

Effect of Two Different Types of denture Base Materials on the Supporting Structures of Mandibular Mini Implant Supported Over denture

Ahmed Atef Elmahdy¹, Hany Ibrahim Eid², Shaimaa Lotfy Mohamed Ouda³

Abstract

Objectives: This research was carried out to evaluate radiographically the effect of different denture base materials “poly methyl methacrylate base (PMMA) processed by conventional technique versus thermoplastic biocompatible (polyan IC) base processed by injectable mold technique on the supporting structures of the mini implant retained mandibular overdenture using CBCT.

Materials and Methods: Fourteen edentulous patients with a mean age of 55 year were selected to participate in this study. Inclusion criteria were: U-shaped alveolar arches, Angle class I ridge relationship, adequate inter arch space. Exclusion criteria were: Patients having systemic diseases affecting bone metabolism, patients having parafunctional habits, patients suffering from neuromuscular disorders, and temporomandibular joint disorders. Uncontrolled diabetes. For all the selected patients, mucosa supported maxillary complete denture and mini-implant retained mandibular over denture by four mini- implants installed in the interforaminal region. Patients participating in this study were randomly divided into two equal groups according to the denture base materials, Group 1:Seven patients were rehabilitated with upper conventional acrylic resin complete denture and lower mini-implant retained mandibular overdenture processed by the conventional technique Group 2:Seven patients were rehabilitated with upper conventional acrylic resin complete denture and lower mini-implant retained mandibular overdenture processed by injectable technique. Follow up visits were scheduled, 0, 6and 12 months after loading for making radiographic records. The marginal bone height changes around the implants were evaluated, using the linear measurement system supplied by the Cone Beam CT. The marginal bone loss at different intervals was obtained by calculating the difference in bone height at that interval from the base line measurement and statistically analyzed.

Results: In this study, at the end of the follow up period there was statistically significant difference of peri-implants bone changes between group 1 (conventional technique) and group 2 (injectable technique). The least bone loss was reported around the implants in group 2. The mean difference of bone height loss at the periods(0-6) months were (0.817±0.265), (0.443±0.109),and at the period of (6-12) months mean difference of bone height loss were (0.829±0.226), (0.429±0.229).while at the period of (0-12) months the mean difference of bone height loss were(1.646±0.491), (0.872±0.238) in group 1 and group 2 respectively. It was found also that the posterior alveolar bone height changes by time between the two groups were no statistically significant with p value >0.05.

Conclusion: Within the limitation of this study, it was concluded that Polyan IC denture base processed by using injectable mold may show more favorable bone/implant interface and may ensure well fitted denture base compared to PMMA denture base processed by conventional method in mandibular mini-implant supported overdenture.

KEY WORDS: Lower, overdenture , mini implant , injectable.

1. Doctorate degree student, Faculty of Dentistry ,Ain Shams University.
2. Professor of Prosthodontics, Faculty of Dentistry, Ain Shams University.
3. Assistant Professor of Prosthodontics, Faculty of Dentistry, Ain shams University

Introduction:

Residual ridge supported by complete denture is unstable by time because of gradual reduction of the ridge. General health of patients may also affect with poorly retained dentures due to their inability to chew food resulting in corruption of patients' general health. Some patients feel embarrassed from using complete dentures as denture movement, discomfort. This can be corrected by promoting denture retention to improve their diet. (1)

Stability and retention of mandibular dentures problems can often be corrected using endosseous implants to which an overdenture can be attached. (2) Mini dental implants (MDIs) are biocompatible titanium screws with very small diameter designed by Victor I. Sendax. Conventional implants integrated into the bone while mini dental implants were originally used for temporary stabilization of overdentures. (3) Nowadays, mini-implants appeared to osteo-integrate into the bone, proving to be much more than temporary implants. The application of MDIs for immediate overdenture stabilization has been reported to show great success. Mini dental implants also have the advantages of single-stage implants with short healing period & minimum post-operative discomfort, immediate restoration of patient's mastication and aesthetics. (4)

In comparison with conventional-diameter implants, MDIs can be used in edentulous arches with minimal remaining bone in a facial-lingual dimension to avoid bone graft. MDIs are less cost, have fewer complications during flapless implant placement. (5)

