

T-SCAN EVALUATION OF INJECTION VERSUS COMPRESSION MOLDED MAXILLARY COMPLETE DENTURES OPPOSED BY IMPLANT RETAINED MANDIBULAR OVERDENTURES

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ABSTRACT

Objectives: This research was carried out to evaluate the bite force distribution of the maxillary complete dentures processed by injection molded (IM) and compression molded (CM) techniques opposed by implant retained over denture (IOD) using T-scan.

Materials and Methods: Ten completely edentulous patients were rehabilitated by mandibular (IOD) and maxillary complete denture. Each patient received two maxillary dentures, one was formed of thermoplastic acrylic resin processed by (IM) technique and the other was formed of conventional acrylic resin processed by (CM) technique. The bite force distribution on the two maxillary dentures was evaluated by T-scan one week and three months after denture insertion.

Results: In this study, at the end of the follow up period there was statistically significant difference in the bite force distribution between the (IM) & (CM) complete dentures. After one week of denture insertion, the means of difference of bite force distribution between the right and left posterior edentulous areas of (IM) & (CM) complete dentures were (7.700 ± 3.860) and (15.80 ± 4.984) consequently. While the means of bite force distribution for anterior edentulous areas of (IM) & (CM) complete dentures were (10.80 ± 2.658) and (17.60 ± 3.239) respectively. After three months, the means of difference of bite force distribution between the right and left posterior edentulous areas of (IM) & (CM) complete dentures were (9.400 ± 4.695) and (18.40 ± 7.106) consequently, and the means of bite force distribution in the anterior region were (16.40 ± 2.591) and (23.80 ± 3.824) in (IM) & (CM) complete dentures respectively.

Conclusion: Within the limitation of this study, it could be concluded that IM complete dentures showed even bite force distribution along the posterior area of both sides of the edentulous arch and less bite force on the anterior edentulous area compared by CM complete denture. Both dentures showed increased bite force distribution by time on the anterior edentulous area.

Key Words: Dental Implant, maxillary, mandibular overdenture, injection molded, compression molded, bite force distribution and T-Scan.

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INTRODUCTION

Edentulous patients are commonly exposed to difficulties in masticatory and oral functions that often arise from their ill fitted dentures. ⁽¹⁾

Dental implant were used successfully in the field of prosthodontics to overcome the problems encountered with the complete dentures.^(2,3) It was claimed that using at least two implants in the mandibular arch to retain an overdenture against maxillary conventional denture is approved as a regular, less offensive and economically satisfied treatment modality for completely edentulous patients. ^(4,5)

Although this treatment modality may improve the masticatory and oral function, it may cause excessive uncontrolled occlusal forces that may lead to an adverse effect on the ridges resembling those observed in "Combination Syndrome". ^(6,7) The presence of the mandibular implants that were connected by bars and retained to the dentures by clips improved the dentures retention and stability which give the patients the confidence to use the anterior teeth during function with increased biting forces that caused more load on the anterior part of maxilla with subsequent bone resorption. ^(7,8)

Moreover, the uncontrolled occlusal forces may lead to implant failure as well due to nonexistence of periodontal ligaments that act as a cushion under the occlusal forces. ⁽⁹⁾ Occlusal forces are transferred to the residual ridges through the denture bases. The material of these bases is believed to have effect on the mode of transmission of these forces and the subsequent bone changes that may occur. ⁽¹⁰⁾

Polymethyle methacrylate (PMMA) was used as denture base material for decades. This material was processed by compression molding technique that yielded many discrepancies in the final restoration that many studies had confirmed. ⁽¹¹⁻¹³⁾ The adaptation accuracy of the denture base was one of the parameters that was negatively affected by the

processing technique and subsequently influenced the fit of the denture base to the underlying ridge. ⁽¹⁴⁻¹⁶⁾ Continuous improvements in techniques and materials were introduced to overcome the problems of PMMA that were developed due to the processing technique. Injection molding processing method is commonly used nowadays with different systems using injectable material that is thermally plasticized and injected into a mold under very high pressure. Several studies reported that the injection molding processing technique yielded restorations with high adaptation and dimensional accuracy. ⁽¹⁶⁻¹⁸⁾

