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Comparative Evaluation of tooth movement processed with two different investing methods and two different heat cure denture base resins

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Abstract

Background: Tooth movement may be in any direction and occurs as a result of processing procedures and dimensional changes of the acrylic resin denture base. An understanding of this phenomenon may enable a general dentist to better choose a resin and packing method for denture fabrication hence constructs functional complete dentures that require less occlusal adjustments.

Aim: To evaluate and compare the effects of two different investing methods using two different heat cure acrylic denture base resin on tooth movements after the processing.

Settings and Design: Original research article

Statistical Analysis: The test of significance of mean difference of parameters between the groups was tested by Independent t-test and within groups comparison was done by paired t-test.

Methods and Material: 40 similar maxillarytrial dentures were made and assigned randomly to two experimental groups (n = 20 each) according to investing method: plaster–stone–stone (P-S-S), and plaster- stone (P–S). The two groups were further divided each into two subgroups according to the heat cure denture base acrylic used. Specimens in all experimental groups were compression molded. Transverse inter incisor (I–I) and inter molar (M–M) distances, and anteroposterior incisor–molar (LI–LM and RI–RM) distances, were measured with digital callipers at the wax denture stage

(pre-polymerization) and after fabrication without denture decasting (post-polymerization).

Results: Significant dimensional changes were observed for all the groups, however, DPI heat cure denture base resin with two pour investment techniques showed the greatest change especially in the inter-molar region. Lucitone heat cure denture base resin with three pour investment technique showed least amount of tooth movement especially in the inter-incisor region.

Conclusions: Three pour technique for investing with lucitone heat cure material led to smaller tooth displacement.

Keywords: tooth-movement, poly methyl methacrylate, investment methods

Introduction

Loss of teeth is a matter of great concern and their replacement by artificial substitutes, such as dentures, is vital to the continuance of normal life. Acrylic resins were introduced to dentistry in 1937, and to date, no material has been found to match the appearance and comfort to the oral soft tissues with as great fidelity as acrylic resins. However, it shows dimensional changes during processing, frequently owing to polymerization shrinkage. The shrinkage distorts palate of the maxillary denture and effects the position of the teeth. It may partially be compensated by water absorption[1], resiliency of gingival mucosa[2]& the saliva film between the resin base and support tissues[3,4]. Causes of these include acrylic and investing medium types, polymerization temperature, denture base thickness[5], physiological and anatomical conditions of patient's oral tissue[6,7], flask closure method and post-pressing time[8], internal stresses developed in acrylic resin dentures during polymerization[5,9] and denture finishing.

Occlusal harmony is important for complete denture control and accuracy of fit of the prosthesis. Disruption of this may result in non-uniform distribution of occlusal stresses, changes in oral function, comfort, and masticatory efficiency.

In India, various heat-cure acrylic resins have been introduced. It is very difficult to know if these materials satisfy the requirement of properties of acrylic resins in accordance with well-known ADA specification no. 12[10].This study is an attempt to overcome occlusal interferences, mainly driven by tooth displacement during processing of the prosthesis. There is a lacuna of studies concerning the outcomes provided by the combination of different flasking methods, investing material and polymerization techniques. Hence the result derived from the present investigation will enable a general dentist to better choose a resin and packing method for denture fabrication.

The null hypothesis is that there is no tooth movement seen after polymerization of heat cure denture when using different investment methods and different heat cure denture base resin.

Material and Methods

A total of 40 maxillary dentures were fabricated constituting 20 samples of each investment technique i.e. two pour and three pour technique. These groups were further divided into 2 subgroups each constituting of 10 samples each of DPI heat cure denture base material and Lucitone heat cure denture base [Table I]. The measurements were made before and after polymerization of the denture. The ethical committee of the Institute approved the research protocol.