A successful denture should have dimensional stability to enhance chewing efficiency, increase patients' comfort, and prevent injury to the oral tissue. During processing, dimensional changes of the denture base are affected by the type of

material used and other factors like polymerization shrinkage or stresses generated by cooling of flask. Although acrylic resin is the most commonly used material in fabrication of denture base, it is dimensionally changed and distorted during acrylic processing and throughout clinical use. These dimensional changes lead to inappropriate adaptation of the denture base to the oral tissue, reduced denture stability, and changes of the positions of the artificial teeth. In addition to factors related to physical properties, processing procedures of denture base material, physiological and the anatomical conditions of patient's oral tissue also could affect the dimensional stability of denture base. (6)

Thermoplastic resins are completely polymerized or prepolymerized resins which are processed using only thermal energy processing without any chemical reactions. They are characterized by high dimensional stability, fatigue and wear resistance. Thermoplastic resins are processed using injection molding technique. In injection molding technique, the polymerization shrinkage is compensated by continuously injecting resin at certain pressure through a carefully controlled procedure. (7)

Thermoplastic resins have excellent alternative cosmetic restorations for esthetic-demanding patients. These restorations can be relined and repaired, by repressing the restoration. These restorations display excellent esthetics and provide long-term comfortable use for the patient. (8)

Hence, this study was conducted to evaluate which type of these denture base materials causes less bone height changes of mini implant supported mandibular overdenture.

Materials and Methods:

This study had been done in Prosthodontics Department, Faculty of Dentistry, Ain shams University. Fourteen completely edentulous patients were chosen between the

ages of 50 to 65 years. Inclusive criteria: The alveolar ridge was free from any pathological signs, remaining roots, bony undercut, or neoplastic lesions and adequate width with minimum 5 mm and height with minimum 12 mm and covered by firm dense mucoperiosteum. Patients free from TMJ Disorders., Patients having adequate interarch space. Exclusion criteria: Patients having systemic diseases affecting bone metabolism., Patients having parafunctional habits. Flat or flabby ridge. Severe neuropsychiatric disease, mental disability, and narcotic drug addicts. Uncooperative patients who have no understanding of the need for regular follow up. All patients participating in this study were clearly informed about the importance of the procedure they were going to undertake and the importance of good oral and denture hygiene for the success of the study. They agreed and signed on an informed consent form.

They were rehabilitated by maxillary complete denture and implant supported mandibular over denture by installing four mini implants (two in canine region, and two in the premolar region)

The patients were randomly divided into two equal groups according to the technique of processing into:

Group1: Seven patients were rehabilitated with mini implant retained mandibular overdenture of PMMA denture base (Vertex regular, Zeist, Netherlands) processed by conventional method using compression mold technique. Group 2 Seven patients were rehabilitated with mini implant retained mandibular overdenture of thermoplastic biocompatible denture base (Polyan IC, Modified methacrylate, Bredent, Germany) processed by injectable mold technique.

Upper and lower primary impressions were done using alginate impression material then Setting of teeth on

primary cast was done and self-cure clear acrylic resin was used for construction of clear acrylic resin that was used as a radiographic stent then gutta-percha were fixed on the radiographic stent labial at estimated positions of implants placement at canines and premolars areas Cone Beam CT radiograph (CBCT) was done (fig1). The radiographic stent was converted into surgical stent by making four holes was done at the planned positions. (fig2). The stent was sterilized and stored until its use in the surgery.

For the patients involved in the study. The implant used was self-threading grade 5 titanium transmucosal one-piece fixture with micro roughened surface (double acid etch) were selected with width 2.7 mm and length 10 mm. (Leader Italia Nano Mini Implant OVD Micro Ball Slim). The surgical stent was properly placed in position, the markings of planned implant sites were transferred accurately to the depth of labial vestibule at the corresponding areas. After that, the stent was removed. The implant surgical procedures were performed under local anesthesia.

After complete healing of the gum within 2 to 3 weeks. Upper and lower complete dentures were constructed following the conventional procedures. For group (2) pink wax was attached to the try in as a path of injection of thermoplastic acrylic resin. (fig3) The acrylic teeth were perforated before injection of thermoplastic acrylic which was injected through injecting machine. (Thermopress 400 version 2.4/2.56, Bredent, Germany).