Thermoplastic acrylic resin is PMMA based material which has been introduced as an injectable material that is processed by injection molding technique. It is one of the thermoplastic materials that has been widely invaded the dental practice in the last years. ^(19,20)

Different evaluation methods were used to assess the occlusal forces of different treatment modalities and their effect on the surrounding tissues. Radiographs were used to assess bone changes due to masticatory and oral function. ^(8,21) Bite force was assessed with wide range of devices. ⁽²²⁾ T-Scan is a computer aided device that analyze the occlusal forces by recording the distribution of relative forces from the first occlusal contact to maximum intercuspation and display them as percentage not as actual values. ^(23,24)

T-Scan III developed by Tekscan (Boston, MA, USA) is a device that provides computer assisted occlusal analysis. A disposable sensor having the shape of the dental arch is held by a probe connected to the computer. The sensor is sensitive to pressure so that the distribution of relative force and timing of occlusal contact during clenching are being recorded and displayed by the software in a dynamic movie. ⁽²⁴⁾

Researches were mostly directed to evaluate the effect of oral functions of different treatment

modalities of the implant retained mandibular overdentures on the mandibular posterior ridge and the anterior maxilla by changing the mode of connection between the mandibular over denture and their implants. ^(8,21,25)

Using different treatment options for maxillary edentulous ridges to overcome or counteract the effect of mandibular implant retained overdenture without using implant in the maxilla were seldom assessed. Hence, this cross over study was conducted using T-Scan to investigate the effect of using IM versus CM maxillary complete dentures opposed by bar implant retained mandibular overdenture on bite force distribution.

MATERIALS AND METHODS

Patient selection and study design

Ten completely edentulous patients were selected from outpatient clinic of Removable Prosthodontics Department, Faculty of Dentistry, Ain Shams University to participate in this within patient cross over study. Patients were 6 males and 4 females with age ranged from 55 to 65 years. They were having persistent complaints about their mandibular dentures. All patients were enrolled in the study according to inclusion criteria as being edentulous for around 10 years and exposed to more than one denture. The bone height was more than 15 mm in the interforaminal area. Maxillomandibular relation exhibited "Angel's" class I. Adequate interarch space of at least 30 mm. Exclusion criteria were: Any medical, physical and psychiatric condition that might affect the neuromuscular coordination or contraindicate implant surgery. Written consent was signed by each patient after being informed about the details of the study.

Clinical and radiographic examination "cone-beam computed tomography" was performed for all patients prior treatment to evaluate bone quality and quantity for implant site.

Each patient received two implants inserted in the canine regions and connected with a bar and retained to a new mandibular denture by a clip. Two duplicate maxillary dentures were provided, one made of conventional acrylic resin (PMMA) processed with compression molding (CM) technique and the other one made of thermoplastic acrylic resin (PMMA based resin) processed with injection molding technique (IM). According to the sequence of which the two types of maxillary denture were inserted, the patients were assigned randomly and equally to one of the two treatment sequence groups. First group, CM dentures were inserted followed by IM ones. The second group, IM dentures were inserted followed by CM ones. Each type of denture was used for three months. Two weeks rest period was provided between the use of one denture and the other to minimize the "carryover" influence i.e. "wash out" the effect of the first denture. ⁽²⁶⁾

T-scan measurement was done one week and three months after fitting of each type of maxillary dentures.

The clinical procedures were done for all patients as follows:

Surgical and prosthetic procedures:

Each patient received two implants in the canine area bilaterally with dimensions 13 mm length and 3.7 mm width (Implant direct, Replant™ implant, CA 91301 Germany). The surgical procedures were done following "two stages submerged surgical protocol". Patients were not allowed to use their dentures before 2 weeks post-surgical, their existing mandibular dentures were relieved opposite to canine areas and then refitted by tissue conditioner in order to avoid early loading on the implants. Three months later, the implants were exposed and healing abutments were screwed in place for two weeks to improve healing. Bar was constructed on the two implants with at least 2mm clearance between the bar and the underlying mucosa for easy cleansing (Fig 1).

