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DIFFERENT IMPLANT SUPPORTED MODALITIES OF COMPLETELY EDENTULOUS MANDIBLE

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ABSTRACT

Background/aim: The use of mini-implants and short implants have increased recently for treatments of patients with atrophic ridges or to over the anatomic limitationof implant insertion. However, the clinical effectiveness of short implants versus conventional implants or mini-implants was not fullyconsidered. Therefore, the aim of this research was to assess the marginal bone loss around short implants, mini-implants and conventional implants radiographically.

Materials and Methods:twenty-one completely edentulous patients were randomly categorized into three groups according to the type and distribution of dental implants inserted into the mandible. **Group I:** received 4 mini dental implants, **Group II:** received,two conventional implants in the interforaminal area, while **Group III:** received 2 mini dental implants in the lateral incisor/ canine area and 2 wide short implants in the first molar area.Marginal bone loss was assessed around the dental implants by cone beam computed tomography (CBCT) at denture insertion, after 6 and 12 months. Data was collected and statistical analysed by One Way ANOVA followed by Tukey`s Post Hoc test. TheSignificant difference was set at $P<0.05$.

Results: Bone loss in all groups showed a significant difference in all time intervals as $P<0.05$. In the time interval from denture insertion to -6 months, group III showed significant least amount of bone loss. While group I and II showed an insignificant difference of bone loss

Conclusion: The overdentures retained by two mini-implants anteriorly and two short dental implants posteriorly are successful treatment option with the least amount of bone loss when compared to 4 mini-implants overdenture or two conventional implants restoring a completely edentulous mandible.

Clinical Significance: To know the most appropriate line of treatment with different implant diameter and distribution in completely edentulous mandible.

KEYWORDS: Mini- implants, short implants, implant supported overdenture, implant distribution.

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INTRODUCTION

Nowadays, dental practitioners have different options in the management of totally and partially edentulous patients. The conventional treatment modality for these patients was the construction of a complete denture. However, those who received complete dentures were dissatisfied due of the lack of retention, support and stability of the complete denture leading to discomfort, and diminish of the patients' function.[1,2]

Utilization of dental implants in restoring the missing teeth started in the 1970's. This treatment concept consisted of using the dental implants to inspire the implant over-denture treatment modality, instead of the well-known tooth over-denture. As the dental implant was used instead of the missing teeth roots, the dental implants connected to the denture using attachments while attachments were optional in tooth over-dentures, they are mandatory in implant over-dentures to enhance the retention, support, and stability of the prosthesis.[3]

Dentists have a great potential to enhance their patients' quality of life and dental hygiene using implant-supported overdentures. In comparison to a conventional complete denture, the chewing efficiency of an implant-supported overdenture is increased by about 20%.The main reasons for a mandibular implant-supported over-denture include issues with mandibular dentures that are frequently encountered, including: lack of retention or stability, deteriorationof function, speech, tissue sensitivity, and soft tissue abrasion..[2]

The most used dental implants were those with diameters between 3.75mm and 4.1mm. Those dental implants were employed for numerous clinical situations and provide great scientific success particularly in the long-term treatment.[4,5]These dental implants are frequently considered as having the standard diameter of implants.However, with having the diameter standardized it poses a disadvantage that, Sometimes the distances between neighboring teeth and dental implants, as well as the accessible horizontal crestal dimensions of the alveolar ridge, are too narrow for practical application.[6]

Numerous authors advised that at least 1mm of residual alveolar bone should be present facially and lingually around the implant in order to improve implant success, which consequently requires at least 6 mm width of residual alveolar bone for the utilization of standard diameter implants. In addition, according to researchs that are currently available, a 3 mm inter-implant spacing is sufficient and advantageous for papillary fill.[7,8]

As an alternative to bone augmentation techniques, narrow implants are employed in clinical situations when there are small interdental gaps and narrow bony ridges.This method could benefit older patients or those with general medical risk factors since there is reduced surgical invasiveness. In addition, it is not a time-consuming treatment protocol with less complication and post-operative pain. The most important indication is their use in small inter dental or inter-implant gap, which usually found in premolar or incisor regions.[4]

Dental implants that are less than the standard diameter are categorized mostly based on their diameter or design (e.g., one piece or two piece). As a result, implants with a diameter below the standard diameter were considered narrow-diameter implants (3.5 to 3.0 mm) while the mini-implants diameter were less than (3.0 mm). The mini-implants are sometimes divided in hybrid implants (2.7 to 2.9 mm) and mini implants (1.8 to 2.7mm).[5]

