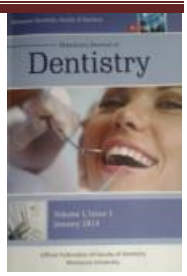


Effect of Inter-Implant Angulation on Bone Height Around Two Implants Assisting Mandibular Complete Overdenture.

Ahmed M Maher1 , Ashraf A Gibreel2, Mohammed M Fouad3
1Dentist, Ministry of health, Egypt.
2Associate Professor of Removable Prosthodontics, Faculty of Dentistry, Mansoura University, Egypt
3Professor of Removable Prosthodontics, Faculty of Dentistry, Mansoura University, Egypt.

Abstract:
Purpose: This study aimed to evaluate the effect of inter-implant angulation on the bone height around two implants assisting mandibular complete over denture retained by locator attachment. **Materials and Methods:** A total of 6 edentulous male patients delivered mandibular complete over denture assisted by two canine implants. After construction of complete dentures, the patients were classified into two equal groups: Group I received axial implants while Group II received 15° distal inclined implants. Radiographic assessment was done immediately (T1), six months (T2) and twelve months (T3) following insertion of definite overdenture. The peri-implant bone height changes were calculated during the 1st six months (T1-T2) and 2nd six months (T3-T2) months of study. **Results:** The mean values of vertical peri-implant bone resorption of **Group I** during the 1st six months (0.873± 0.009 mm) and in **Group II** (1.093± 0.016 mm) was found to be statistically significant. Also, the means of vertical peri-implant bone resorption of **Group I** during the 2nd six months was (0.591± 0.012 mm) and in **Group II** (0.605±0.004 mm) was found to be statistically significant. The means of horizontal peri-implant bone resorption of **Group I** during the 1st six months (0.173± 0.014 mm) and in **Group II** (0.2± 0.012 mm) was found to be statistically significant. Also, the means of horizontal peri-implant bone resorption of **Group I** during the 2nd six months was (0.061±0.001 mm) and in **Group II** (0.073±0.003 mm) was found to be statistically significant. The means of vertical peri-implant bone resorption during the (12 months) of study in **Group I** (1.464± 0.015 mm) and in **Group II** (1.698± 0.014 mm) was found to be statistically significant. The means of horizontal peri-implant bone resorption during the (12 months) of study in **Group I** (0.234± 0.013 mm) and in **Group II** (0.273± 0.014 mm) was found to be statistically significant. **Conclusion:** (1) The 15° distally inclined implants inserted in the canine areas for assisting mandibular complete overdenture may induce peri-implant bone loss more than the axially inserted implants. (2) Immediate loading accelerates the initial alveolar bone loss around implants used for assisting mandibular complete overdenture. **Recommendations:** Other elongated studies must be conducted with more number of patients using other evaluation methods to compare between axially and non-axially inserted implants following delayed loading concept to assist mandibular complete overdenture.
Keywords: Implant assisted overdenture, Locator attachments, inclined implants and immediate loading.

Introduction

Teeth loss causes damage to the alveolar ridge due to bone resorption. This causes reduction in denture stability and retention thus, leading to less comfort, reduced chewing ability, reduced chewing force and so, general dissatisfaction with the denture. (1)

The restoration of patient normal function, health, aesthetics and speech regardless the disease, the atrophy or injury of the stomatognathic system is the goal of modern dentistry. In response to this essential goal, dental implants become a successful option treatment for patients in good general oral health who have unfortunately lost one or more teeth due to trauma, periodontal disease or other reasons. Dental implants are biocompatible metal anchors surgically placed into the bone of the jaw. (2)

Different treatment options for edentulous patients are available. Implant assisted overdenture is a good solution which is simple and cost effective. (3) It preserves the alveolar bone and muscular efficiency, increases the retention, support and stability. (4)

Various methods to connect overdentures and implants have been described, balls, locators, magnets and bar attachments are frequently used.(5)

Two implants with locator attachment assisting an overdenture in the mandible considered as a suitable treatment as it provides minimal bone loss and adequate health of the peri-implant mucosa. It also provides little frequency of technical complications/repairs and maintenance than other types of attachments. (6)

Some anatomic and surgical limitations may indicate the use of inclined implants. Implant angulation is considered one of the most important solutions to overcome stresses around implants. The behavior of per-implant bone is closely related to the direction, magnitude and concentrations of stresses transferred to the implant. Direction of stresses at the implant-bone interface would be changed by inclined implants. So, these stresses at implant-bone interface may affect bone height around these implants. (7)

This work is aiming to study the effect of inter-implant angulation on the bone height around two implants assisting mandibular complete over denture.