Pick up of the housing was done indirectly with the same material either for conventional technique or injectable technique. The lower denture was loaded using implant analogues. Implant analogue was used to mimic the implant while dental

stone was used to close the undercut underneath the head of the ball attachment.

The denture was checked for complete seating above the housings before completing the pick-up procedures, the denture was placed accurately in position to perform an indirect pickup of the metal housings while the articulator was closed in centric position. After setting of the acrylic resin, the denture was gently removed from the lower cast, checked that all metal housings were picked up into its fitting surface, then the analogues were removed from the denture after deflasking. (fig4) Finishing and polishing of the denture were done and the dentures were delivered to the patient where the housing in its position above the implants exactly. (fig5)

Follow up visits were scheduled, 0, 6 and 12 months after loading for making radiographic records to evaluate bone height changes around each implant and at the posterior alveolar ridge.



Fig (3) Pink wax attached to the try in



Fig (4) Deflasking

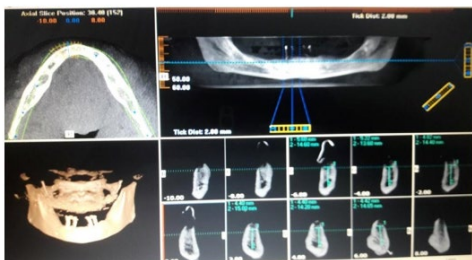


Fig (1) Cone beam showing length and width of bone using radiographic stent



Fig (2) Surgical stent



Fig (5) Housing in its right place

Radiographic evaluation

Marginal bone height changes around the implants and the posterior alveolar ridge bone height changes were evaluated using the linear measurement system supplied by the cone beam computed tomography. Marginal bone height changes around each implant and the posterior alveolar ridge bone height changes were monitored.

The measurements were carried out at the end of each follow up appointment (at insertion, 6, and 12 months post insertion).

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

Results:

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean \pm standard deviation (SD). Qualitative data were expressed as frequency and percentage. Independent t-test was used to compare between the two groups.

As shown in table 1 throughout the whole follow up period there was statistically significant difference between the two groups with the least mean difference within group 2.

In this study, as confirmed in table 2

Statistical analysis revealed that the posterior alveolar bone height changes by time between the two groups were not statistically significant with p value >0.05 .

Table (1): Mean values (mm), standard deviation (SD) and test of significance of peri-implant bone height change for group 1 versus group 2 during the follow up period.

Time	Group 1		Group 2		Independent Sample t-test	
	Mean	\pm SD	Mean	\pm SD	t-test	P- value
0-6 months	0.817	0.265	0.443	0.109	2.610	0.040*
6-12 months	0.829	0.226	0.429	0.229	2.486	0.047*
0-12 months	1.646	0.491	0.872	0.238	2.837	0.029*

Using: Independent Sample t-test; *p-value <0.05 NS

Table (2): Mean values (mm), standard deviation (SD) and test of significance of posterior alveolar bone height changes for group 1 versus group 2 during the follow up period.

Time	Group 1		Group 2		Independent Sample t-test	
	Mean	\pm SD	Mean	\pm SD	t-test	p-value
0-6 months	0.200	0.157	0.229	0.196	0.231	0.825
6-12 months	0.200	0.159	0.257	0.169	0.491	0.641
0-12 months	0.400	0.316	0.486	0.365	0.356	0.734

Using: Independent Sample t-test; p-value >0.05 NS

Discussion:

Maxillary dentures have been assessed to have better stability and retention than mandibular dentures so the mandibular ridge was chosen for implantation rather than the maxillary ridge. (9)

The use of implants to support and retain complete mandibular overdentures has aided to fulfill the functional requirements of patients with this challenging treatment indication. Mini-implant-retained mandibular over-dentures present a simple

and reliable solution for denture retention and stability problems. (10)

Four mini implants were placed at canines and premolars areas were used to support and retain complete mandibular overdenture as this is the least number of mini-implants required for appropriate retention of complete implant overdentures. (11)

All patients have been totally edentulous for at least 6 months before placement of the implants in the mandibular arch to prevent the effect of alveolar bone remodeling that follows tooth extraction. (12, 13) In this study, the Polyan IC was selected to be used as a material for fabrication of denture bases, it is a thermoplastic resin biocompatible, residual monomer content $<1\%$ so no irritation to the mucosa and colour stable using the injection molding technique. Also, this thermoplastic can be relined and repaired easily. (14)

