ASDJ
AINSHAMS DENTAL JOURNAL

Print ISSN 1110-7642
Online ISSN 2735-5039

AIN SHAMS DENTAL JOURNAL
Official Publication of Ain Shams Dental School
June2022 • Vol. 26

Effect of Using Two Different Mini Dental Implant attachments on Marginal Bone Height and Prosthetic Maintenance in Implant Retained Mandibular Overdenture

Amr Mohamed Ismail Badr[1]

Background: Patients with thin atrophied mandibular ridges cannot receive conventional implants so the shift to mini-implants is mandatory instead of complicated surgical techniques.
Aim: The aim of this study was to evaluate radiographically the effect of using two mini-implant attachments on crestal bone level and prosthetic complications and maintenance were detected for both attachments.
Materials and methods: sixteen completely edentulous patients received conventional dentures. after one month of adaptation all patients randomly divided into 2 groups: patients in group I received 4 mini implants with ERA attachments while patients in group II received 4 mini implants with ball and socket attachments. Radiographic evaluation of crestal bone level was measured using CBCT. Moreover, Prosthetic complications and maintenance were detected for both groups.
Results: No significant difference were recorded between both groups regarding the crestal bone loss. While regarding the prosthetic maintenance the ERA group showed more complications that requiring adjustment and maintenance.
Conclusion: Within the limitation of this study, it can be concluded that four mini implant placement is considered an alternative treatment option to two regular size implants specially in thin atrophied mandibular ridges. The crestal bone loss during the one-year follow up for both attachment systems was moderate and within the acceptable limits. The ERA attachment group required more prosthetic maintenance than that of ball and socket group.

Key Words: ERA attachment, ball and socket attachment, Implant retained mandibular overdenture, Marginal bone loss and prosthetic maintenance.

1. Associate professor at Prosthodontic department, Faculty of Dentistry, Minia University.
Corresponding author: Amr Mohamed Ismail Badr, email: hanaa.gamal@miuegypt.edu.eg

Introduction

The use of two conventional implants retaining mandibular overdenture has been considered by many authors as the standard protocol for treating mandibular edentulism.[1]

Meanwhile, long-term denture wearers without serviceability, systemically impaired patients with diseases affecting bone quality and quantity or geriatrics usually have atrophied mandibular ridges with a narrow bone width, especially at the inter-foraminal region. Placement of a regular sized implant with a diameter more than 3 mm is not feasible in these cases with compromised ridges. In this case, additional complex surgical augmentation procedures with a high degree of surgical skills or ridge splitting are required to accommodate standard sized implants.[2,3]

The Glossary of Oral and Maxillofacial Implants defines the term "mini-implant" as an implant fabricated of the same biocompatible materials as other implants but of smaller dimensions. [4]

The Insertion of mini-implants supporting overdentures in narrow bucco-lingual atrophied ridges is a simple and minimally invasive trans-mucosal flapless technique. It is considered an alternative to the conventional implant regime, limiting the requirement for hard tissue grafting procedures and designed to expand the bone as they are placed in narrow osteotomy sites.[5]

Moreover, they can be used as a temporary stabilizer for dentures while conventional implants heal. [6-9]

The presence of limited current scientific guidelines and scientific evidence about long-term survival are considered the main disadvantages. [10,11]

The number of implants required to totally support or retain a removable prosthesis may vary from 4 to 6 in the maxilla and 4 in the mandible, installed with a high degree of parallelism to ensure proper seating of the dentures. [12-15]

Removable supported overdentures are considered superior to fixed prostheses, regarding the ease of cleaning around implants, better aesthetics in cases with incompetent maxilla-mandibular relationship, and easy modification of the denture base. Patients treated with upper complete dentures and lower overdentures showed a high level of satisfaction and better masticatory efficiency and performance. [16-24]

Various abutments can be used with mini implants, such as ball, ERA, Locator, and straight or angled regular abutments for fixed restorations. [25]

ERA attachment has many advantages as low profile height permitting its use in limited inter arch distances, less horizontal detrimental forces are exerted on the implants, their patrix is fixed to overdentures while the matrix is fixed to implants and the ease of changing the nylon matrices with various color coded giving different elasticity and different degrees of retention. [26,27]

Ball and socket attachment is one of the most common systems used as it is simple in design, easy to incorporate, and easy to change the nylon cap. It is commonly used with non-splinted implants for retaining overdentures.

The aim of this study was to evaluate radiographically the effect of using two mini implant attachments; the ball and socket versus ERA attachment on crestal bone level. Moreover, prosthetic complications and maintenance were detected for both attachments.