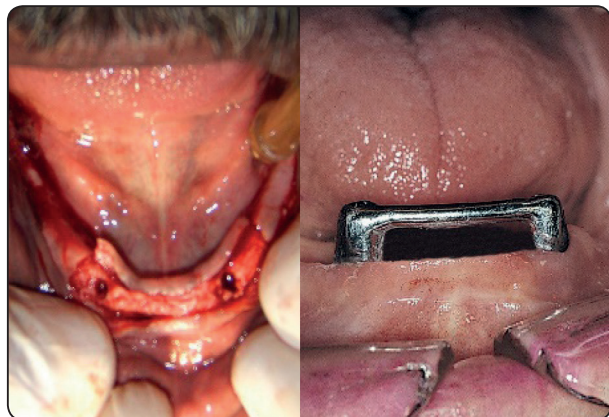


Fig (1) show implant placement & bar construction

Secondary impressions for maxillary and mandibular arches were taken by rubber base on a special tray. The impressions were poured by dental stone to produce the master casts. The maxillary master cast was duplicated by rubber base impression and poured into dental stone.

Record blocks were constructed on the main master casts and jaw relation was recorded and mounted on semi-adjustable articulator using a face bow record and centric occluding relation. Protrusive records were taken to adjust the horizontal condylar guidance of the articulator. The lateral condylar guidance was adjusted by using "Hanu formula".

In this study, two maxillary and one mandibular trial dentures were formed. The first maxillary trial denture base was formed for IM denture using acrylic teeth prepared with mechanical means of retention. The teeth were arranged according to lingualized occlusion concept. Both the first maxillary and mandibular trial dentures were tried in the patient mouth and then waxed up. The mandibular denture then processed by conventional technique, remounted and occlusal adjustment then carried out on the lower teeth only as the mandibular denture was common for both maxillary dentures.

The maxillary cast was indexed on the anterior and posterior sides and then the first trial denture base was duplicated to make the second one with the

same denture base thickness and teeth arrangement. Rubber base impression was used to produce a mold in which similar set of maxillary teeth were positioned and then a molten base plate wax was placed into the denture base area of the mold where the cast then repositioned against it in the mold. Two holes were made on the lateral sides of the mold for excess molten wax to escape. ⁽²⁷⁾

The first trial denture was positioned on the duplicate cast and processed by injection molded technique using "Polyan" (Polyan IC, Modified methacrylate, Bredent, Germany). Thermopress unit (Thermopress 400 version 2.4/2.56, Bredent, Germany) was used at a temperature of 265°C and under pressure of 5 bars for 15 min. The duplicate trial denture was processed by compression molded technique using conventional heat polymerized PMMA (Vertex regular, Zeist, Netherlands). Processing took place at 100°C for 30 min in the curing unit (OMECA, Curing Unit, Italy).

Dentures were then fitted intra orally. Pick up of retentive clips for mandibular overdenture was done intra orally using autopolymerized acrylic resin (Fig 2). Sequence of wearing the two maxillary dentures was done randomly as mentioned before. Patients were recalled for follow up 24 hours after denture wearing, 3 days and one week later.



Fig (2) Pick up of retentive tip

Occlusal analysis using T-Scan III

Occlusal analysis for bite force distribution was performed one week and three months after denture insertion using T Scan.

The sensor of T Scan was introduced into the patient’s mouth with its central line aligned with the mid line of upper incisors. The patient was asked to clench on the sensor in maximum intercuspation. Recordings were processed by the software for graphical display in two and three dimensions. Occlusal analysis shows relative force distribution through each quadrant of the dental arch (Fig 3).

