also it might be considered an immediate bone reaction after insertion of the prosthesis which attributed to the healing and reorganization following trauma to the bone and periosteum combined with remodeling due to implant loading [31]. Crestal bone loss could also be explained by the finding that forces applied on implants are concentrated on the crestal bone rather than along the entire implant/bone interface [32,33].

The insignificant difference between one or two piece ERA mini implants in regards to crestal bone resorption values may be attributed to different qualities; possessed by the two systems over each other; which make both of them successful in relation to crestal bone height levels. One-piece implant systems were designed to minimize crestal bone loss based on the theory that contamination of the implant–abutment junction (the microgap) and violation of the biological width are the causes for the initial bone loss in 2 piece implants [34-42]. On the other hand, in two piece implants, decreased stresses and strains are exerted on the peri-implant bone in comparison to the one piece implants during loading. This may be due to the dissipation of some of the forces falling on them through the fixture abutment-connection. These forces eventually may cause abutment loosening but will not cause stresses on the crestal bone [43]. Also, the 2 piece mini implants were cement retained, which adds to their stress distributing qualities. Luting cements have favorable properties that make them enhance stress distribution and improve axial loading of implants. In addition, cement retained designs permit the development of occlusal interdigitation and correct loading characteristics [44-46].

At this point of the discussion, due to the insignificant difference in bone loss between the two groups, the choice of whether to use one piece or two piece mini implants depends on whether guided surgical protocols are followed or not. In case guided implant surgery (that eliminate angulation problems) are to be performed, given the simpler procedure one-piece mini-implants might be the treatment of choice. However, when guided surgery is not a viable option, two-piece mini-implants are preferred.

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