Effects of Angulated and Non-Angulated Mini-Implants Abutment Supporting Mandibular Overdenture on Peri-Implant Bone Height

Khalid Ahmad Omar Arafa, MSc, PhD*

Background: Mini-implants have been successfully used when there is a little bone to support complete dentures, using of mini-implants abutment is the key solution for stable and retentive overdentures.

Objective: To compare peri-implant bone height post angulated or non-angulated mini-implants insertion.

Design: A Randomized Two-Arm Parallel Study.

Setting: Faculty of Dentistry, Al-Azhar University-Assiut Branch, Egypt.

Method: The study was performed from October 2012 to December 2014. Twenty patients were included in the study based on two criteria (1) free from any systemic diseases and (2) their lower flat ridges resorbed with ill-fitted lower dentures. The patients were divided into two groups. The first group received lower overdenture with non-angulated abutment while the second group received lower overdenture with angulated abutment. The bone height for each subject was evaluated with panoramic X-ray after 6, 12, 18 and 24 months. The data were analyzed using SPSS program.

Result: Twenty edentulous patients participated in this study. They were homogenous in their personal characteristics. Their education levels varied between primary and secondary levels. Insignificant differences in age, education level and gender were found ($p > 0.05$).

The differences between the two groups were highly significant. Mean bone height was found to be significantly higher in Group 1 than in Group 2 ($p = 0.03$). The paired sample t-test showed a significant improvement in bone height in the non-angulated group ($p = 0.03$) and insignificant increase in the angulated group ($p = 0.14$).

Conclusion: Lower overdenture mini-implant with non-angulated abutment is better for edentulous patients compared to angulated abutment in term of bone height.

Bahrain Med Bull 2016; 38 (2): 97 - 100

Implant-supported overdentures with normal ridges may be the treatment of choice for flat ridge relations. However, if an inadequate number of implants and poor implant distribution or alignment is found, it is appropriate to use mini-implants to support the overdentures[1]. In the lower ridge dentures, patients usually reflect poor retention. This is mainly related to the vertical and lateral forces received[2].

The satisfaction of wearers is mainly influenced by denture retention[2,3]. Satisfied wearers of complete dentures could enjoy more stable dentures by adding additional means of retention. Dissatisfaction of lower dentures has been a common problem for denture wearers in cases of severe bone resorption[4].

Various types of treatment modalities include adhesive materials and pre-prosthetic surgery, such as ridge augmentation therapy. The purpose is to improve the ridge and conventional dentures[5,6]. However, the old patients are not willing to use such extensive surgical procedure or conventional stage implant therapy[7,8]. Conventional dental implants have proven to have long-term clinical success[9,10].

Mini-implants were used in difficult positions where there is little bone density[11]. There are studies using mini-implants to maintain removable prostheses and support partial and complete dentures[12,13]. The treatment of edentulous patients with mini-implants is used as minimally invasive dentistry. It offers some advantages, such as less damage exposure and bone displacement compared to standard-size implants[2]. Full implants replace teeth; they have been used since the 1970s while mini-implants were not approved for use until 1999. Mini-implants are about half the width of full implants and cost considerably less[13]. Therefore, mini-implants could be a more acceptable alternative in these conditions.

* Associate Professor and Consultant Prosthodontics
Dental Health Department
Faculty of Applied Medical Sciences
Albaha University
PO Box 7273, Unit 2, Albaha 65536-3047
Kingdom of Saudi Arabia
Email: drkhalidarafa@yahoo.com

The success of osseointegration of implant depends on several factors: anatomical, operative techniques and post-operative distribution of biomechanical stress on the supporting bony structure[14]. The bone morphology and density were found to be very important for long-term implant success[15]. The anatomy of the peri-implant site may force the surgeons to adjust for variation in prosthetic axis by using angulated abutments. Angulated abutments are the treatment of choice if there is difficulty to place implants in the usual axial positions[16,17]. The effects of such angulation and biomechanical stresses that may arise have not been fully studied. Two types of forces usually generated in peri-implant bony structure, vertical and lateral forces. Studies on the biomechanical behavior of implants have found that the main concentration of stresses at the implant-bone interface usually occurs at the crestal bone level[18,19]. In angulated abutments these forces might be massive and could cause bone resorption[20].