The null hypothesis was that there could be no significant difference in crestal bone loss and prosthetic complications between ERA and ball attachment used with mini implants retaining mandibular overdentures.

Materials and Methods

Selection of patients:

Sixteen completely edentulous male patients with age ranging from 60 to 65 years were selected from the outpatient clinic of the Prosthodontic department, Faculty of Dentistry, Minia University to be included in this study. the inclusion criteria are: systemically free patients, anterior mandible provided with minimal bone height of 15 mm, all the patients are angel's class I skeletal relationship between mandible and maxilla and enough inter arch space suitable to accommodate over dentures and attachments. The exclusion criteria are patients with class II or III maxilla-mandibular relationship, abnormal habits as clenching, bruxism, smoking, history of chemotherapy or radiotherapy and any systemic disease that may give risk to the patient from surgery, patients having tempro-mandibular joint disorders.

laboratory and radiographic investigations were performed for all patients. Also, they were informed about the study protocol, possible complications and follow-up times and finally signed an informed consent.

Prosthetic procedures before implant installation

All patients received complete dentures fabricated according to standard technique of construction and used for a period of one month to assure denture settling and adaptation. The denture teeth helped in accurate determination of implant positioning and esthetics. All patients were informed about the importance of follow up after denture delivery to adjust any occlusal interference and sore spots. After one month of adaptation, all dentures were duplicated into clear acrylic resin surgical guide (Vertex Rapid Simplified; Vertex-Dental BV, Zeist, The Netherlands) for accurate implant installation at the canine region.

Implant surgical protocol

All patients were randomly divided into two equal groups using a software (Minitab 17.0, Pennsylvania, USA) for randomization:

Group I: Eight patients received 4 one-piece Sterngold ERA Mini implants (Micro. Sterngold ImplaMed, USA) 2.4 mm diameter, 13 mm length equidistantly in the canine region of the mandible. (Fig. 1a)

Group II: Eight patients received 4 one-piece Mini implants (Cowellmedi Co., Ltd.48 Hakgam-daero 221beon-gl, Busan, Republic of Korea) 2.4 mm diameter, 13 mm length equidistantly in the canine region of the mandible. (Fig. 1b)

The seating the surgical guide was done intraorally, then determination of the proposed implant sites for flapless implant installation. Starting with the pilot drill, four indentations were made in the mandible guided by the stent. using a 2.2 mm drill with copious saline coolant at a speed of 800 RPM and torque of 25N, osteotomy sites were prepared in a way to be parallel to each other with the aid of paralleling pins. mini implants were installed using the implant insertion tool and then fastened directly to the osteotomy sites until slight resistance was felt, then complete insertion was performed using torque wrench.

Dentures were relieved at fitting surface area opposite to implant sites and a resilient liner (Coe Comfort; GC Corporation, To−kyo, Japan) was applied to the dentures and seated intraorally under biting force with opposing denture. After setting of the relining material, the excess materials were removed, then finishing and polishing.

Clinical Picking-up

All patients were recalled within one week after implants installation for immediate loading.

The mandibular overdenture base was relieved at the area opposite to mini-implants to accommodate the implant attachments.

Group I: The micro-overdenture metal Jackets with black nylon patrix were placed on top of the implant micro ERA matrix. 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). Escape holes were made lingually opposite to the implants to allow for excess pick-up materials escape 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 applied to the denture fitting surface at the area of attachments for direct picking-up. After setting of acrylic resin, the black nylons were removed and replaced by the white nylons. Any further adjustment was performed to ensure proper occlusion with opposing maxillary denture, any sore spots and finally the denture was finished and polished. (Fig. 1c)

Group II: The ball and socket (metal housing with nylon cap). The metal housing caps were attached to the mini implants ball, red modelling wax was applied to block the undercuts beneath the metal housings, escape holes were made lingually to allow for excess pick up material escape and to ensure proper seating of the denture and should be occluded with maxillary opposing denture. the dentures checked for the accurate fitting of the metal housing to the ball abutments of the mini implants and excess material was trimmed then Patients were instructed for the proper way of denture cleaning, usage, removal and insertion. (Fig. 1d)

Radiographic evaluation of crestal bone loss

A Cone Beam Computed Tomography machine (Scanora 3Dx, Sordex, Finland) was used for measuring the marginal bone height and change in bone height to determine the value of crestal bone loss around the implants. Three follow-up times were scheduled at time of loading, after six months and after one year.

The four implant surfaces crestal bone height were evaluated (mesial, distal, buccal and lingual) using the calibrated system of the software (On demand 3D) supplied by the CBCT. the coronal plane was used to measure the distal and mesial crestal bone height around the implants. Another horizontal line was drawn tangential to the apex of the implant and perpendicular to its long axis.

