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Effects of Anchored Resin Polymerization Technique on Retention in Conventional and Injection Moulded Complete Denture

Research Article

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Abstract

Aim: To evaluate retention offered by anchored resin polymerization technique in complete denture patients.
Materials and Method: Impressions of maxilla of 5 edentulous patients were taken and 4 dentures were fabricated for each- conventional, conventional anchored, injection moulded and injection moulded anchored. Acrylic resin was used for conventional method and Ivoclar material was used for injection moulded technique. 20 denture bases without denture teeth were fabricated. A hook was attached to each denture on its polished surfacesand tried on the patients. The retention of each denture was analyzed using a hanging digital weighing machine by pull-out test. The maximum force required to dislodge each denture was noted. One way ANOVA analysis was done using the SPSS software and the results were calculated.
Result: The retention offered by the various processing systems were expressed as N/cm^2. The retention for conventional processing method was 2.8 ± 2.16 N, for a conventional anchored method was 5 ± 2.55 N, for injection moulded it is 12.60 ± 2.88 N and for injection moulded complete denture it is 14.40 ± 2.88 N. ANOVA showed a high statistically significant difference between the 4 groups(p=0.001).
Conclusion: As seen from this study, injection moulded anchored resin polymerised dentures are better at retention as it helps to reduce polymerisation shrinkage and causes better adaptation and posterior seal of the denture in the patient's mouth. Thus, it can be concluded that injection moulding BPS shows better retention than conventional dentures.
Clinical Significance: Better retentive dentures are more comfortable, functional and satisfactory for the patient and prevents the loosening of the denture. It also improves adaptation and prevents harm to the surrounding tissues.

Keywords: Anchored Resin; Retention; Denture; Dislodgement; Original Research.

Introduction

Debilitating and irreversible loss of the natural dentition, generally known as edentulism, is a common occurrence in patients of older age groups. A completely edentulous State leads to loss of integrity of the oral and facial structures and can also result in loss of functional and aesthetic sequelae [1]. Dentures or false teeth, are aids made in the prosthodontics industry to replace missing teeth in the patient's oral cavity and are supported by the surrounding hard and soft tissues. Dentures were first said to be fabricated as early as in the 7th BC where false partial dentures were made by fastening animal or human teeth together using human cords. Well fitting dentures help in supporting the surrounding structures and also help in maintaining an environment of good oral function and can also improve the self esteem of the patients [2]. The dentures can be classified as either complete or partial and removable or fixed. Removable dentures are mainly fabricated by the conventional technique and are more cost effective. There are many ways to fabricate a denture. Complete dentures are preferred by completely edentulous patients after a full mouth extraction [3]. The infusion of computer-aided design/computer-aided manufacturing (CAD/CAM) into fabrication of complete

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dentures combines conventional and technological methods and thus facilitates and fastens the process. The fabrication of dentures is done by the process of polymerisation. In conventional acrylic denture bases, dimensional changes tend to occur during the polymerisation process. The conventional method utilizes Polymethyl methacrylate (PMMA) for fabrication [4] (Figure 1). This method comprises of heat activation in a water bath coupled with compression moulding [5]. During the polymerisation process, dimensional shrinkage of the resin occurs. Shrinkage, which is caused by the differences in the densities of the monomer and the polymer, results in a lifting of the denture base away from the posterior palate as a result of polymerisation [6]. Thus modifications have been made to the conventional method of fabrication to increase its retentive properties and improve its overall fitness.