The aim of this study is to evaluate the effect of angulated and non-angulated mini-implants which support mandibular overdenture on peri-implant bone height.

METHOD

A randomized two-arm parallel design was performed from October 2012 to December 2014. The first group received non-angulated abutment, and the other group received angulated abutment. Twenty patients met the selection criteria. Patients with confirmed healthy bone at the implant site and have no chronic diseases that could affect bone remodeling such as diabetes, renal failure or liver cirrhosis were selected. All completely edentulous patients with ill-retentive lower dentures, due to bone resorption affecting lower alveolar ridge, were included.

The selected patients were divided into two groups. The first group represented patients who have received mandibular overdentures with non-angulated abutments of supporting mini-implants. The second group represented patients who had received mandibular overdentures with angulated abutments of supporting mini-implants. The angulation was indicated to compensate for resorbed bone and redirect the abutments in ideal axial positions.

Patients received four mini dental implants (1.8 mm × 13 mm) in the anterior region of the mandible. The mini-implants were loaded on pre-made overdentures. The peri-implant marginal bone level was measured in implant's proximal sides from the polished platform to the crestal bone. X-rays were taken at postoperative follow-up sessions. The square neck of mini-implant was located supra-gingivally. O-ring shaped abutments were attached to spherical part of mini-implants. Holes were drilled in the lower surface of complete dentures in pre-determined locations.

In some cases, where redirection of screw in pre-determined 45° angle of abutments was not possible, the closest possible abutment angle to 45° were used. The height of crestal bone was assessed every six months for two years. Panoramic radiographs were used to evaluate bone height by two independent investigators. They compared radiographs of each follow-up sessions with pre-operative baseline radiographs. The mini-implants used in this study were fabricated by Dentium, Slim Line, No: SDM1304.

The informed consents were obtained from all the participants. The trial was registered in the (ISRCTN) registry with study ID ISRCTN17902623 (International Standard Randomized Controlled Trials Number).

The data were analyzed by SPSS version 22. The significant differences in characteristics were examined using Chi-square test. The independent t-test was used to identify differences between the two groups. The mean and standard deviations were obtained for each numerical variable. The results were considered significant ($p < 0.05$) with a 95% confidence level.

RESULT

Twenty edentulous patients participated in this study. They were homogenous in their personal characteristics. Their education levels varied between primary and secondary levels. Insignificant differences in age, education level and gender were found ($p > 0.05$), see table 1.

Table 1: Personal Characteristics of Group 1 and Group 2 Edentulous Patients

Variable		Group 1 (N 10)	Group 2 (N 10)	P-value
Patients Education Background	Primary	6 (60%)	5 (50%)	0.85
	Intermediate	3 (30%)	3 (30%)	
	Secondary	1 (10%)	2 (20%)	
	University	0	0	
Gender of Patients	Male	10 (100%)	10 (100%)	A
	Female	0	0	
Age of Edentulous Patients		56.2 ± 1.34	55.62 ± 1.21	0.64

A: not comparable

Panoramic X-ray was performed after 6, 12, 18 and 24 months. The differences between the two groups were highly significant. Mean bone height was found to be significantly higher in Group 1 than in Group 2 ($p = 0.03$). The paired sample t-test showed a significant improvement in bone height in the non-angulated group ($p = 0.03$) and insignificant increase in the angulated group ($p = 0.14$), see table 2.

Table 2: The Bone Height (Mean and Standard Deviation) for the Two Groups

Time of Evaluation	6 Months		12 Months		18 Months		24 Months		P-value between 6m and 24m
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
First Group (Non-angulated)	2	0.7	2.5	0.8	3	0.8	4	1.2	0.03*
Second Group (Angulated)	1.5	0.5	1.5	0.5	1.75	0.6	2	0.7	0.14
P-values	00.4*		0.02*		0.01**		0.00**		

(*) significant **(**)** highly significant **(m)** months

DISCUSSION

The initial interventions were conducted with the mini-implants with either angulated or non-angulated abutment for 24 months. Throughout this period, the loaded mini-implants were assessed for bone height by X-ray. This duration was based on the average duration of use for mini-implants in humans and the bony remodeling period. The mini-implant has only been used recently in dental practice with undetermined life expectancy[21].