Materials and methods

Six healthy male completely edentulous patients of age ranging from 45 to 50 years were selected for this study. They are healthy, free from any systemic diseases and normal maxillofacial relationship. They have a good quality and quantity of mandibular alveolar bone covered with

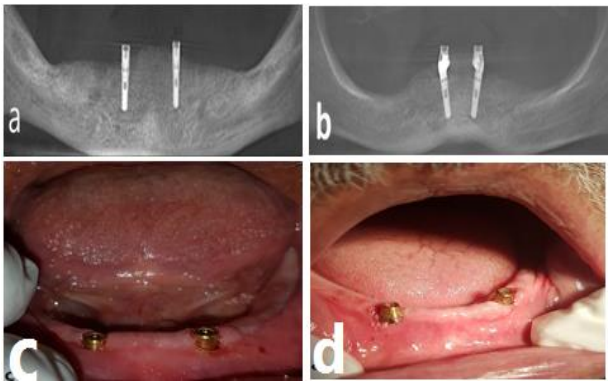
healthy firm mucosa and Inter-arch space suitable for insertion of implants with locator attachment and mandibular

overdenture. Exclusion criteria for this study include the patients with metabolic disease, chemotherapy and radiotherapy for any head and neck tumors, history of Parafunctional habits, Alcoholics, smokers and bad oral hygiene. For each patient, conventional complete denture was constructed and inserted. The stereolithographic guide template which used as a guide during implant insertion was constructed. The patient grouping according to inclination of the implant was as follow Group I**:** Received two axially placed implants (11.5 mm length×3.5 mm diameter) in the mandibular canine area and Group II**:** Received two implants (15° distally inclined implants (11.5 mm length×3.5 mm diameter) inserted in the mandibular canine areas. The implants inserted using the one stage surgical technique. The locator attachments were screwed into the implants immediately after surgery. (Fig.1)

Evaluation of peri-implant alveolar bone height changes

Radiographic assessment of the peri-implant bone height was done at the following times for ever patient immediately, 6 months and 12 months after fixation of the definitive attachments.Vertical and horizontal peri-implant crestal bone loss was measured as described by Walter et al. [8] and Heckmann et al. [9] To measure the vertical bone loss (VBL), the distance between the implant shoulder (point A) and the first implant to bone contact (point B) was measured and referred to the vertical bone level in millimeters (AB line). AB line at 0 month was subtracted from AB line at T1, T2 and T3 to measure the VBL. To measure the horizontal bone loss (HBL), the distance between the periimplant bone level (C point) [which is crossing point of the tangent to the horizontal bone crest (CD line) and the tangent to the crater shaped defect (CB line)] and the implant at right angle was measured and referred to the horizontal bone level. Horizontal bone level at 0 month was subtracted from horizontal bone level at T1, T2 and T3 to measure HBL. All measurements were determined at mesial and distal surfaces of each implant. (Fig. 2)

Fig 1: a) Post-surgical panoramic radiograph for group (I) b) Post-surgical panoramic radiograph for group (II) c) Locator attachment screwed into their implant for



group I d) Locator attachment screwed into their implant for group

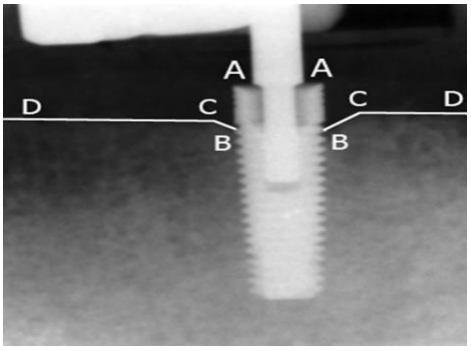


Fig 2: Lines and reference points for vertical and horizontal peri-implant bone measurements