Results of this study have shown that the mean difference in peri-implant bone height changes at the end of the follow-up period, were statistically significant for the two groups. A total change of 1.64 ± 0.49 mm and 0.87 ± 0.23 mm was detected for group 1 (patients received mini-implant retained mandibular overdenture base processed by conventional mold technique) and group 2 (patients received mini implant retained mandibular overdenture base processed by injectable mold technique). This amount of reduction is considered within the acceptable range of implant success and this is in agreement with the findings of Cox and Zarb (15) who stated that mean crestal bone loss reaching 1.6 mm is accepted as a radiographic sign for implant success during the first year of implant loading. (16)

In this study, the group 2 exhibited the least crestal bone loss throughout the study period compared to the group 1. This

could be due to that the injection molding technique produces a more dimensionally stable denture compared to dentures fabricated using compression molding technique (17) It was evaluated that injection molding technique enhances the physical properties of dentures and dimensional stability in comparison with compression molding technique. Also, it reduces polymerization shrinkage. (18)

Gharechahi(19) examined the dimensional changes of acrylic resin denture bases progress using injection molding technique to those fabricated using conventional molding technique. They concluded that, injection molding technique procedure showed higher dimensional accuracy compared to conventional molding technique, leading to higher denture base adaptation.

Aboelroos(20) noted that the significant difference in the total gap formation among the conventional packed and injection molded resins which could be attributed to difference in packing technique. As the modern injection molding techniques result in more dimensional accuracy than conventional processing techniques, since the resin is continuously injected under pressure to compensate for polymerization shrinkage. (21)

It was supposed that the combination of polymerization shrinkage and distortion of denture bases due to thermal stresses which occur in compression molding technique affects the adaptation accuracy of denture base to the underlying tissues creating a microgap. Injection molding technique is an alternative technique which may reduce these problems and increase denture base adaptation. (22, 23)

Also the results of this study agree with a study showed that the denture base affect the load applied to implant and act as a critical factor for implant success rate. Close adaptation of the denture base

decreases the movement of the denture and allow the forces distribution over the implants and supporting structure in turn decrease the stress concentration around the implants. (24-26)

Conclusion:

Within the limitation of this study, it was revealed that Polyan IC denture base processed by using injectable mold may show more favorable

Bone/implant interface and may enhance well fitted denture base compared to PMMA denture base processed by conventional method.

References

1. Carlsson GE. Clinical Morbidity and Sequelae of Treatment with Complete Dentures. *J Prosthet Dent.* 1998; 79: 17-23.
2. Whitmyer C, Esposito S, Alperin S. Longitudinal Treatment of a Severely Atrophic Mandible: A Clinical Report. *J Prosthet Dent.* 2003; 1; 90(2) 116–20.
3. Chugh D, Phull S, Rana A, Saini Y. Modified functional impression technique for resorbed mandibular ridge: Two case studies. *Int J. Med Dent.* 2015 ;1;5:2.
4. Naert I, Gizani S, Vuylsteke M and Van Steenberghe D; A 5-year prospective randomized clinical trial on the influence of splinted and unsplinted oral implants retaining a mandibular overdenture: prosthetic aspects and patient satisfaction. *J Oral Rehabil.* 1999 26(3) 195-203.
5. Elsyad MA, Gebreel AA, Fouad MM, Elshoukouki AH. The clinical and radiographic outcome of immediately loaded mini implants supporting a mandibular overdenture. A 3-year prospective study. *J Oral Rehabil.* 2011; 38(11):827-34
6. Phoenix RD, Mansueto MA, Ackerman NA, Jones RE. Evaluation of Mechanical and Thermal Properties of Commonly Used Denture Base Resins. *J Prosthodont.* 2004; 13(1):17-27.
7. Parvizi, A., T. Lindquist, R. Schneider, D. Williamson, D. Boyer and D. Dawson,. Comparison of the Dimensional Accuracy of Injection-Molded Denture Base Materials to that of Conventional PressurePack Acrylic Resin. *J Prosthodont.* 2004;13(2): 83-89.
8. Fujisawa M, Adachi K, Tsuruta S, Ishibashi K. A procedure for fitting a fixed partial denture to an existing removable partial denture. *J prosthet Dent.* 2004; 91(4):392-4.
9. Hendricks S, Wilson V, Angellilo I. Patient satisfaction and dentist evaluation of dentures in South Africa. *S. Afri. Dent. J.* . 1996; 51(3):143-7.
10. Preoteasa E, Meleşcanu-Imre MA, Preoteasa CT, Marin M, Lerner H. Aspects of oral morphology as decision factors in mini-implant supported overdenture. *Rom J Morphol Embryol.* 2010 1; 51(2):309-14.
11. Wang B, Sen HK, Khin NT, Cheng AC. Mini-dental implants for definitive prosthesis retention—A synopsis