Mini-implantsare one of the conceivable solution of problems associated withconventional implants such as, being too expensive to replace missing teeth. In comparison to conventional, they are less invasive and technically simpler. These narrow implants were often used where the thickness of the bone is insufficient.[9,10]

Implant size affects the area of potential bone retention. In addition, variables including occlusion, masticatory forces, the quantity of implants, and their placement within the prosthesis affect the forces acting on the bone nearby the implants.[11,12]Furthermore, stress distribution is influenced by load direction in addition to implant diameter and form.[13]

Although the clinical outcomes of direct comparisons between short implants and longer implants with the same surface design have not been fully evaluated in large prospective trials with a long follow-up, short dental implants can currently be regarded as an alternative for bone augmentation procedures in the posterior regions of the maxilla and/or mandible.[14,15]

Therefore, this research aimed to assess the marginal bone loss around short implants, mini-implants and conventional implants radiographically.

MATERIALS AND METHODS:

Patient selection:

Twenty-one completely edentulous patients were selected from the outpatient clinic of the Prosthodontic Department Faculty of Dentistry Misr for science and Technology University and the Dental clinics of Medical Excellence Centre, National ResearchCentre (NRC)according to the following criteria, the age ranged from 55 – 65 years, the lower residual ridges had adequate bone height covered by firm dense fibrous mucoperiosteum with no sharp bony spicules, Patientshave Angle's class-I skeletal maxillo-mandibular relationship and Patients had adequate interarch distance. While the exclusion criteria were, smoking patients, patients having parafunctional habits and systemic or metabolic disease that can affect osseointegration. These criteria were fulfilled through routine diagnostic procedures including history taking (medical and dental), clinical examination (extra-oral and intra-oral), and through laboratory investigation and radiographic examination. The randomization was done using research randomizer free software (copyright c 1997-2023 by Geoffrey C.Urbaniak and Scott Plous)

Sample size:

Sample size was calculated according to previous study [16] Maryod WH, Etal. This study sample size was 6 per group, when the mean ± standard deviation of group I is 0.72 ± 0.13 and mean ± standard deviation of group II was 0.51 ± 0.08 with 1.94 effect size the power was 80 % and type I error probability was 0.05. The Independent t test was performed by using G Power 3.1.9.7.

Ethical approval

This study was approved by the "Medical Research Ethical committee" (MREC)with agreement No: (5557082022) at NRC, Cairo-Egypt, which is in harmony with Helsinki Declaration of 1975. All patients were received detailed information about the practical steps of this research and signed the approval consent.

Denture Construction:

Alginate impressions of the maxillary and mandibular edentulous ridges were taken by the aid of stock trays and poured to obtain diagnostic casts. Customized trays were used to make the secondary impression by medium and light base rubber impression material. The obtained casts were poured, and upper and lower occlusion blocks were fabricated on the master cast. Provisional centric relation was recorded at the correct vertical occlusal dimension and the casts were mounted on a mean average articulator (Swagen, JakobsdalType,ARM Articulator) to evaluatethe interarch space, the maxillomandibular relationship, parallelism between the upper and lower ridges, and at least 15 mm vertical space for the mandibular denture. Complete denture was constructed from heat cured

acrylic resin following the conventional method. Patients were randomly categorized into three equal groups according to the type and distribution of dental implants inserted into the mandible.

Group I: patients received 4 mini dental implants (2.4 mm diameter and 13mm length).

Group II: patients received,two conventional implants with ball attachment system at the canine regions bilaterally with diameter of 3.7mm and 12mm in length.

Group III: patients received 2 mini dental implants (2.4 mm diameter, 13mm hight) installed in the lateral incisor/ canine area and 2 short conventional implants with (4.3 mm diameter and 6 mm length) installed in the posterior first molar area.

Radiographic stent preparation*:*

The finished mandibular dentures were duplicated, and the duplicate dentures were modified by fixing gutta percha markers to the planned future position of the implants along the buccal side bilaterally to be used as a radiographic stent. The radiographic stent was placed in the patient's mouth. The patient's mandible was radiographed using Cone Beam Computed Tomography scanning machine (CBCT) (CAT 17-19, Imaging Sciences International, Hatfield, PA). The patient radiographic stent was used as a surgical guide for implant insertion.

Surgical procedures

Field block anesthesia was used, and the surgical stent seated in position in the patient's mouth, to identify the positions of the implants.