Results

Table (1):Comparison between the means of vertical peri-implant bone resorption in the two groups during the 1st and 2nd six months:

Intervals	The means of vertical peri-implant bone resorption		t	P
	Group I	Group II		
1st 6 months	0.873± 0.009	1.093± 0.016	-29.74	<0.001*
2nd 6 months	0.591± 0.012	0.605± 0.004	-2.6	0.02*
T	44.2	64.2		
P	<0.001*	<0.001*		

Table (2): Comparison between the means of horizontal periimplant bone resorption in the two groups during the 1st and 2nd six months:

Intervals	The means of horizontal peri-implant bone resorption		t	P
	Group I	Group II		
1st 6 months	0.173 ± 0.014	0.200 ± 0.012	-3.6	0.005*
2nd 6 months	0.061± 0.001	0.073 ± 0.003	-10.6	<0.001*
T	19.73	30.04		
P	<0.001*	<0.001*		

Discussion

Discussion of the results

Through the 12 months of the study, the mean of vertical bone loss was (1.464 mm) in Group I and (1.698 mm) in Group II while the mean of horizontal bone loss was (0.234 mm) in Group I and 0.273 mm in Group II which were within the accepted limits of peri-implant bone resorption especially in group I. Rasouli Ghahroudi *et al*. [(10)] stated that the value of bone loss following 1 year of implantation should not exceed 1.5 mm, with a mean annual rate of 0.1 mm in the following years. Naert and colleagues [(11, 12)] illustrated that even after 15 years, the bone resorption never exceeded 2 mm. They found that mean of periimplant resorption was 1.8 mm for patients without periodontal disease and 2.2 mm for patients with periodontal disease.

In the present study, when comparing between the 1st and 2nd six months in each group, a statistically significant decrease in peri-implant bone resorption (vertical and horizontal) was found during the second six months. This may be due to the natural biological process of bone remodeling which occurs after implant placement and early response of bone to healing and reorganization in combination with immediate function loading. This explanation is concurred with Akca et al. [(13)] who reported that the initial healing might be impaired by the early mechanical environment in bone around implants when inserting two unsplinted implants to support mandibular overdenture using immediate loading protocol. Additionally, locator attachment has the advantage of dual retention obtained from the friction between its inner and outer surfaces with reduced lateral and hinge movement causing transfer extra moment load to the implant and so participate in increasing bone loss. Celic and Uludag [(14)] compared between immediate and delayed loaded implants and found that the immediate loading causes increase in bone loss rather than delayed loading of implants submerged for 3 months. Naret et al. [(15)] agreed with that explanation and observed that non-submerged implants supporting a mandibular overdenture exhibit more bone loss than submerged implants. They noted also increased bone loss around non-submerged implants is influenced by surgical trauma, contact with oral microbial plaque and abutment connection. In contrast, Alsabeeha et al. [(16)] studied single implants inserted in the midline of the mandible immediately loaded with locator-assisted overdentures and found a lower rate of bone resorption. They related the cause of lower rate of bone resorption to the specific surface characteristics of the used implants and the resistance of basal bone to process of resorption.

Fouad et al. [(17)] compared between two different designs of four implants used for assisting mandibular complete overdentures. They found that the elevation of peri-implant metabolic activity is caused by inflammation during the interval after implant insertion and early existence of mechanical environment in bone around immediately loaded implants. This inflammation may be due to micro movements on the implant-bone interface or post-surgical infection.

Radiographic evaluation of marginal bone loss around the implant mesially and distally revealed more loss during the first 3 months, which could be due to the trauma associated with surgical procedure, bone removal during drilling, detachment of the marginal periosteum, high bone remodeling rate during the stage of osseointegration, and future changes was happened after the implant conjunction with the overdenture then subjected to functional loading through the metal framework partial denture. This is in agreement with the findings of Habeab [(18)], who suggested that the impaired remodeling during the healing phase can be a causative factor for initial bone loss to implants during the first year of function loading. The results in this study are in agreement with those of Elmahdy *et al*. [(19)], who showed a significant bone loss during the first 3 months after insertion of an immediate loaded implant with O-ring attachment, and then showed a non-significant marginal bone loss after 1-year follow-up period, which could be attributed to the stable peri-implant conditions and maintenance of oral hygiene. Cochran et al. [(20)], reported that remodeling of periimplant bone after insertion of the implant is more noticeable in the 1st six months after surgery. They found that the major percentage of bone loss occur in the 1st six months between the initial implant insertion control and the final implant placement control of the prosthesis.