- of the current evidence. *Singapore Dent. J* 2019 (01):1-9.
12. Esposito M, Grusovin MG, Pellegrino G, Soardi E, Felice P. Safety and effectiveness of maxillary early loaded titanium implants with a novel nanostructured calcium-incorporated surface (Xpeed): 1-year results from a pilot multicenter randomised controlled trial. *J Oral Implantol.* 2012; 1; 5(3):241-9.
 13. Olson JW, Shernoff AF, Tarlow JL, Colwell JA, Scheetz JP, Bingham SF. Dental endosseous implant assessment in a type 2 diabetic population: a prospective study. *Int J Oral Maxillofac Implants* 2000; 1; 15(6):811-8.
 14. Ibrahim W, Elawady D. Evaluation of masticatory muscle activity and survival rate of single implant-retained mandibular overdenture fabricated from thermoplastic versus conventional acrylic resin. A randomized controlled trial. *Egypt Dental J.* 2021;1; 67: 571-81.
 15. Cox JF, Zarb GA. The longitudinal clinical efficacy of osseointegrated dental implants: a 3-year report. *International J Oral Maxillofac Implants.* 1987; 1; 2(2).
 16. Misch CE, Perel ML, Wang HL, Sammartino G, Galindo-Moreno P, Trisi P, Steigmann M, Rebaudi A, Palti A, Pikos MA, Schwartz-Arad D. Implant success, survival, and failure: the International Congress of Oral Implantologists (ICOI) pisa consensus conference. *Int J Implant Dent.* 2008; 1; 17(1): 5-15.
 17. Gharechahi J, Asadzadeh N, Shahabian F, Gharechahi M. Flexural strength of acrylic resin denture bases processed by two different methods. *J Dent. (Tehran)* 2014; 8(3):148.
 18. Ucar Y, Akova T, Aysan I. Mechanical Properties of Polyamide versus Different PMMA Denture Base Materials. *J Prosthodont* 2012; 21(3):173-6.
 19. Gharechahi J, Asadzadeh N, Shahabian F, Gharechahi M. Dimensional changes of acrylic resin denture bases: conventional versus injection-molding technique. *J Dent (Tehran)* 2014; 11:398-405.
 20. Abuelroos IM, Ibrahim TO, Elsis HA. The Effect of Different Packing Techniques on Adaptation of Resin Denture Base Materials. *Int J Health Sci. Res.* 2020; 10:28-34.
 21. Ahmed M. Comparative adaptation accuracy of heat cured and injection molded resin denture base materials. *J Appl Sci Res.* 2012; 8(8):4691-6.
 22. Lee C, Bok S, Bae J. Comparative adaptation accuracy of acrylic denture bases evaluated by two different methods. *Dent Mater J* 2010;29(4):411-7.
 23. Shawky Y, Youssef H. Adaptation accuracy and retention of injection - and compression - molded maxillary complete denture: in - vitro and in - vivo study. *Egypt Dent J* 2014; 60(1): 1011-26.
 24. Palmqvist S, Sondell K, Swartz B. Implant supported maxillary overdentures outcome in planned and emergency cases. *Int J Oral Maxillofac Implants* 1994;1;9(2).
 25. Shamnur SN, Jagadeesh KN, Kalavathi SD, Kashinath KR. Flexible dentures- An alternate for rigid dentures *J Dent Sci Res.* 2010; 1:74-9.
 26. Ichikawa T, Horiuchi M, Wigianto R, Matsumoto N, in vitro study of mandibular implant retained overdentures the influence of stud attachment on load transfer to the implant and soft tissue. *Int J Prosthodont* 1996,1;9(4).