High forces applied on peri-implant bone may cause bone resorption. There are many confounding variables, such as the type of bone, loading forces, construction of prosthesis and angulation of abutment[12]. Studies showed that strains produced around 35° angulated abutments were physiologically tolerable by the bone[22]. Also, angulation of abutment with 0°, 15° and 20° showed similar results[23].

In the present study, the bone height for the first group with non-angulated abutment was significantly more (p=0.03) than the bone height for the second group (p=0.14). This result was highly significant after 18 months and 24 months. Different studies found that mini-implants are effective; Pearce et al mentioned a series of protocols for different animal models used for implant experimentation[24]. Implants with a diameter no greater than 2 millimeters and a thread length of 6 millimeters should be used, with a maximum of six implants placed in a single rabbit. Other studies have exceeded this range with success[24]. These results contrast with other findings.

In this study, the effect of abutment axis angle was assessed using prefabricated 45° angulated abutment. Previous studies suggested that the optimum angle of an abutment was 25°[25,26]. It was reported that the abutment angulation changed from 0° to 20°; however, this was the tolerated limit of the bone[27].

The mini-implants were successfully used in many cases to overcome problems associated with the types of implant[28]. Bone height in patients with mini-implants was found to be comparable to conventional implants[29].

CONCLUSION

Mini-implants with non-angulated abutment provide a stable, immediately functional aesthetic overdentures in flat ridges. In addition, it improves bone height. This is possibly due to how force is distributed during mastication. It could be concluded that non-angulated abutments may be capable of better force distribution than angulated abutment.

Potential Conflicts of Interest: None.

Competing Interest: None.

Sponsorship: Albaha University, Saudi Arabia.

Submission Date: 18 January 2016.

Acceptance Date: 12 April 2016.

Ethical Approval: Ethical Committee, Faculty of Applied Medical Sciences, Albaha University, Kingdom of Saudi Arabia. The project was supported and funded by Albaha University, while the data was collected from the hospital at Alazhar University – Assiut Egypt.

REFERENCES

1. Sadowsky SJ. Treatment Considerations for Maxillary Implant Overdentures: A Systematic Review. The J Prosthet Dent 2007; 97(6):340-8.
2. MacEntee MI, Walton JN, Glick N. A Clinical Trial of Patient Satisfaction and Prosthodontic Needs with Ball and Bar Attachments for Implant-Retained Complete Overdentures: Three-Year Results. J Prosthet Dent 2005; 93(1):28-37.
3. Morneburg TR, Proschel P. Success Rates of Microimplants in Edentulous Patients with Residual Ridge Resorption. Int J Oral Maxillofac Implants 2008; 23(2):270-6.
4. Cune M, Burgers M, van Kampen F, et al. Mandibular Overdentures Retained by Two Implants: 10-Year Results from a Crossover Clinical Trial Comparing Ball-Socket and Bar-Clip Attachments. Int J Prosthodont 2010; 23(4):310-7.
5. Lerner H. Minimal invasive implantology with small diameter implants. Implant Pract 2009;2(1):30-5.
6. Allen PF, McMillan AS, Walshaw D. A Patient-Based Assessment of Implant-Stabilized and Conventional Complete Dentures. J Prosthet Dent 2001; 85(2):141-7.
7. Dewan K, Hems E, Owens J. A Retrospective Study to Assess Patient Satisfaction with Implant-Stabilized Prostheses. Dent Update 2007; 34(8):470-2, 5-7.
8. Bulard R, Vance JB. Multi-Clinic Evaluation Using Mini-Dental Implants for Long-Term Denture Stabilization: A Preliminary Biometric Evaluation. Compend Contin Educ Dent 2005; 26(12):892-7.
9. Campelo LD, Camara J. Flapless Implant Surgery: A 10-Year Clinical Retrospective Analysis. Int J Oral Maxillofac Implants 2002; 17(2):271-6.
10. Ahn MR, An KM, Choi JH, et al. Immediate Loading with Mini Dental Implants in the Fully Edentulous Mandible. Implant Dent 2004; 13(4):367-72.
11. Mundt T, Schwahn C, Stark T, et al. Clinical Response of Edentulous People Treated with Mini Dental Implants in Nine Dental Practices. Gerodontology 2015; 32(3):179-87.
12. Cavallaro J, Greenstein G. Angled Implant Abutments: A Practical Application of Available Knowledge. J Am Dent Assoc 2011; 142(2):150-8.
13. Flanagan D, Mascolo A. The Mini Dental Implant in Fixed and Removable Prosthetics: A Review. J Oral Implantol 2011; 37 spec:123-32.
14. Steigenga JT, Al-Shammari KF, Nociti FH, et al. Dental Implant Design and Its Relationship to Long-Term Implant Success. Implant Dent 2003; 12(4):306-17.
15. Molly L. Bone Density and Primary Stability in Implant Therapy. Clin Oral Implants Res 2006; 17 Suppl 2:124-35.
16. Eger DE, Gunsolley JC, Feldman S. Comparison of Angled and Standard Abutments and Their Effect on Clinical Outcomes: A Preliminary Report. Int J Oral Maxillofac Implants 2000;15(6):819-23.
17. Sethi A, Kaus T, Sochor P. The Use of Angulated Abutments in Implant Dentistry: Five-Year Clinical Results of an

