

FRACTURE INCIDENCE IN IMPLANT-RETAINED MANDIBULAR OVERDENTURES CONSTRUCTED BY EITHER CONVENTIONAL METHOD OR CAD/CAM TECHNOLOGY-A ONE YEAR FOLLOW UP

Mahmoud Darwish*

ABSTRACT

Purpose: To compare clinically the fracture incidence in overdentures constructed by CAD/CAM technology and compare it with those overdentures constructed by conventional heat cured methods in mandibular overdentures retained by two implants.

Materials and Methods: Twenty completely edentulous patients were participated in this study. The patients were randomly allocated to two equal groups of patients (Group A and group B). Group A patients received complete dentures constructed by conventional heat cured technique. Group B patients received complete dentures constructed by CAD/CAM technology. All the patients received two root form implants bilaterally in the canine regions following delayed loading protocol. Locator attachment was then used to retain the overdenture after 3 months healing period. Overdenture fracture was evaluated for the next 12 month after implant loading.

Results: Only two overdentures from the conventional overdenture group (group A) experienced fracture at area near to the abutment. Chi-square test indicated that, there is no significant differences in the fracture incidence between the study groups after 12 months observation period ($P > 0.05$).

Conclusion: The incidence of overdenture fractures was not significantly different between overdentures constructed by CAD/CAM or conventional heat curing techniques. When fractures take place, they tended to be in areas close to the abutment.

KEY WORDS : Implant overdenture, Fracture, CAD/CAM

INTRODUCTION

Implant retained overdentures are considered the standard of care, and the first treatment option to rehabilitate totally edentulous patient.^(1,2) By providing maxillary complete denture and 2 implant retained mandibular overdenture, functional and

esthetic satisfaction for totally edentulous patients can be easily achieved.⁽³⁻⁵⁾ Denture retention, stability, chewing function, biting force as well as patient satisfaction will be improved in completely edentulous patients with implant retained overdenture in comparison to conventional dentures. Additionally, implant-retained overdenture treatment option

* Lecturer of Prosthodontics, Faculty of Dentistry, Suez Canal University, Ismailia, Egypt.

provide reasonably lower cost and less surgical and prosthetic procedures if compared with implant-supported fixed prosthesis.^(6,7)

However, it was reported that implant-retained overdenture treatment, have many prosthetic complications like wearing down, breaking, or continuous replacement and activation of retention device, the denture base may require relining or rebasing with time, fracture of acrylic resin teeth and denture base.⁽⁸⁻¹⁰⁾

Prosthesis fracture may result from insufficient prosthetic space⁽¹¹⁾ or occur when the loads applied exceed the strength of the prosthetic materials.⁽⁸⁾ A review study of the clinical complications of implant prosthesis, reported that 12 % of overdenture cases undergo prosthesis fracture.⁽¹⁰⁾ Overdenture fracture is an inconvenient complication, as the patient is generally unable to use the prosthesis until it is repaired. One of the common methods used to reduce the risk of overdenture fracture is by reinforcement of the denture base with a metal framework, but it is associated with additional laboratory procedures and cost.^(12,13)

With the advent of CAD/CAM technology in complete denture construction, CAD/CAM PMMA was recommended as a promising treatment option to reduce the risk of overdenture fracture, particularly in cases with limited prosthetic spaces.^(14,15) This is attributed to enhanced mechanical properties of CAD/CAM dentures in the form of increased flexural, and impact strength of CAD/CAM resins if compared to traditional heat processed resins.^(15,16) CAD/CAM denture is made of resin pucks produced under controlled conditions of heat and pressure, the outcome is condensed acrylic resins, with reduced shrinkage, porosity or free monomer.⁽¹⁷⁾

It has been the aim of the present study to compare after one year of service, the fracture incidence of CAD/CAM and conventionally constructed overdentures. Therefore, the null hypothesis for this study was that there is no difference in fracture

incidence between CAD/CAM fabricated overdentures and conventional fabricated overdentures after one year of service.

