Two different designs of the four implants used for assisting mandibular complete overdentures: peri-implant alveolar bone height changes.

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Abstract:
Objectives: This study was done to compare between two designs of four implants used for assisting mandibular complete overdentures regarding the peri-implant alveolar bone height changes.
Methods: Ten healthy male completely edentulous patients of age ranging from 50 to 60 years were selected for this study. All patients received conventional complete dentures. The patients were divided randomly into two equal groups according to the four-implants design concept. Group A: Received four axially placed implants in canine and second premolar areas and Group B: Received four implants (two axial implants inserted in canine areas and two 30 degree distally inclined implants inserted in the first premolar areas). Ball attachments were screwed into implants to retain the overdentures. Peri-implant alveolar bone height was evaluated immediately, 6 months and 12 months after insertion of definitive overdenture. This was done using standardized periapical radiographs.
Results: When comparing between the means of peri-implant vertical bone loss (VBL) during the first and second 6months in each group (anterior and posterior), a statistically insignificant difference was found, although the higher VBL during the first 6 months. When comparing between the means of VBL around the anterior and posterior implants of group (A) during the observation times of the study, a statistically insignificant difference was found, in spite of the increased resorption around the posterior implants. Also, the VBL around inclined posterior implants of group (B) was found to be insignificantly more than the VBL around vertical anterior implants through the first and second 6 months. Finally, the mean of VBL around implants in group (A) was statistically insignificant less than that around implants in group (B).
Conclusions: Within the standard level of peri-implant bone resorption, the four axially inserted implants and the four implants inserted according to the All-on-four design can be used for assisting the mandibular complete overdentures. Assisting the mandibular complete overdentures by four axially inserted implants (in canines and second premolars areas) can be considered slightly more advantageous than the four implants inserted according to the All-on-four design.
Recommendations: Other studies with long follow up time and more patients in addition to other methods of evaluation are recommended to differentiate between the two studied designs.
Keywords: Implant assisted complete overdenture, Inclined implants, Vertical peri-implant bone loss.

Introduction

Edentulism is a dentition defect that is defined as the loss of all permanent teeth in the maxilla or (and) mandible. It has a critical effect on eating, talking, facial appearance and the quality of life. The conventional treatment for edentulism was a complete denture. However, the lack of stability and retention of mandibular complete dentures and decreased chewing ability have been common complaints. So, the restoration of the edentulous mandible with a conventional denture is no longer the first-choice prosthodontic treatment.(1)Advances in implant dentistry have allowed a shift from conventional complete denture to implant assisted overdenture for oral rehabilitation of edentulous patients. Retention and stability problems of conventional complete dentures have been solved using implants assisted overdentures, in addition to improved chewing efficiency and general patient satisfaction.(2)The number and distribution of loaded implants affect the peri-implant supporting alveolar bone. The use of two implants to assist the mandibular complete overdentures is stated, although it's problems of poor implant support and stability, mandibular ridge resorption distal to the implants due to stresses transmitted to the ridge as a result of rotation of the denture around the anterior implants and increase the rate of attachment wearing during function.(3) Adding two posterior implants may increase the support of the denture and prevent its rotational movements. In the mandible, the inferior alveolar nerve and associated structures may provide minimal bone for implant anchorage or prevent the placement of implants distal to the mental foramina.(4) The solutions of inadequate ridge height include vertical ridge augmentation procedures or cantilever prostheses. With the four intraforaminal implants, tilting of the posterior implants may represent another possible treatment option. The placement of distally inclined implants between the mental foramina makes it possible to use the implant assisted overdentures with long implants, eliminating the possibility of the inferior alveolar nerve damage and increase the distance between the implants.(5)

The aim of this study was to evaluate the alveolar bone height changes around implants of two different designs of 4-implants assisted mandibular complete overdentures.