Another two lines were 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. Sagittal cross-sectional views were used for measuring the buccal and lingual crestal bone levels. (Fig. 2). All measurements were carried out at loading, six months and twelve months after loading. For measuring the crestal bone loss, the bone height difference between each follow-up times was calculated. This difference indicated the amount of crestal bone loss.

The crestal bone loss measured at three different intervals the first interval from loading time till six months and the second interval from six months till twelve months and the third interval from loading time till twelve months.

All the data were collected, tabulated and statistically analyzed.

Prosthetic complications and subsequent maintenance:

All patients had scheduled appointments once a month. All the prosthetic complications, services, and subsequent repairs were detected. The types of repair were classified into three categories. The first category was related to the mini implant itself i.e., abutment, fixture or the whole assembly. The second category was related to repairs of the dentures and teeth

fractures. The third category was concerned with soft tissue complications and denture adjustments i.e., sore spot under denture, Relining of overdenture, Occlusal adjustment of overdenture, Aesthetic problems, Excessive wear of teeth and hyperplasia under denture around attachment. The results of this outcome were recorded as descriptive not comparative.

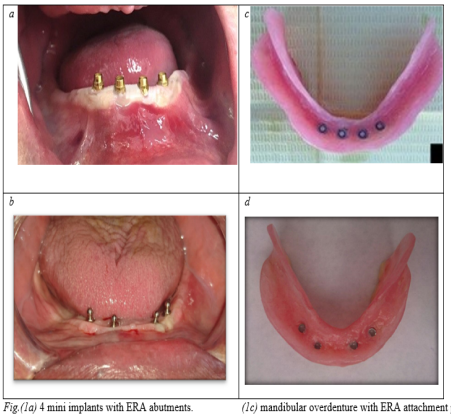

Fig.(1a) 4 mini implants with ERA abutments. *(1c)* mandibular overdenture with ERA attachment patrix

(1b) 4 mini implants with ball abutments. *(1d)* mandibular overdenture with metal housing and nylon cap matrix

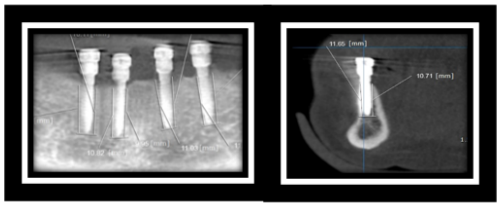

Fig. (2) CBCT for measuring the mesial, distal, lingual, and labial bone heights

Results

The crestal bone loss

The mean values of crestal bone loss at mesial, distal, lingual and buccal were analyzed for statistical significance. The data showed that there was no statistically significance between the four readings. Consequently, the four bone loss readings were added then divided by 4 to get the mean value of implant bone loss. Moreover, the data of the four mini implants showed no statistically significant difference so the readings of the four implants cumulated together and divided by 4 to get the mean marginal bone loss per patient. The crestal bone loss was measured radiographically at three different follow-up intervals, the first interval from baseline to six months and the second interval from six months to twelve months and the third from base line to twelve months. There was statistically significant change in marginal bone loss within each group at different follow up intervals.

However, when comparing marginal bone loss between the two groups at each follow-up interval, no significant difference was observed. The mean ± standard deviation of the crestal bone loss for group I and II was 0.47±0.23 mm and 0.53±0.21 mm for the first interval respectively, 0.41±0.19 mm and 0.39±0.28 mm for the second interval respectively, and 0.88±0.24 mm and 0.92±0.21 mm for the third interval respectively. (Table 1 and fig. 3)

(Table 1): Comparison of crestal bone loss values at different time intervals between the two studied groups

Follow-up interval	ERA Group I mean± SD	Ball and socket Group II mean± SD	P-value
First interval (0-6)	0. 47±0.23	0.53±0.21	0.2
Second interval (6-12)	0.41±0.19	0.39±0.28	0.14
Third interval (0-12)	0.88±0.24	0.92±0.21	0.18
P-value	0.032*	0.03*	

p-value at or less 0.05 considered significant

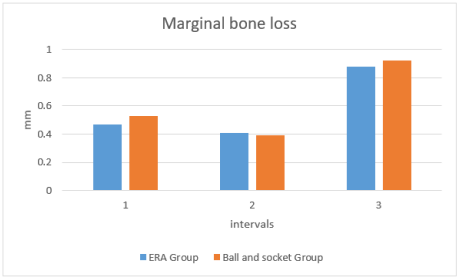

Fig. (3) Bar chart showing crestal bone loss values at different time intervals between the two studied groups.