The decreased bone loss in the second 6 months may be due to increased bone strength from the initial loading after surgical exposure and 12 months after loading, the density of bone increased due to the increase in its mineral content. The increased bone loss in the first 6 months may be attributed to an organization of the surrounding bone after implant insertion. The surrounding bone becomes necrotic and replaced by woven bone because of trauma from implant placement procedures.[(21)] Fouad *and* Marzook [(22)] compared three different design-concepts for mandibular complete overdentures assisted by 4-implants regarding the implant stability and marginal alveolar bone loss. They revealed that the rate of marginal bone loss in all groups was fast during the first 6 months after loading, and then becomes slower afterwards at 12 and 18 months after loading.

When comparing between the two groups during each time interval, the means of peri-implant bone resorption (vertical and horizontal) in group II was found to be statistically significant higher than in group I. This may be due to the increased stress and strains in the bone around inclined implants used in Group II which lead to the increase in bone resorption. This explanation is concurred with

Watanabe et al. [23] conducted a two-dimensional finite element study using a single implant and observed that compressive stresses at implant-bone interface increases

with increasing the inclination of the implant, leading to the increase in bone loss. Also, in agreement with this explanation, Elsyad et al. [24, 25] in two studies evaluated the influence of implant angulation (even mesial or distal) on strains around implants with mandibular overdentures retained by Locator attachments and found that strains are more when increasing the angle of the implant inclination compared with axial implants. This result is inconsistent with the result of Javier et al. [26] who conducted a meta-analysis study to compare the course of patients treated with tilted implants versus those treated conventionally with axial implants, and found that there is no evidence of differences in success rate between tilted and axial implants. The resorption of marginal bone noted with inclined and axial implants proved very similar. So, it can be concluded that inclined implants show the same behavior as parallel implants.

Conclusion:

(1) The 15° distally inclined implants placed in the canine areas for assisting mandibular complete overdenture may induce peri-implant bone loss more than the axially inserted implants. (2) Immediate loading accelerates the initial alveolar bone loss around implants used for assisting mandibular complete overdenture**.**

Recommendations:

Other elongated studies must be conducted with more number of patients using other evaluation methods to compare between axially and non-axially inserted implants following delayed loading concept to assist mandibular complete overdenture.

References

1. Wismeijer D, Vemeeren JI, Van Waas MA. Patient satisfaction with overdenture supported by one stage TPS implant. Int J Oral Maxillofac Implants. 1992 Spring;7(1):51-5.

2. Yoshiki O, Elif B. T, and Koray G. Dental Implant System: Int J MoL Sci. 2010; 11(4): 1580–16787.

3. Shor A, Goto Y, Shor k. mandibular two implant retained overdenture: Prosthetic design and fabrication protocol. Compend Contin Educ Dent. 2007; 28:2: 80-89.

4. Jayasree K., Bharathi M., Vinod B. Precision Attachment: Retained
Overdenture. J Indian Prosthodont Soc. 2012; 12(1): 59–62.

5. Lachmann S, Muller E, Gebring K, Axmann D, et al. A comparisons of implant-supported, bar or ball retained mandibular overdentures. Int J Prosthodont. 2007;20:1 :37-42.

6. Gotfredsen K, Holm B. Implant-supported mandibular overdentures retained with ball or bar attachments: a randomized prospective 5-year study. Int J prosthodont. 2000, 13(2):125-130.

7. Manmohan CG, Narayana VN, Sanjay DM, Varalakshmi RS, Praveen KM, Reddi NRM. Predicting Peri-implant Stresses Around Titanium and Zirconium Dental Implants—A Finite Element Analysis J Indian Prosthodont. 2013; 13(3): 196–204.