Retention is the principle by which the denture resists vertical motion opposite to the direction of insertion. Decreased retentive capability can cause discomfort to the patient. Retention can be defined as 'that quality inherent in the prosthesis acting to resist the forces of dislodgement along the path of insertion' [7]. There are many factors that affect the retention of complete dentures. These include anatomic factors such as the size and quality of the denture bearing area and parallelism of the ridge walls, physiological factors including the amount and consistency of saliva, muscular factors such as oral and facial musculature and mechanical factors such as undercuts. Effective retention is attained by the close mucosal contact of the denture base. The gap between the denture and the oral tissues should be maintained as small as possible. Also, there has to be a border seal, which can be achieved by extending the denture flanges to the sulci. The border seal is composed of the edges of the anterior and lateral aspects and the posterior palatal seal [18]. Difference in the densities of the monomer and polymer can result in the shrinkage of the denture during polymerization and lead to the lifting of the denture base at the posterior palate. In order to overcome the disadvantage of shrinkage and consequently less retention, the injection moulding technique was introduced by Pryor in 1942. In 1970, an acrylic resin modified injection moulding process was discovered by Ivoclar [9-11]. The method comprises of premeasured mixing of the liquid and powder of methyl methacrylate, which is injected under constant pressure through a fabricated sprue in the injection moulding flask. This compensates for the polymerisation shrinkage of the denture. The whole contraption is then immersed in a water bath at 100°C. This process lasts for about an hour and produces a dimensionally stable denture which is not much affected by polymerisation shrinkage. Ivoclar acrylics are the most widely used in injection moulding techniques [12].

Anchored resin polymerisation is a relatively new and novel concept. Here, anchoring holes are made in the casts in the posterior land area and in the midsagittal area [13]. Generally, The anchoring method uses holes drilled on the cast and a special flange extended onto the posterior aspect of the maxillary cast. anchoring methods Improve the adaptation of denture bases by minimizing the discrepancy between the denture base and cast. The acrylic flows into the anchoring holes and helps lock the denture base and prevents its shrinkage. The sharp edges in the denture due to the anchoring holes, is trimmed off before attaching onto the patient (Figure 2). Since anchored resin polymerisation is a new concept, not much research is done on this field, but it is a promising technique in the prosthodontics industry. This study was done to evaluate retention offered by anchored resin polymerization technique in complete denture patients using both conventional and injection moulding technique.

Materials and Method

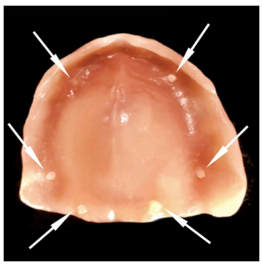
Impressions of maxilla of 5 edentulous patients were taken and 4 dentures were fabricated for each-conventional, conventional anchored, injection moulded and injection moulded anchored. Acrylic resin (Travelon Dentsply) was used for the conventional method and BPS material (Ivoclar Vivadent) was used for injection moulded technique. 20 denture bases without denture teeth were fabricated. A hook was attached to each denture on its polished surfaces joining both canine eminence and tried on the patients. The retention of each denture was analyzed using pull-out method. The maximum force required to dislodge each denture was noted (Figure 3). One way ANOVA analysis was done using the SPSS software and the results were calculated.

Result

The retention offered by the various processing systems were expressed as N/cm^2. The retention for conventional processing

Figure 1. Conventional Polymerized denture based.

Figure 2. Anchored resin polymerization denture based.



method was 2.8 ± 2.16 N, for a conventional anchored method was 5 ± 2.55 N, for injection moulded it was 12.60 ± 2.88 N and for injection moulded anchored denture it was 14.40 ± 2.88 N. ANOVA showed a high statistically significant difference between the 4 groups, p=0.001. The results were first expressed in Kg which was converted to force (Newton). It can be seen that injection moulded complete denture shows the highest retention- 14.40 ± 2.88 N, while conventional denture shows the lowest retention- 2.8 ± 2.16 N. It can be seen that dentures by anchored resin polymerisation in both techniques have higher retention than their unanchored counterpart. Also, ANOVA shows a significant P value which denotes that there is a significant variation in data between all 4 techniques even in a larger sample size. The ANOVA shows maximum retention in injection moulded anchored method (14.40 ± 2.88 N) followed by injection moulded method (12.60 ± 2.88 N), conventional anchored method (5 ± 2.55 N) and conventional method (2.8 ± 2.16 N) wth p value of 0.001 (p<0.05) statistically significant (Table 1) (Figure 4). Table 2 shows the pairwise comparison between the groups. The mean difference is the difference between the mean retentive values of the groups compared. Between conventional method and conventional anchored method, the latter is better but the difference, 2.20, is not statistically significant with a p value of 0.591 (p>0.05). Between conventional method and injection moulded method, the latter has a better retention with a statistically significant mean difference of 9.80 with a p value of 0.001 (p<0.05). Between conventional method and injection moulded anchored method, the latter has higher retention with a statistically significant mean difference of 11.60 with a p value of 0.001 (p<0.05). Comparing conventional anchored method and injection moulded method, the latter is better with a statistically significant mean difference of 7.60 with a p value of 0.001 (p<0.05). In comparison of conventional anchored method with injection moulded anchored method, the latter displays a better retentive value with a statistically significant mean difference of 9.40 with a p value of 0.001 (p<0.05). Between injection moulded method and injection moulded anchored method, the latter is better but the difference, 1.80, is not statistically significant with a p value of 0.728 (p>0.05) (Table 2).