MATERIALS AND METHODS

This study was done in accordance with the principles of Helsinki Declaration (version, 2008), and was approved by the Scientific Committee of Alfurabi College of Dentistry and Nursing – Riyadh, KSA. Twenty completely edentulous patients (men, average 56 years of age) were selected from the clinics of the Faculty of Dentistry. At the beginning, the aims, consequences and eventual complications of this clinical study were discussed with all patients, and in case of acceptance to participate, the patient sign an informed consent.

Inclusion criteria

Patients selection were based on the following criteria: Cooperative men patients, with class I Angle jaw relation, have normal tongue size and behavior, with at least 12 mm of interocclusal space, have bone volume suitable for the size of the used implant (12 mm length, and 3.3 mm diameter).

Exclusion criteria

Smoking patient, drugs or alcohol abusers, patient with medical condition that complicate the surgery, physical or psychiatric reasons that could affect follow-up, and those who received radiotherapy to the maxillofacial region that may affect the implant site were excluded.

Grouping of patients

The patients were randomly distributed into two equal groups each group have 10 patients as follow; Group A: The patients received a maxillary complete denture and a mandibular overdenture constructed in a conventional heat processed acrylic resin method and retained by two implants.

Group B: The patients received a maxillary

complete denture and a mandibular overdenture constructed from resin pucks using CAM/CAM technology and retained by two implants.

Construction of the dentures

Dentures for group A were made following the conventional clinical methods in accordance with the recommendations of the British Society for the Study of Prosthetic Dentistry.⁽¹⁸⁾ Then the acrylic dentures were processed following the conventional compression molding technique, and heat cured in a thermostatically controlled water bath according to the manufacturer recommendations. The water heated up to 80°C and maintained for 2 hours and then allowed to boil for a further 30 minutes. All the dentures were constructed by the same dental technician.

For patients in group B, CAD/CAM dentures were made following the AvaDent digital system (AvaDent TM Digital Dentures, Scottsdale, AZ, USA) with materials and techniques supplied by the manufacturer. The CAD/CAM denture was done in two clinical sessions, in the first session, impressions were made using thermoplastic trays and heavy body and light body polyvinyl-siloxane border molding and impression materials, respectively. Jaws relation record was done using the Anatomic Measuring Device (AMD, Global Dental Science- Scottsdale, AZ-USA) that was supplied by the manufacturer. AMD consists of mandibular and maxillary trays, which are available in various sizes. The mandibular AMD tray has a tracing table, while the maxillary tray provided with central adjustable bearing pin in order to get a Gothic arch tracing. The maxillary AMD tray has also an adjustable flange to support the upper lip. The mandibular and maxillary AMD trays were relined with fast set polyvinyl-siloxane impression in order to stabilize them on the residual ridge. After determination of the vertical dimension of occlusion (VDO), and placing the relined AMD trays in the patient's mouth, the patient is asked to close until the adjustable pin touches the tracing

table at the appropriate VDO. After that the patient is asked to move the mandible in protrusive and lateral directions, in order to get Gothic arch tracing with an apex that represent centric jaw relation. The apex is marked by creating small pit using round bur, then the mandible is guided until the pin fits in the created pit. Following that both maxillary and mandibular AMD trays are secured together by injecting an interocclusal recording material in-between. Finally lip support, midline, horizontal lip line, as well as suitable tooth size and shape was recorded by using flange and tooth mould templates. Then all obtained records were sent to the laboratory for scanning and denture fabrication. Prior to milling of the final denture, a virtual design of the denture was sent back for evaluation and acceptance. In the second clinical session, after the milling of the complete denture, delivery procedures similar those used for the conventional complete denture.