8. Walter, M., Marre, B. & Eckelt, U. (2000) Prospective study on titanium barretained overdentures: 2-year results. Clin Oral Impl Res 11:361-369.

9. Heckmann, S.M., Schrott, A., Graef, F., Wichmann, M.G. & Weber, H.P. (2004) Mandibular two-implants telescopic overdentures. Clin Oral Impl Res 15:560-569.

10. Rasouli Ghahroudi A, Talaeepour A, Rokn A, et al. Radiographic vertical bone loss evaluation around dental implants following one year of functional loading. J Dentist Teh Univ Med Scie 2010; 7:89–97.

11. Naert I, Duyck J, Hosjy M, et al. Evaluation of factors influencing the marginal bone stability around implants in the treatment of partial edentulism. Clin Implnt Dent Relat Res 2001; 3:8–30.

12. Hardt C, Grondahl K, Lekholm U. Outcome of implant therapy in relation to experienced loss of periodontal bone support: a retrospective 5-year study. Clin Oral Implants Res 2002; 13:94–488.

13. Akca K, Akkocaoglu M, Comert A, Tekdemir I, Cehreli MC. Bone strains around immediately loaded implants supporting mandibular overdentures in human cadavers. Int J Oral Maxillofac Implants. 2007;22:101–109.

14. Celik G, Uludag B. Photoelastic stress analysis of various retention mechanisms on 3-implant-retained mandibular overdentures. J Prosthet Dent. 2007;97:229–235.

15.Naert I, Gizani S, van Steenberghe D. Bone behavior around sleeping and non-sleeping implants retaining a mandibular hinging overdenture. Clin Oral Implants Res. 1999;10:149–154.

16. Alsabeeha NH, Payne AG, De Silva RK, Thomson WM. Mandibular single-implant overdentures: preliminary results of a randomised-control trial on early loading with different implant diameters and attachment systems. Clin Oral Implants Res. 2011;22:330–337.

17. Mohammed M Fouad, MN Amr Mohamed shawky, , Radwa Emera. Two different designs of the 4-implants used for assisting mandibular complete overdentures peri-implant metabolic activity. Mansoura Journal of Dentistry 2018; 5 (15), 59-63.

18. Habeab A. Comparison between immediate and early loading protocols for implants used to retain mandibular overdenture, a study of implant marginal bone loss. Egypt Dent J 2006; 52:133.

19. Elmahdy M, Abdel-Hameed A, Homoos A, et al. A comparison between two different attachment systems for mandibular implant retained overdenture. Egypt Dental J 2011; 57:2907–2916.

20. Cochran DL, Nummikoski PV, Schoolfield JD, Jones AA, Oates TW. A prospective multicenter 5-year radiographic evaluation of crestal bone levels over time in 596 dental implants placed in 192 patients. Journal of periodontology. 2009;80(5):725-33.

21. Roberts W, Turley P, Brezniak N, Fielder P. Implants: Bone physiology and metabolism. CDA Journal California Dental Association. 1987;15(10):54.

22. Fouad MM, Marzook H. Three design concepts of four-implant assisted mandibular complete overdentures: implant stability and marginal alveolar bone loss. E.D.J. 59(2).

23. 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;91:31–36.

24. Elsyad, Moustafa & M. Eltowery, Salem & A. Gebreel, Ashraf. (2017). Peri-implant strain around mesially inclined two-implant-retained mandibular overdentures with Locator attachments. Journal of Oral Science. 59. 10.2334/josnusd.16-0626.

25. Elsyad, Moustafa & Abo Setta, Fathi & Samir Khirallah, Ahmed. (2016). Strains around distally inclined implants retaining mandibular overdentures with Locator attachments: An in vitro study. The Journal of Advanced Prosthodontics. 8. 116. 10.4047/jap.2016.8.2.116.

26. Javier Ata-Ali J, Peñarrocha-Oltra D, Candel-Marti E, Peñarrocha-Diago M. Oral rehabilitation with tilted dental implants: a metaanalysis. Med Oral Patol Oral Cir Bucal. 2012;17(4):e582-7. Published 2012 Feb 9. doi:10.4317/medoral.17674.