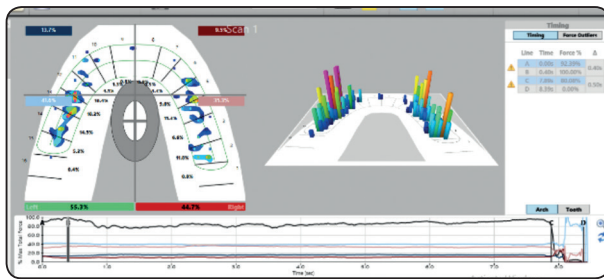


Fig (3) Bite force distribution

RESULTS

Statistical analysis was performed using Graphpad prism (Prism 5 for windows), version 5, Graphpad software, Inc. Data are presented in the form of means and standard deviation (SD) values. Mann Whitney test was used to study the effect of processing technique on the bite force distribution and Wilcoxon signed rank test to study the effect of time on bite force distribution for each type of dentures. The significant level was set at $P \leq 0.05$.

Effect of processing techniques on bite force distribution

a) Comparison between means of differences of force distributions of the two sides of the arch in posterior region

The effect of two processing techniques on the distribution of force between the two sides of the edentulous arch is presented in table (1). Statistically

significant difference ($P \leq 0.05$) was evident between the means differences of load distribution of the two sides of the arch of the two processing techniques.

TABLE (1): Means, standard deviation (SD) and results of Mann Whitney test for the effect of processing technique on the load distribution between the two sides of the arch in the posterior region one week, three months after denture insertion.

Time	Groups		P-value
	CM	IM	
One week	Mean (SD) 15.80 (4.984)	Mean (SD) 7.700 (3.860)	0.0031*
3 months	Mean (SD) 18.40 (7.106)	Mean (SD) 9.400(4.695)	0.0065*

**Significant at $P \leq 0.05$*

The CM group showed significantly higher means of differences of load distribution posteriorly between the two arches than IM group in all follow up period.

b) Comparison between the effect of CM and MI on load distribution in the anterior region in all follow up period using Mann Whitney test.

The effect of processing techniques on load distribution in the anterior region is presented in table (2). Statistical significant difference ($P \leq 0.05$) was detected between the means of load distribution in the anterior region of the two groups.

TABLE (2): Means, standard deviation (SD) and results of Mann Whitney test for the effect of processing technique on the load distribution in the anterior region in all follow up period.

Time	Groups		P-value
	CM	IM	
One week	Mean (SD) 17.60 (3.239)	Mean (SD) 10.80 (2.658)	0.0007*
3 months	Mean (SD) 23.80 (3.824)	Mean (SD) 16.40 (2.591)	0.0013*

**Significant at $P \leq 0.05$*

The CM group showed significantly higher load than IM group in the anterior region after one week and three months of denture insertion.

Effect of time on load distribution in the anterior region for each group

The effect of time on load distribution in the anterior region for each group is presented in table (3). Statistical significant difference ($P \leq 0.05$) was detected between the means of load distribution in the anterior region of the two groups.

TABLE (3): Means, standard deviation (SD) and results of Wilcoxon signed rank test for the effect of time on the load distribution in the anterior area when using the two types of dentures.

Groups \ Time	One week	3 months	P-value
	Mean (SD)	Mean (SD)	
CM	17.60 (3.239)	23.80 (3.824)	0.0055*
IM	10.80 (2.658)	16.40 (2.591)	0.0055*

*Significant at $P \leq 0.05$

The mean load distribution in the anterior region showed statistically significant increase ($P \leq 0.05$) after 3 months of denture insertion when using each type of denture.

DISCUSSION

This cross over study design was carried out to avoid the background variation between individuals where patients act as their own control, also to have the advantage of using small number of patients. However, a carryover effect of one denture could affect the results of the other denture in sequence (28,29), so two weeks wash out period was given between the use of one denture and the other to avoid this problem.

The lower denture was processed first after the try in procedure and then remounted where all occlusal adjustment was carried out on the lower teeth only before processing of the maxillary dentures as the mandibular denture was common for both of them. This was done to decrease the need for any further occlusal adjustment after processing the maxillary dentures and to exclude the lower denture processing from any processing errors that may affect the occlusion. Hence, any further change in occlusal relation during denture insertion will be related to the processing technique of the maxillary dentures.