Ongoing Prospective Study. The Int J Oral Maxillofac Implants 2000; 15(6):801-10.
18. Papavasiliou G, Kamposiora P, Bayne SC, et al. Three-Dimensional Finite Element Analysis of Stress-Distribution Around Single Tooth Implants as a Function of Bony Support, Prosthesis Type, and Loading During Function. J Prosthet Dent 1996; 76(6):633-40.
19. Kenney R, Richards MW. Photoelastic Stress Patterns Produced by Implant-Retained Overdentures. J Prosthet Dent 1998; 80(5):559-64.
20. Duyck J, Van Oosterwyck H, De Cooman M, et al. Three-Dimensional Force Measurements on Oral Implants: A Methodological Study. J Oral Rehabil 2000; 27(9):744-53.
21. Shatkin TE, Shatkin S, Oppenheimer BD, et at. Mini Dental Implants for Long-Term Fixed and Removable Prosthetics: A Retrospective Analysis of 2514 Implants Placed Over A Five-Year Period. Compend Contin Educ Dent 2007; 28(2):92-9; quiz 100-1.
22. Clelland NL, Gilat A. The Effect of Abutment Angulation on Stress Transfer for an Implant. J Prosthodont 1992; 1(1):24-8.
23. Clelland NL, Gilat A, McGlumphy EA, Brantley WA. A Photoelastic and Strain Gauge Analysis of Angled Abutments for an Implant System. Int J Oral Maxillofac Implants 1993; 8(5):541-8.
24. Pearce A, Richards RG, Milz S, et al. Animal Models for Implant Biomaterial Research in Bone: A Review. Eur Cell Mater 2007; 13:1-10.
25. Cardelli P, Montani M, Gallio M, et al. Angulated Abutments and Perimplants Stress: FEM Analysis. Oral Implantol (Rome) 2009; 2(1):3-10.
26. Arun Kumar G, Mahesh B, George D. Three-Dimensional Finite Element Analysis of Stress Distribution Around Implant with Straight and Angled Abutments in Different Bone Qualities. J Indian Prosthodont Soc 2013; 13(4):466-72.
27. Bahuguna R, Anand B, Kumar D, et al. Evaluation of Stress Patterns in Bone Around Dental Implant for Different Abutment Angulations Under Axial and Oblique Loading: A Finite Element Analysis. Natl J Maxillofac Surg. 2013; 4(1):46-51.
28. Siddiqui AA, Sosovicka M, Goetz M. Use of Mini Implants for Replacement and Immediate Loading of 2 Single-Tooth Restorations: A Clinical Case Report. J Oral Implantol 2006; 32(2):82-6.
29. Simon H, Caputo AA. Removal Torque of Immediately Loaded Transitional Endosseous Implants in Human Subjects. Int J Oral Maxillofac Implants 2002; 17(6):839-45.