Implant placement

The implant sites were evaluated radiographically and clinically as following: Bone height was measured in the proposed implant site by using digital panoramic radiograph, in reference to 2 metal balls inside a clear radiographic stent that produced from duplicating the patient mandibular denture. Bone width in the proposed implant site was evaluated by mapping the residual ridge using graduated periodontal probe under topical anesthesia.⁽¹⁹⁾ Each patient received two implants in the mandibular canine regions bilaterally following delayed loading protocol. The implants used have the following specifications: root form titanium – zirconium implants (Roxolid SLActive; Institute Straumann AG- Switzerland) with a diameter of 3.3 mm and a length of 12 mm. Then the mandibular overdenture was modified and relined by soft liner (COE-SOFT; GC America, Alsip, Ill) opposite to the healing abutments that cover the implants, and the patients were instructed for using soft diet and meticulous oral and denture hygiene.

After 3 Months healing period, Locator abutments (LOCATOR Attachment System; Zest Dental Solutions) was placed on each implant, and the locator housing attachments were attached to the denture by the chairside direct pickup relining technique by using auto-polymerizing hard relining material (Simplex Rapid; Kemdent- UK) according to the conventional method.⁽²⁰⁾ In this study, a light retention pink replacement male was used. Then the patient was directed the correct way of denture insertion and removal many times. Before patient's dismissal, all were instructed about denture and implant hygiene and were requested to present in scheduled follow-up visits for assessment.

Evaluation of overdenture fracture

Patients who suffered broken overdenture were known from clinical reports. Any case with noticeable crack in the acrylic base or total separation of the denture parts, during follow up was considered fracture.

The recorded data were tabulated and analyzed using the SPSS statistical package (version 20). Study of the incidence of overdenture fracture for both groups was done by chi-square test. The level of significance was set at 0.05.

RESULTS

All the participants in this clinical trial completed 12 months evaluation and no implants were lost.

Fracture of the mandibular overdenture

During the twelve months observation period following the implant loading, two subjects of group A patients experienced fracture of the denture near to the attachment, while there was no fracture reported in group B patients. Comparing these results using a chi-square test, this difference was not statistically significant ($P=0.136$) (Table 1). Repair was carried out to the fractured dentures using self cured acrylic resin (Simplex Rapid; Kemdent- UK) following the conventional methods of denture repair.

TABLE (1) Comparison of patients with CAD/CAM and Conventional heat cured overdenture who experienced overdenture fracture, using chi-square test:

Overdenture type	Fracture	No Fracture	Total	P- Value
Group A	2	8	10	0.136 (ns)
Group B	0	10	10	
Total	2	18	20	

ns: Non significant difference ($P > 0.05$)

DISCUSSION

It is well recognized that the aim of any prosthetic dental treatment is to provide a satisfactory and long-lasting dental prosthesis that preserve the integrity of the supporting dental structures. So, the goal of this study was therefore to evaluate and compare the CAD/CAM overdenture construction method and conventional heat curing method, with respect to incidence of overdenture fracture after one year of services.

Overdenture fracturing around supporting abutment is a popular clinical complication in prosthodontic practice.^(10, 21-23) Various methods have been investigated to improve the acrylic denture bases and prevent the fracture of overdenture, including development of new materials, chemical modification, and mechanical reinforcement of acrylic with metal framework or glass fibers.^(24,25) Manufacturers and authors have reported that CAD/CAM dentures have excellent mechanical features compared to conventional heat-cured dentures.^(14-17,26-28) Therefore this clinical study was conducted to compare the fracture incidence between CAD/CAM and traditional heat cured overdentures retained by dental implants. The result indicates that the null hypothesis for the incidence of denture fracture was not rejected, as the incidence of denture base fractures was not significantly different between the study groups after 1 year of

service. The small sample size, and short observation period (1 year) were a limitation of this study which may account for the lack of significance between the fractures of overdentures in both groups A and B. The finding indicates that 20 % of group A overdenture experienced fracture near to the attachment, where there is a concentration of stress, usually over the implant. This comes in line with a clinical study carried out by Gonda et al⁽²⁹⁾, who reported 15.3% fracture of overdentures retained by single or double implants. On the other hand, overdentures in group B did not show any fracture during twelve months observation period, and this may be attributed to the fact that group B overdenture fabricated from a prepolymerized acrylic resin block that may offer several advantages over conventionally processed prostheses that include reduced porosity and increased strength. This is consistent with published data from Peng et al in 2017⁽¹³⁾ during managing fracture resulted from limited prosthetic space in implant retained overdenture, they observed no complications for six months following denture insertion after using CAD/CAM.