Discussion

Heat cured acrylic resin polymerisation technique is the most commonly used method for fabricating dentures. But nowadays, better methods are in place which compensates for the limitations of conventional denture pouring methods [14]. In the study con-

Figure 3. Test for retention.

Figure 4. Mean plot showing the retention of different polymerization technique.

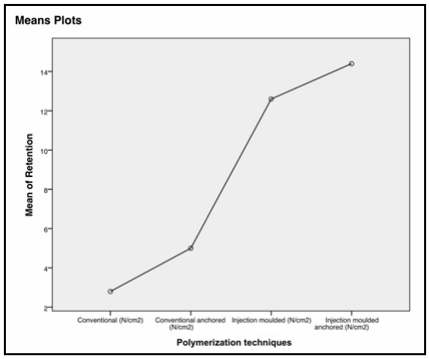


Table 1.

	Group	Mean	Standard Deviation	Standard Error	95% Confidence Interval (Lower bound)	95% Confidence Interval (Upper bound)	F value	P value
Conventional	1	2.8	2.16	0.97	0.11	5.49		
Conventional anchored	2	5	2.55	1.14	1.83	8.17		
Injection moulded	3	12.6	3.2	1.43	8.62	16.58	21.521	0.001*
Injection moulded anchored	4	14.4	2.88	1.28	10.82	17.98		

P value was derived from one way ANOVA test. *significant at P<0.05.

Table 2.

Group	Mean Difference	Standard Error	P value
Conventional vs Conventional anchored	2.2	1.72	0.591
Conventional vs Injection moulded	9.80 †	1.72	0.001*
Conventional vs Injection moulded anchored	11.60 †	1.72	0.001*
Conventional anchored vs Injection moulded	7.60 †	1.72	0.002*
Conventional anchored vs Injection moulded anchored	9.40 †	1.72	0.001*
Injection moulded vs Injection moulded anchored	1.8	1.72	0.728

† The mean difference is significant at 0.05 level. *Significant at P<0.05.
P value derived from Tukey HSD Post hoc test.

ducted, The method of fabrication was segregated into 4 groups. Groups 1, 2, 3 and 4 are conventional, conventional anchored, injection moulded and injection moulded anchored methods of fabrication respectively. Conventional dentures tend to get distorted in the presence of stress during processing. This distortion along with the polymerization shrinkage it undergoes tends to reduce the palatal adaptation of the denture and thus resulting in reduced retention. The polymerization shrinkage occurs in the form of lifting up of the base from the cast in the location of the midpalatal area. The material from the mid palate which has lesser bulk moves to the area of larger bulk, namely, the ridges. This leads to warping of the cast and thus compromised dimensional stability. Injection moulded techniques employ injection of acrylic into the mould under high pressure during the curing process which aids in prevention of shrinkage and warping of the dentures and thus providing a stable structure. This can be seen in the form of better retention value of 12.60 ± 2.88 N. Injection moulded dentures are better counterparts to conventional dentures in various ways. It includes the compensation of shrinkage during processing or curing by the continuous injection of Ivoclar material with resin reservoir, absence of stresses during curing, no resin leakage, use of pre polymerized resin and a well controlled and proportioned polymer to monomer ratio. This indicates that injection moulded dentures tend to have higher retention when compared with either conventional or conventional anchored dentures. Anchored resin polymerization is quite a novel and new concept where anchoring holes are made along the posterior land area and in the midline in the master cast. The acrylic or Ivoclar material tends to flow into these holes and prevent polymerization shrinkage. During polymerization, the anchoring holes aid in holding the denture base towards the cast rather than it distorting towards the investing matrix. This can be seen in the form of increased retention in comparison with their conventional counterparts.