Materials and methods

Ten healthy male completely edentulous patients of age ranging from 50 to 60 years were selected for this study. They are healthy, free from any systemic diseases and normal maxillofacial relationship "Angle`s class I". They have a good quality and quantity of mandibular alveolar bone covered with healthy firm mucosa and Inter-arch space suitable for insertion of implants with ball attachment and mandibular overdenture. Exclusion criteria for this study include the patients with history of anticoagulant drugs, immunosuppresses, chemotherapy and radiotherapy for any head and neck tumors, patients with Chronic temporomandibular joint disorders, history of Parafunctional habits, Alcoholics and smokers. For each patient, conventional complete denture was constructed and inserted. The stereolithographic guide template which used as a guide during implant insertion was constructed after one month of denture wearing without any complain. The patients were divided randomly into two equal groups according to the four implants design, Group A**:** Received four axially placed implants (13mm length×3.75mm diameter) in the mandibular canine and second premolar areas and Group B**:** Received four implants (two axial implants(13mm length×3.75mm diameter) inserted in the mandibular canine areas and two implants (16mm length×3.75mm diameter) 30 degree distally inclined implants inserted in the mandibular first premolar areas). The implants inserted using the one stage surgical technique. The ball attachments were screwed into the implants immediately after surgery. For the inclined distal implants in group B, the angulated abutments were placed over the implants by using the abutment holder to ensuring the parallelism with the anterior ball attachments and the ball attachments screwed over them and the immediate loading protocol was followed.

<u>Evaluation of peri-implant alveolar bone height changes</u>

Standardized intraoral radiographic evaluations were made immediately, 6 months and 12 months after fixation of the definitive attachments according to Sewerin 1990(6) To achieve reproducible periapical images, the paralleling technique was used with an occlusal bite index prepared from silicone material and fixed to a film holder. Then the film holder was attached to the cone of the radiographic unit after placement in the patient's mouth. Radiographs were scanned, digitized and stored in a personal computer. Mesial and distal peri-implant bone heights were measured using Corel draw program. Readings of mesial and distal bone levels adjacent to each implant were made to the nearest 0.01 mm. The vertical distance was measured between the coronal margin of the implant collar (taken as the reference point) (point A) and the most coronal bone-to-implant contact (point B). The distance between implant collar (point A) and first bone to implant contact (point B) indicated vertical bone level in mm (AB line). The alveolar bone height changes were measured by subtracting AB line length at Time of 6 months and 12 months after fixation of the definitive attachments from AB line at time of fixation of the definitive attachments at mesial and distal surface of each implant

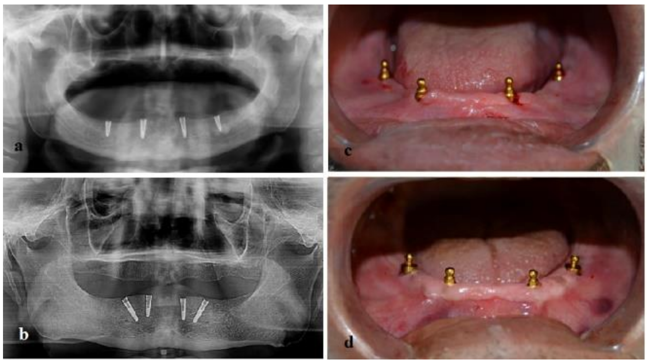

Fig 1: a) Post-surgical panoramic radiograph for group (A) b) Post-surgical panoramic radiograph for group (B) c) Ball attachments screwed into their implants for group (A) d) Ball attachments screwed into their implants for group (B).

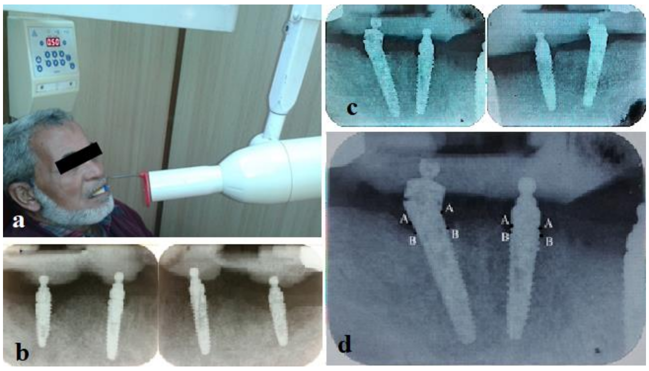

Fig 2: a) Standardized periapical radiographic exposure using the long cone paralleling technique b) Standardized periapical radiographs for group (A) c) Standardized periapical radiographs for group (B) d) AB line represent the peri-implant alveolar bone height measurements.