The fracture incidence in the present study was non-significant, and this may be attributed to the strict selection criteria of the participants with adequate interocclusal distance of 12 mm space, that give the chance to design the overdentures with adequate denture base thickness of at least 2 mm around the locator attachment system, so reduced the risk of overdenture fracture around the implant abutment. This attribution is supported by previous studies in treatment planning for 2 implant retained overdenture and the restorative space required for implant overdenture cases.⁽³⁰⁻³¹⁾ This indicates that further research is required to evaluate the difference in fracture incidence in cases with limited interocclusal space that may compromise the minimal dimensions of the denture base materials used.

A limitation of this study is the small sample size. Also, the study included only men patients and

the observation period was limited to 12 months following implant loading. Further studies that consider these limitations are advised to validate the findings of the present study.

CONCLUSION

By taking the limitations of this study into consideration, it can be concluded that:

The incidence of overdenture fractures was not significantly different between overdentures constructed by CAD/CAM or conventional heat curing techniques. When fractures take place, they tended to be in areas close to the abutment.

REFERENCES

1. Feine JS, Carlsson GE, Awad MA, ChehadeA, Duncan WJ, Gizani S, et al. The McGill consensus statement on overdentures. Mandibular two-implant-overdentures as first choice standard of care for edentulous patients. Montreal, Quebec, May 24-25, 2002. *Int J Oral Maxillofac Implants.* 2002;17:601-602.
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;93:28-37.
3. Timmerman R, Stoker GT, Wismeijer D, Oosterveld P, Vermeeren JI, van Waas MA. An eight-year follow-up to a randomized clinical trial of participant satisfaction with three types of mandibular implant-retained overdentures. *J Dent Res.* 2004;83:630-633.
4. Cune M, Burgers M, van Kampen F, de Putter C, van der Bilt A. Mandibular overdentures retained by two implants: 10-year results from a cross over clinical trial comparing ball-socket and bar-clip attachments. *Int J Prosthodont.* 2010;23:310-317.
5. Kuoppala R, Napankangas R, Raustia A. Outcome of implant-supported overdenture treatment-a survey of 58 patients. *Gerodontology.* 2012;29:e577-e584.
6. Emami E, Heydecke G, Rompre PH, de Grandmont P, Feine JS. Impact of implant support for mandibular dentures on satisfaction, oral and general health-related quality of life: A meta-analysis of randomized-controlled trials. *Clin Oral Implants Res.* 2009;20:533-544.