The patients in group I received 4 mini-implants (3M dental implants-Italy measured 2.4 x 13mm) in the interforaminal area.At the planned implant site, a tissue punch was used to remove the soft tissues then a pilot drill with stopper at 13mm in length was used in a vertical direction and moved up and down during drilling with light intermittent finger pressure with internal and external irrigation, at speed 800 RPM. The mini-implant was inserted manually using the implant mount into the osteotomy made by the pilot drill, it was inserted under pressure in clockwise direction, when resistance was felt, the ratchet was then used to complete the full insertion of the mini-implant in the prepared osteotomy. The mini-implant was totally submerged except for its ball head which was fully protruded from the soft tissue (Figure 1). Patients were recalled 1 week later for implant loading. Patients were recalled after one week of implant insertion for implant loading. The metal housings with the rubber caps were attached to the implant heads and a wax spacer was used to block out any undercuts. A relief was made in the fitting surface of the mandibular denture opposed to the mini-implants head. The denture was checked for complete seating in maximum intercuspation. Thenrelived areas were filled with pink, fast cold-cure (Acrostone Dental Company, Egypt) acrylic resin mix in dough stage and the denture was inserted in patient's mouth and the patients were instructed to bite in maximum intercuspation till full curing. The dentures were removed, cleaned, any flash was trimmed, and occlusion was checked. Patients were instructed about denture hygiene and recalled for radiographic evaluation and assessment of marginal bone loss by CBCT.

Fig. (1): Mini implants placed in the interforaminal area.

For group II patients, two conventional implants (J dentalCare, JD Evolution, Italy, measuring 4.3 x 12mm) were inserted in the interforaminal area by the aid of surgical guides (Figure 2). The osteotomy was performed using three sequential drills sized 2.2, 2.8 and finally 3.7mm (3DDX, twist drills, America). Then implants were inserted with its top flushed with bone surface via depth controlling implant driver then covering screws were inserted. Patients were recalled after three month and the fixture positions were detected by palpation or by the aid of the surgical stent, the implants were exposed and ball heads (4.5mm in diameter and 2mm height, Dentis, Korea) were screwed to implant abutments and the female sockets were attached to implants ball heads and pick up of the dentures were done in the way as group I.

Fig. (2): Two conventional Implants in interforaminal area.

While group III patients received first, twowide short implants (J dental Care, JD Evolution, Italy, measuring 4.3 x 6 mm) in the first molar zone by the aid of surgical guide (Figure 3). Following the same technique of group II. Second, after 3 months patients were recalled to receive 2 mini-implants (3M dental implants-Italy measured 2.4 x 13mm) in the lateral incisor/canine area. Then after one week the patients were recalled to receivethe final restoration through direct pick up following the same technique as group I and II.

Marginal bone loss around the implants were assessed by cone beam computed tomography (CBCT) at denture insertion and after 6 and 12 month.

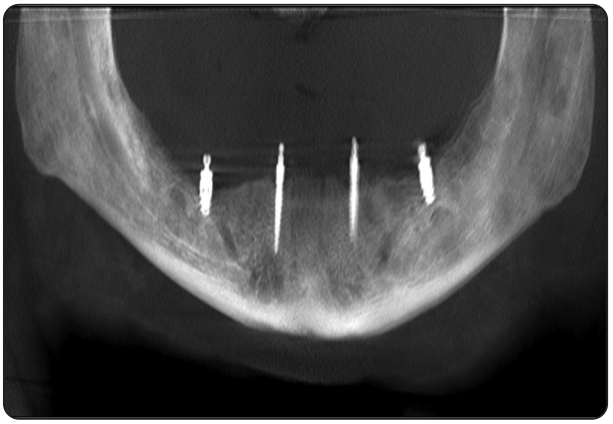

Fig. (3): Short implants in the first molar area.

Image analysis:

The marginal bone heights around the implants were evaluated (mesial, distal, buccal and lingual) using the linear measurement system of the software (RomexisViewer_Xray bat) with flat panel detector supplied by CBCT.

The marginal bone loss at different intervals was acquired by calculating the difference in bone height at that interval from the base line measurement.

Statistical analysis:

Statistical analysis was completed with SPSS 16 (Statistical Package for Scientific Studies), Graph pad prism & windows excel and presented in 2 tables and 2graphs. Exploration of the given data was performed using Shapiro-Wilk test and Kolmogorov-Smirnov test for normality which revealed that data originated from normal data.

One Way ANOVA test followed by Tukey`s Post Hoc test for multiple comparison were used to compare between the two groups while the comparison between the different intervals was performed by using repetitive One-Way ANOVA test followed by Tukey`s Post Hoc test for multiple comparison.

RESULTS

Bone loss around dental implants of the different groups at different intervals:

The bone loss of the tested groups was measured at different time intervals from denture insertion to 6 month, from 6 month to 12 month, and from denture insertion to 12 month.