Results

Table 1: Comparison between the means of peri-implant VBL during the observation times and between the means of the peri-implant VBL of anterior and posterior implants during the different intervals of the study in group (A).

Intervals	Anterior implants	Posterior implants	T	P
The first 6 months	0.3780 ± 0.0421	0.4060 ± 0.0416	1.06	0.321
The second 6 months	0.3260 ± 0.0451	0.3620 ± 0.0396	1.34	0.217
T value	1.89	1.71		
P	0.096	0.125		

*** statistical significance when $p \leq 0.05$**

Table 2: Comparison between the means of peri-implant VBL during the observation times and between the means of the peri-implant VBL of anterior and posterior implants during the different intervals of the study in group (B).

Intervals	Anterior implants	Posterior implants	T	P
The first 6 months	0.3940 ± 0.0321	0.4160 ± 0.0550	0.77	0.462
The second 6 months	0.3660 ± 0.0658	0.4040 ± 0.0410	1.10	0.305
T value	0.86	0.39		
P	0.417	0.706		

Table 3: Comparison between the means of peri-implant vertical bone loss in group (A) and group (B) during the first 6 months, the second 6 months and the whole 12 months of the study.

Intervals	Implant position	Group (A)	Group (B)	T	P
The first 6 months	Anterior	0.3780 ± 0.0421	0.3940 ± 0.0321	0.68	0.518
	Posterior	0.4060 ± 0.0416	0.4160 ± 0.0550	0.32	0.754
The second 6 months	Anterior	0.3260 ± 0.0451	0.3660 ± 0.0658	1.12	0.295
	Posterior	0.3620 ± 0.0396	0.4040 ± 0.0410	1.65	0.138
The whole 12 months	Anterior	0.7040 ± 0.0844	0.7600 ± 0.0561	1.24	0.252
	Posterior	0.7680 ± 0.0769	0.8200 ± 0.0911	0.98	0.358

Discussion

The results of this study showed that the mean of peri-implant VBL in the two groups over the period of 12 months was within the acceptable range (0.82 mm) according to Albrektsson et al., 1986(7) who stated that the peri-implant bone loss in the first year after implant insertion should be less than 1.5 mm and the ongoing annual bone loss should be less than 0.2 mm.

When comparing between the means of peri-implant VBL during the first and second 6months in each group (anterior and posterior), a statistically insignificant difference was found, although the higher VBL during the first 6 months. This result may be due to the early marginal bone loss around implants as a result of the surgical trauma during implant insertion and immediate prosthetic loading (Qian et al., 2012(8) and Tae-Ju Oh et al., 2002(9)). Roberts et al., 1994(10) explained that the surgical process of the implant osteotomy preparation, implant insertion and prosthetic loading cause a regional accelerated phenomenon of bone around the implant-bone interface resulting in crestal bone loss during the first 3 months. Additionally, peri-implantitis may be a major cause of early bone loss as stated by Tae-Ju Oh et al., 2002(9). Fouad et al., 2014(11) explained the increased peri-implant enzyme activity during the initial period after implant insertion by the post-surgical risk of inflammation and immediate prosthodontic loading. Furthermore, the immediate loading in this study may have contributed to early peri-implant bone loss because of the initial micromotion of implants. This explanation is agreed with Romanos and Nentwig., 2006(12). Moreover, this result is consistent with the results of Fouad and Marzook, 2013(13). They explained their results by the localized remodeling resulting from full functional occlusal loading and the increased inflammation resulting either from the post-surgical risk of bacterial infection or micro-movements on the bone-implant interface.