Based on a previous study done by Sykora et al. to compare the palatial adaptation between conventional acrylic resin denture bases and anchored resin polymerisation denture bases, it was noticed that within 24 hours of polymerizationthe gap distance between the cast and the denture base at the lateral and mid palate areas was reduced from approximately 0.3mm to 0.1mm in the anchored resin polymerisation technique [15]. Increased palatial adaptation indicated increased retention of the denture in the patient's mouth. In another study done by Takahiro et al. in 2004, it was seen that injection moulded denture resin base when injected during the early stage of resin dough displayed significantly better adaptation compared to conventional pouring method [16, 17]. On comparison of injection moulded technique, conventional heat pressed technique and anchored processing techniques done by Chalapathi Kumar et al., it was found that injection moulded technique showed better retention compared to the former two while anchored processing technique had better retention than the conventional technique [18]. This result is in conformity with the results obtained in our study. By a study by Takamata et al., the polymerization shrinkage in conventional dentures was clearly highlighted [4]. Laughlin et al. highlighted the better palatal adaptation of anchored resin dentures in comparison with conventional dentures. In a previous research by Chintalacheruvu et al., similar to the present study, it was observed that injection molded technique exhibited less processing errors when compared to conventional compression molding technique [19]. Study by Nogueira et al indicated that injection moulding is a better way of fabricating dentures by proving that injection moulding produced a smaller incisal pin opening compared to the compressive method [20], whereas the present study was done on patients to understand the concept in a better way. A similar study by Strohaver et al. on the changes in the vertical dimension, the injection moulding technique produced little to no incisal pin opening in comparison with conventional methods [21]. Veena Gowri et al., analysed the effect of anchorage in RPDs based on their accuracy of fit. This study revealed that the accuracy of fit was significantly higher in the anchorage group in comparison with the non anchorage control group [22]. This is similar to the present study except that our study was for completely edentulous patients where the denture is mainly tissue supported with no retention from teeth and thus there is a requirement of greater adaptation and retention.

In this study, there was the comparison between conventional, anchored conventional, injection moulded and anchored injection moulded dentures [23]. Based on the data retrieved from this study and in comparison with older studies, it can be said that anchored injection moulded dentures offer the best retention. These dentures are more functional and comfortable for the patients

[24]. Better retentive dentures are more satisfactory for the patient and prevents the loosening of the denture. It also improves adaptation and prevents harm to the surrounding tissues. While conventional method is more cost effective and more widely preferred for its simple procedure, further progressive steps can be taken to perform better processing methods in order to improve the treatment type and the overall patient satisfaction. The limitations of this study is its minimal sample size. Further research can be conducted on a larger scale to get a more definitive data.

Conclusion

As seen from this study, injection moulded anchored resin polymerised dentures are better at retention as they helpin reducing polymerisation shrinkage and have better adaptation and posterior seal. On evaluation of the retention offered by anchored resin polymerization technique in complete denture patients using both conventional and injection moulding technique, it can be concluded that anchored injection moulded dentures display the maximum retention while the conventional dentures show the least retention.

Clinical Significance

Dentures with better retention provide psychological and physiological relief and comfort for the patient. It prevents harm to any surrounding structure and aids in better occlusion and places less strain on the muscles while mastication. Usage of better denture fabrication techniques aid in preventing polymerization shrinkage and thus extends the usage time of the denture.

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