The Minimum, maximum, mean and standard deviation of bone loss at different time intervals were presented in table (1) and figure (4).

Group I and II showed a significant difference between all intervals as P<0.0001. The time interval from denture insertion to 12 month showed the highest values of bone loss of both groups while the time interval from denture insertion to 6 month showed the least values of bone loss. For group III: the time interval from denture insertion to 12 month showed the highest significant values of bone loss while the other two time intervals showed insignificant lowest values of bone loss.

Bone loss around different dental implants of different groups:

Bone loss in all groups showed a significant difference in all time intervals as P<0.05.

In the time interval from denture insertion to -6 months, group III showed significant least amount of bone loss. While group I and II showed an insignificant difference of bone loss. Table (2) and figure (5).

Regarding the time interval from 6 months to 12 months**,** group III revealed a significant least amount of bone loss followed by group I while group revealed the highest significant amount of bone loss P<0.05. Table (2) and figure (5).

In the time interval from denture insertion to 12 months, group III also showed the least significant amount of bone and group II showed the highest significant values of bone loss as presented in table (2) and figure (5).

TABLE (1) Minimum, maximum, mean and standard deviation of bone loss in all groups and comparison between different intervals (effect of time).

Group	Interval	N	Min	Max	MD	SD	P value
Group I	Denture insertion -6Month	7	0.23	0.29	0.26 [a]	0.03	<0.0001*
	6 months - 12 months	7	0.31	0.37	0.34 [b]	0.03	
	Denture insertion -12Month	7	0.54	0.67	0.61 [c]	0.05	
Group II	Denture insertion -6Month	7	0.24	0.40	0.31 [a]	0.06	<0.0001*
	6 months - 12 months	7	0.51	0.57	0.54 [b]	0.02	
	Denture insertion -12Month	7	0.78	0.90	0.85 [c]	0.04	
Group III	Denture insertion -6Month	7	0.01	0.26	0.16 [a]	0.10	0.003*
	6 months - 12 months	7	0.23	0.28	0.26 [a]	0.02	
	Denture insertion -12Month	7	0.31	0.59	0.42 [b]	0.11	

Min: minimum Max: maximum MD: mean difference SD: standard deviation

**Significant difference as P<0.05.*

Means with the same superscript letters were insignificantly different as P>0.05.

Means with different superscript letters were significantly different as P<0.05.

TABLE (2) Mean and standard deviation of bone loss at different intervals and comparison between different groups (effect of used implant):

Time intervals	Group I		Group II		Group III		P value
	MD	SD	MD	SD	MD	SD	
Denture insertion-6Month	0.26 a	0.02	0.31 a	0.06	0.16 b	0.10	0.002*
6 months - 12 months	0.35 a	0.02	0.54 b	0.02	0.26 c	0.02	<0.0001*
Denture insertion -12Month	0.61 a	0.05	0.85 b	0.04	0.42 c	0.11	<0.0001*

*MD: mean difference SD: standard deviation *Significant difference as P<0.05.*

Means with the same superscript letters were insignificantly different as P>0.05.

Means with different superscript letters were significantly different as P<0.05.

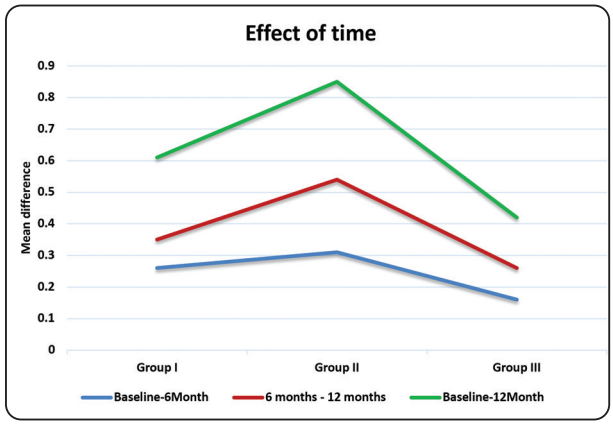

Fig. (4) Line chart representing bone loss changes by time in different groups.