In addition to the previous results, a statistically insignificant difference was found when comparing between the means of VBL around the vertical anterior and posterior implants of group (A) during the observation times of the study, in spite of the increased resorption around the posterior implants. This may be the result of less posterior bone quality and/or higher posterior occlusal forces. This explanation is consistent with Blanes et al., 2007(14) who stated that the posterior region of the mouth offers a challenging for rehabilitation with oral implants because of the resorption of the alveolar ridge, the presence of the inferior alveolar nerve, poor bone quality and high occlusal forces. As well as, stresses that stimulated on posterior implants by mandibular deformation (flexure) that occurs during mandibular movements may be another cause of increased bone resorption around posterior implants as explained by Zarone et al., 2003(15). Also, the difficulty in achieving the oral hygiene measures in posterior regions may cause plaque accumulation and gingival inflammation as confirmed by Behneke et al., 2000(16). Additionally, this results are concurred with Fouad and Marzook., 2013(13) who concluded that the implants installed in the canine areas provide better stability and less peri-implant alveolar bone loss than those installed in the first molar areas.

Also, the VBL around inclined posterior implants of group (B) was found to be insignificantly more than the VBL around vertical anterior implants through the first and second 6 months. In addition to the position in the posterior area of the mandible, the inclination of the posterior implants of group (B) may be another cause of increased stresses on the peri-implant alveolar bone and the increased resorption. This explanation was confirmed by Watanabe et al., 2003(17). Also, this consistent with Takahashi et al., 2010(5) who concluded that the use of inclined implants induces an increased stresses in the peri-implant alveolar bone. In the same way, Caglar et al., 2006(18) stated that the inclination of the implant in the molar region was found to result in increased stress.

Finally, the mean of VBL (mm) around implants in group (A) was statistically insignificant less than that around implants in group (B). This may be attributed to the induced stresses around the inclined posterior implants in group (B). This explanation is supported by the study of Fabbro et al., 2014(19) who concluded that the inclination of the implants induce insignificant increase in crestal bone level change as compared to conventional axial placement after 1 year of function. Also, this results are agreed with Shawky and fouad et al., 2018(20) who compared the metabolic activity around four implants inserted according to the All-on-four concept to assist the complete mandibular overdentures with four implants inserted axially parallel to each other in the canine and the second premolar areas of the mandible and found that the mean values of GAGs and C4S of the All-on-four group was insignificantly more than that of the axially parallel implants group at the end of 6th month of their study and attributed this to the posterior location of ball attachments of the inclined implants and the more stresses around the non-splinted inclined implants in the All-on-four group. Similarly, Naini et al., 2011(21) compared four dental implants placed according to the All-on-four concept in the intraforaminal region of the edentulous mandible to support full-arch fixed prostheses (the posterior implants are tilted distally to a maximum of 45 degrees) with another design in which the four implants are placed parallel to each other and perpendicular to the occlusal plane. They found higher stress concentrations in the peri-implant bone of the all implants in the All-on-four group during anterior loading. Also, they found higher stress concentrations in the peri-implant bone of the posterior implants in the All-on-four group during posterior loading. They explained their results by the angulations of the posterior implants in the All-on-four group. Although, they noticed lower stress concentrations around the anterior implants in the All-on-four group during posterior loading. A shortened cantilever in the tilted posterior implant design was their explanation for this result.

conclusion

Within the standard level of peri-implant bone resorption, the four axially inserted implants and the four implants inserted according to the All-on-four design can be used for assisting the mandibular complete overdentures. Assisting the mandibular complete overdentures by four axially inserted implants (in canines and second premolars areas) can be considered slightly more advantageous than the four implants inserted according to the All-on-four design.

Recommendations

Other studies with long follow up time and more patients in addition to other methods of evaluation are recommended to differentiate between the two studied designs.

References

1. Zhang L, Lyu C, Shang Z, Niu A, Liang X. Overdenture and Conventional Complete Denture in Restoring the Edentulous Mandible : A Systematic Review. Implant Dent. 2017;26:945–50.

2. Sharma AJ, Nagrath R, Lahori M. A comparative evaluation of chewing efficiency , masticatory bite force , and patient satisfaction between conventional denture and implant supported mandibular overdenture : An in vivo study. J Indian Prosthodont Soc. 2017;17:361–72.