Denture base material and processing techniques may have effect on load transmission to the underlying supporting structures. Distortion of denture base and subsequent movement of teeth may occur during CM technique (30,31) leading to changes in occlusal relation and decreased retention and stability of the dentures (32,33), while IM technique was reported to show more superior results regarding dimensional stability and occlusal changes(34,35) as well as high denture adaptation to the underlying tissues (16,36) compared with compression molding technique. Also the material is injected under continuous pressure during processing which compensate any expected polymerization shrinkage producing more dense dentures with high flexure strength.(20)

This was in consistent with the results of this study where the IM thermoplastic acrylic resin showed less bite force on the anterior area after three months of denture insertion as well as even distribution of occlusal forces between the right and left posterior edentulous areas after three months of denture insertion compared to the CM conventional acrylic resin. This might refer to less occlusal changes in IM technique and better force distribution across the edentulous arch.

However, some occlusal changes may occur due to deformation of the underlying mucosa when

subjected to compression. ⁽³⁷⁾ Studies showed that the movements of the dentures to closer relation to the soft tissue are due to the viscoelastic behavior of mucosa, which is responsible to the time dependent behavior of denture bearing mucosa. These studies showed changes in occlusal relation as well as slight decrease in vertical dimension during the adaptation period of the denture, where mucosa showed an immediate displacement and gradual and incomplete recovery under occlusal loading. ⁽³⁸⁻⁴⁰⁾

The results of this study support these findings as they showed statistically significant increase in bite force on the anterior area by time for both groups. This could be interpreted by the settling that occurred to the maxillary complete denture over the resilient mucosa which increased by time changing the occlusal relation of the maxillary denture to the stable bar connected IOD placing more occlusal force anteriorly. Moreover, the stability of the mandibular overdenture seemed to encourage the patients to use their anterior teeth during clenching.

The increased bite force anteriorly was corresponded with the findings of some studies that showed higher bone resorption in the anterior region of edentulous maxilla than the posterior part opposed by mandibular overdenture retained by bar connected two implants. ^(8,21,41) Some studies related the reduction of anterior edentulous maxilla opposed by IOD to the type of mandibular prosthesis where looseness of maxillary denture and development of flabby ridges anteriorly were noticed with clip rather than resilient liner retained mandibular overdenture which may suggest the exertion of high forces on the maxilla by clip retained mandibular overdenture. ^(42,43) Another study showed that the reduction of maxillary edentulous ridge is not related to the type of mandibular prosthesis ⁽²⁵⁾, It could be attributed to the relative occlusal force distribution. ⁽⁴⁴⁾ However, The results of this study revealed that the type of maxillary prosthesis could affect the

occlusal load distribution in the anterior maxilla where there was statistically significant increase in anterior occlusal force for CM in comparison to IM after 3 months of denture insertion. This could be related to less dimensional and occlusal changes as well as better adaptation to the underlying mucosa of complete denture processed by IM technique.

This study has some limitations where a relative bite force was used which make it difficult to have direct comparison with other studies that measures absolute bite force. In addition, the material used in processing the dentures of the two groups were not of the same composition although the one used in IM technique was PMM based thermoplastic material and that used in CM technique was conventional PMM.

It is worthy to mention that this study was carried out with a scope to evaluate the effect of the processing technique of maxillary complete denture on bite force distribution when opposed with IOD during the adaptation period to find a way to decrease the occlusal force exerted by IOD on the edentulous maxilla. However, long term studies with wider range of participants are needed for further evaluation before any definitive conclusion can be made. Moreover, it is recommended to investigate the effect of this bite force distribution using IM complete denture on the anterior ridge reduction of edentulous maxilla and find a correlation between them.

CONCLUSION

Within the limitation of this study it could be concluded that processing technique may have influence on the bite force distribution by complete maxillary dentures opposed by IOD where IM complete dentures showed even bite force distribution along the posterior area of both sides of the edentulous arch and less bite force on the anterior edentulous area compared by CM complete denture. Both dentures showed increased bite force by time on the anterior edentulous area.

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