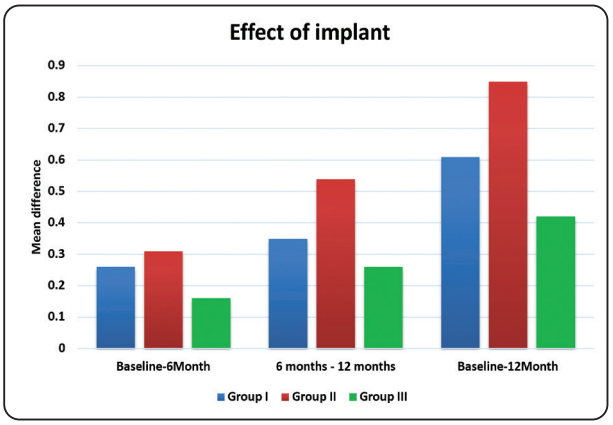

Fig. (5) Bar chart representing bone loss changes at different intervals in all groups.

DISCUSSION

Complete denture wearers usually complainingof decreased denture stability and retention especially the lower denture. The use of dental implants is a superior alternative, particularly in the mandibular ridge. Consequently, utilizing an implant-retained overdenture was seen as a practical and helpful rehabilitation approach[17] thatimproved stability, retention, chewing efficiency and overall patient satisfaction.[17,18]There are multiple factors that might affect the type and number of dental implants used in treating the edentulous mandible. Bone width, bone quality, anatomic limitation, medical condition of the patient, and patient's acceptance of surgery are among these factors. Two conventional implants in the interforamial region are the most common used treatment option which give considerable stability and retention but required specific bone width. As an alternative mini- implants are now available and can be instantly inserted in thin alveolar ridge with flapless approach without the need for ridge management. However, some anatomical consideration such as the bone height affect the placement of conventional implants or mini implants. The alveolar ridge has been augmented using a variety of methods, especially in the posterior mandibular region. In order to prevent substantial bone augmentation and the higher expense, using short implants might be a wise choice.[18] Several

studies have been published proposing that short implantsare successful treatment option of severely atrophied mandible. [19]

However, a detailed investigation of the clinical effectiveness of short implants in comparison to regular implants or mini-implants was not conducted. Thus, this research was designed to investigate the bone loss around different treatment modalities of dental implants retained and supported complete mandibular overdenture.

All implant types utilized in the three groups demonstrated less than 1mm of vertical bone loss over all time intervals until the end of the research which considered as one of implant successful criteriamentioned by Buser et al. [20], Smith &Zarb[21], Albrektsson and Zarb et al. [22]

It was spotted that the bone loss in the period from denture insertion to 6 month aroundall types of dental implants was the least amount of bone loss when compared to the period from 6 month to 12 month or from denture insertion to 12 month with least value was observed for the group that have two posterior short implants.

The bone loss was increased gradually in the period from 6 month to 12 month and from denture insertion to 12 month in all groups with the least values were observed in group III that has short posterior implants support and these findings were in agreement with results of Rizk et al.[23]Omran et al. [24]who found that there was an initial increase in boneloss after 6 month around mini-implant overdenture when compared to two conventional implant supported over denture. While after 12 month the marginal bone loss around the two conventional implant supported over denture was less than around mini-implant overdenture.

Other studies [25-28] compared the marginal bone loss of different implants size and length showed that marginal bone loss was decreased from 6 Months to 12 Months post-loading. This may be explained by the fact that as the number of implants increases, less force will be placed on each implant during function. [29-31]

The debates around marginal bone loss may be due to the lack of standardization in the techniques used to assess bone loss across studies may be the cause of. The use of periapical radiography and CBCTs are regarded as appropriate methods for determining the levels and loss of peri-implant bone.[32,33] Thus, in this research the CBCT was used to record the marginal bone loss due to its high accuracy.[34-36]

Moreover, the results from the current study are entirely supported by systematic reviews by Lee et al.[37] Srinivasan et al. [38] ,Atieh et al., [39]Telleman et al.[40]Monje et al.,[41]Draenert et al.,[42] and Karthikeyan et al.[43] that evaluated the marginal bone loss and survival rates of short dental implants are similar to long implants.

CONCLUSIONS

-The bone loss around the different tested types of dental implants was less than 1mm in the first year of follow up period and this is considered as one of criteria of implant success.

- The overdentures supported by two mini-implants anteriorly and two short dental implants posteriorly are successful treatment optionwith the least amount of bone loss when compared to 4 mini-implants overdenture or two conventional implants bone restoring a completely edentulous mandible.

Clinical Significance: To know the most appropriate line of treatment with different implant diameter and distribution in completely edentulous mandible.

Recommendations

Additional studies are recommended with longer follow-up duration to evaluate the amount of bone loss around each type of dental implant used.

Patient satisfaction and oral heath quality of life evaluation are recommended to correlate between the bone changes and patient satisfactions.

Author Contributions:

All authored are contributing the idea, research design, practical work and writing the manuscript.

Conflict of interest:

All authors have declared no confits of interest.

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