7. Boven GC, Raghoobar GM, Vissink A, Meijer HJ. Improving masticatory performance, bite force, nutritional state and patient's satisfaction with implant overdentures: A systematic review of the literature. *J Oral Rehabil.* 2015;42:220-233.
8. Andreiotelli M, Att W, Strub JR. Prosthodontic complications with implant overdentures: a systematic literature review. *Int J Prosthodont.* 2010;23:195-203.
9. Vahidi F, Pinto-Sinai G. Complications associated with implant-retained removable prostheses. *Dent Clin North Am.* 2015;59:215-226.
10. Goodacre CJ1, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications with implants and implant prostheses. *J Prosthet Dent.* 2003;90:121-132.
11. Bidra AS. Consequences of insufficient treatment planning for flapless implant surgery for a mandibular overdenture: A clinical report. *J Prosthet Dent.* 2011;105:286-291.
12. Orenstein IH, Weinstein BF, Gelman AS, Fiks S, McCartney JW. A technique for converting an existing denture into a cast metal-reinforced implant-retained overdenture. *J Prosthet Dent.* 2010;104:397-400.
13. Özçelik TB, Yılmaz B, Akçimen Y. Metal reinforcement for implant-supported mandibular overdentures. *J Prosthet Dent.* 2013;109:338-340.
14. Peng L, Chen Li, Harris BT, Morton D, Lin WH. Managing complications resulting from limited prostheticspace with a monolithic, multichromatic CAD-CAM implant-retained overdenture: A dental technique. *J Prosthet Dent.* 2017;118:712-716.
15. Al-Dwairi ZN, Tahboub KY, Baba NZ, Goodacre CJ. A Comparison of the Flexural and Impact Strengths and Flexural Modulus of CAD/CAM and Conventional Heat-Cured Polymethyl Methacrylate (PMMA). *J Prosthodont.* 2020;29:341-349.
16. Aguirre BC, Chen JH, Kontogiorgos ED, Murchison DF, Nagy WW. Flexural strength of denture base acrylic resins processed by conventional and CAD-CAM methods. *J Prosthet Dent.* 2020;123:641-646.
17. Infante L, Yılmaz B, McGlumphy E, Finger I. Fabricating complete dentures with CAD/CAM technology. *J Prosthet Dent.* 2014; 111:351-355.
18. Ogden A. *BSSPD Guidelines in Prosthetic and Implant Dentistry.* London: Quintessence Publishing Co. Ltd. Forthe British Society for the Study of Prosthetic Dentistry 1996. p. 7-11.
19. Flanagan D. A nonradiologic method for estimating bone volume for dental implant placement in the completely edentulous arch. *J Oral Implantol.* 2001; 27:115-117.
20. Al-Dharrab A. Three-year Prospective Evaluation of Immediately Loaded Mandibular Implant Overdentures retained with Locator Attachments. *J Contemp Dent Pract.* 2017;18:842-850.
21. Polyzois GL, Andreopoulos AG, Lagouvardos PE. Acrylic resin denture repair with adhesive resin and metal wires: effects on strength parameters. *J Prosthet Dent.* 1996;75:381-387.
22. Duncan JP, Freilich MA, Latvis CJ. Fiber-reinforced composite framework for implant-supported overdentures. *J Prosthet Dent.* 2000; 84:200-204.
23. Rodrigues AH. Metal reinforcement for implant-supported mandibular overdentures. *J Prosthet Dent.* 2000; 83:511-513.
24. Jagger DC, Harrison A, Jandt KD. The reinforcement of dentures (review). *J Oral Rehabil.* 1999; 26:185-194.
25. Gonda T, Ikebe K, Dong J, Nokubi T. Effect of reinforcement on overdenture strain. *J Dent Res.* 2007;86:667-671.
26. Bidra AS, Taylor TD, Agar JR: Computer-aided technology for fabricating complete dentures: systematic review of historical background, current status, and future perspectives. *J Prosthet Dent.* 2013;109:361-366.
27. McLaughlin JB, Ramos V: Complete denture fabrication with CAD/CAM record bases. *J Prosthet Dent.* 2015;114:493-497.
28. Steinmassl PA, Wiedemair V, Huck C, et al: Do CAD/CAM dentures really release less monomer than conventional dentures? *Clin Oral Investig.* 2017; 21:1697-1705.
29. Gonda T, Maeda Y, Walton JN, MacEntee MI. Fracture incidence in mandibular overdentures retained by one or two implants. *J Prosthet Dent.* 2010;103:178-181.
30. Ahuja S, Cagna DR. Defining available restorative space for implant overdentures. *J Prosthet Dent.* 2010; 104:133-136.
31. Lee CK, Agar JR. Surgical and prosthetic planning for a two-implant-retained mandibular overdenture: a clinical report. *J Prosthet Dent.* 2006;95:102-105.