3. Jemt T, Chai J, Harnett J. A 5-year prospective multicenter follow-up report on overdentures supported by osseointegrated implants. Int J Oral Maxillofac Implants 1996;11:291-8.

4. Krekmanov L, Kahn M, Rangert B, et al: Tilting of posterior mandibular and maxillary implants for improved prosthesis support. Int J Oral Maxillofac Implants 2000;15:405-414.

5. Takahashi T, Shimamura I, Sakurai K. Influence of number and inclination angle of implants on stress distribution in mandibular cortical bone with All-on-4 Concept. J Prosthodont Res. 2010;54:179–184.

6. Sewerin I. Device for serial intraoral radi- ography with controlled projection angles. Tandlaegebladet 1990;94:613–617.

7. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria for success. Int J Oral Maxillofac Implants 1986;1:11-25.

8. Qian, J., Wennerberg, A. & Albrektsson, T. Reasons for marginal bone loss around oral implants. Clinical Implant Dentistry & Related Research 2012;14: 792–807.

9. Oh TJ, Yoon J, Misch CE, Wang HL. The causes of early implant bone loss: Myth or science? J Periodontol 2002;73:322–333.

10. Roberts WE, Nelson CL, Goodacre CJ. Rigid implant Anchorage to close a mandibular first molar extraction site. J Clin Orthod 1994;28:693–704.

11. Fouad MM, Neamat-allah MA, Emera RM, Hussin KM. The Metabolic Activity of Bone around Min-implants Splinted with Cantilever Bar for Mandibular Complete Overdenture. Mansoura J Dent. 2014;1:101–4.

12. Romanos GE, Nentwig G-H. Immediate Versus Delayed Functional Loading of Implants in the Posterior Mandible : A 2-Year Prospective Clinical Study of 12 Consecutive Cases. Int J Periodontics Restorative Dent. 2006;26:459–69.

13. Fouad MM, Marzook H. Three design concepts of four-implant assisted mandibular complete overdentures : Implant stability and marginal alveolar bone loss . EDJ. 2013;59:1–12.

14. Blanes RJ, Bernard JP, Blanes ZM, Belser UC. A 10-year prospective study of ITI dental implants placed in the posterior region . I : Clinical and radiographic results. Clin Oral Impl Res. 2007;18:699–706.

15. Zarone F, Apicella A, Nicolais L, Aversa R, Sorrentino R. Mandibular flexure and stress build-up in mandibular full-arch fixed prostheses supported by osseointegrated implants. Clin. Oral Implants Res 2003; 14:103-14.

16. Behneke A, Behneke N, d'Hoedt B. The Longitudinal clinical effectiveness of ITI solid-screw implants in partially edentulous patients: a 5 year follow-up report. Int J Oral Maxillofac Implants 2000; 15:633-45.

17. Watanabe F, Hata Y, Komatsu S, Ramos TC, Fukuda H. Finite element analysis of the influence of implant inclination , loading position , and load direction on stress distribution. Odontology. 2003;91:31–6.

18. Çaglar A, Aydin C, Yilmaz C, Korkmaz T. Effects of Mesiodistal Inclination of Implants on Stress Distribution in Implant-Supported Fixed Prostheses. Int J Oral Maxillofac Implants. 2006;21:36–44.

19. Fabbro M Del, Ceresoli V. The fate of marginal bone around axial vs . tilted implants : A systematic review. Eur J Oral Implant. 2014;7:171–89.

20. Shawky AM, Fouad MM, Emera R, Neamatallah M. Two different designs of the 4-implants used for assisting mandibular complete overdentures: peri-implant metabolic activity . Thesis submitted in partial fulfillment of the requirement for Master degree in Removable Prosthodontics, Faculty of dentistry Mansoura University 2018:86-91.

21. Naini RB, Nokar S, Borghei H, Alikhasi M. Tilted or Parallel Implant Placement in the Completely Edentulous Mandible ? A Three-Dimensional Finite Element Analysis. Int J Oral Maxillofac Implants. 2011;26:776–81.