The prosthetic complications and maintenance:

The overall number of complications and maintenance interventions and services provided were five in group I (ERA) and two in group II (ball) respectively. As an overview of the maintenance performed for both groups. the interventions counted for

group I were (2 sore spots, 1relining and 2 change of nylon male).
On the other hand, the maintenance interventions counted for group II were (1denture base resin fracture and 1 change of nylon cap). Regarding the rest of items, there were no maintenance interventions for both groups.

Discussion

All the patients included in this study showed no signs of clinical or radiographic failure of the implants. Only male patients were selected to be included in this study as old age females have been shown to be prone to osteoporotic changes after menopause, which might affect the implant-osseointegration. All patients were precisely selected and thoroughly examined clinically and radiographically to eliminate any factor or habit that might adversely affect the results and implant success. [28]

All patients received new traditional complete dentures before implant insertion. they used their denture for one month before implant insertion to allow a period of denture adaptation. Standard clinical and laboratory techniques were followed for the construction of the dentures for all patients.

All dentures were duplicated into clear acrylic stent to be used as a guide during implant installation. According to standard protocol being followed for implant installation, the parallelism between implants was checked by paralleling pins.
In the current study, 4 mini implants were used because sufficient number of mini-implants must be placed to adequately distribute loads generated during mastication. [29]

Surgical technique without incision of the soft tissue was preferred owing to the reduced bleeding, decreased post-operative trauma, shortened healing time, and decreased possibility to infection during surgical procedure and immediate loading.[30]

The clinical direct picking up was performed in this study due to its simplicity, fast and allow picking up under occlusal force. This particularly important to allow immediate functional loading by the prosthesis. [31,32]

According to guidelines of implant loading, immediate loading is defined as loading the implant immediately after installation or within two weeks, while conventional loading means loading the implant after 3 to 6 months of installation. in the current study all implants were immediately loaded and connected to the prostheses after one week of implant placement.

The mastication Forces transferred to the implants induce maximum stresses in peri-implant crestal bone. These stresses must be within allowed limits as higher stress concentration is one of causes responsible for crestal bone resorption and subsequent failure. Acrylic complete dentures can reduce the load and stresses transferred to dental implants.

The results of the current study confirm the success of both groups (ERA and ball) and corresponding to other longitudinal studies which reported that crestal bone loss around implants of approximately 1.2 mm to 1.5 mm at the end of the first-year and 0.1 mm annually as a successful implantation. [33]

Some authors stated that mean crestal bone loss reaching 1.6 mm at the first year of implant loading is considered accepted radiographically. The peri- implant bone loss might be due to, bone osteotomy, surgical trauma, and healing process. [34] Forces applied on implants are concentrated on the crestal bone rather than along the entire implant/bone interface this can explain the finding of this study. [35,36]

The crestal bone area bears the maximum stress around implants, acting as an indicator of implant health and is the most important area for primary stability which

governing the time of loading. Also due to less blood supply to the crestal bone area of implants which gained from the periosteum covering the bone compared to that of a natural dentition, gaining blood supply from periodontium. [37] Measuring the crestal bone loss with CBCT technique is considered in our study to measure the bone loss mesially, distally, labially, and lingually.

In the current study, the crestal bone loss in the both groups were minimal and could be attributed to the flapless technique of implant insertion which avoid the traumatization of periosteum, preserves the blood supply and hence the bone height around the implants. in addition, the immediate loading protocol could be another factor, as bone compression can help in minimizing the crestal bone loss and increase bone density in that area around the implants. [38-40]

The insignificant difference between ERA mini implants and ball mini implant in regarding crestal bone loss may be attributed to similarity of implant quality, design and attachment resiliency possessed by the two systems; which make both of them successful in relation to marginal bone height levels.

The null hypothesis was accepted, as no significant difference was found among the mini-implant groups regarding crestal bone loss.

The mini-implant designs prosthetic complications occurred during the first 6 months after insertion. The number of prosthetic interventions is 5 times in ERA group, while 2 times in ball and socket group.

Most of the prosthetic maintenance interventions were for change of nylon cap due to loss of retention. This may be explained by the differ in attachment design and mode of retention in both groups.

Conclusion

Within the limitation of this study, it can be concluded that four mini implant placement is considered an alternative treatment option to two regular size implants specially in thin atrophied mandibular ridges. The crestal bone loss during the one-year follow up for both attachment systems was moderate and within the acceptable limits. The ERA attachment group required more prosthetic maintenance than that of ball and socket group.

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