40 identical maxillary stone casts were prepared using a silicone mold (Columbia Dentoform Company, New York) which was poured with type III dental stone (Kalrock, Kalabhai Karson Private Ltd., Mumbai, India), manipulated according to manufacturers' instructions. For trial denture base, self-polymerizing Polymethyl

Methacrylate (PMMA) (DPI self-cure, Dental products of India Ltd. India) was used. For standardization, 1 sheet thickness of modelling wax (The Hindustan Dental Products, Hyderabad, India) was adapted on the master cast using finger pressure to maintain the same thickness on all areas of the cast. Flasking procedure was followed according to conventional method.[11] After dewaxing, the flasks were allowed to cool to room temperature. Separating medium (DPI Cold Mold Seal, Dental products of India Ltd. India) was applied and allowed to air dry. In a silicone mixing cup, cold cure acrylic resin was mixed with proper monomer: polymer ratio according to manufacturer's recommendation and it was packed in the mold cavity. The flasks were held under hydraulic clamp pressure for a minimum of 14 min as that is the rapid bench cure time given by DPI for its self-cure PMMA53. Wax rim was fabricated on the record base with ideal dimensions.[11] Artificial teeth (Acryrock Ruthinium products Pvt. Ltd. India) were placed on the rim according to basic esthetic and functional guidelines.[11] To maintain standardization of teeth arrangement, Replicated trial dentures were made using a putty index mold (Coltene Affinis Putty super soft) of the first prepared trial wax denture.[9] Two access holes wereprepared in the resulting mold. After placement of artificial teeth in the mold, cast with softened wax rim was placed into the matrix and allowed to cool before removal (Fig 1). The excess wax flows out through the access holes.Thus, 40 similar wax trial dentures were made by aforementioned technique. A round bur (MANI diamond bur BR 31, ISO 001/018, MANI INC.) was used to create a ditch cut on the cingulum region of both the central incisors and mesial aspects of the central grooves of the first molars for all 40 samples (Fig 2). They acted as a reference points for the tooth movement after processing of the denture. Measurement of displacement was made at the wax denture stage (pre-polymerization) (Fig 3) and after denture fabrication (post-polymerization) using Digital calliper (Fig 4) (Insize Digital Calliper 1112-150) [Table II]. Differences between the final and initial measurements indicated tooth movement.

The wax dentures were randomly divided for investing In the two pour technique (Group A) (n=20) (P-S), the lower part of the flask was filled with dental plaster, separating medium was applied and upper portion of the flask was filled with a single layer of dental stone. In the three-pour technique(Group B) (n=20) (P-S-S), the lower part of the flask (the drag) was filled with dental plaster (Trishul, Shiva Mineral Industries, Jammu), separating medium applied, dental stone was poured up to the level of the incisal edges of the anterior teeth and the cusp tips of the posterior teeth (the middle portion of the mold, or the cope), again separating medium was applied and the remaining portion of the flask (the cap) was also filled with dental stone. After the investment material had set, the flask – clamp assembly was placed in a dewaxing bath at 100°C for a time span of 5-7 minutes. The two halves of the flask were separated and the wax flushed out. The flasks were then allowed to cool to room temperature. Separating medium was applied and allowed to air dry.

For packing the mold cavity, two different heat cure denture base resins were used for each group and processed by compression molding technique.The heat-polymerized acrylic resin DPI and Lucitone's monomer and polymer were individually mixed according to manufacture's instructions. When the mixture reached a dough consistency, it was placed in the mold over the teeth. A sheet of separating plastic was applied between the gypsum and the acrylic resin and flask was closed for trial packing procedure. Final closure was performed at

1500-3500 psi and maintained for 30 min (bench curing). The acrylic resin was polymerized in water at room temperature using long polymerization cycle i.e. 9 hours at 165°F[11]. After polymerization and cooling to room temperature in a water bath, deflasking was carefully completed such that dentures were not decasted. In this manner, 40 denture samples were fabricated. Post polymerization measurements were taken.

Statistical analysis

Collected data were analysed by using SPSS 16.0 software. Tests of normality by kolmogorov-smirnov test and shapiro-wilk test for all groups.The test of significance of mean difference of parameters between the groups (Inter group comparison) was tested by Independent t-test followed and within groups (Intra group comparison) was done by paired t-test. The 95% C.I. and 5% level of significance was used for analysis of data. Multiple Comparison of I-I, M-M, LI-LM and RI-RM displacement between four groups by One Way ANOVA and Tukey HSD was evaluated.

Results

Significant dimensional changes were observed for all the groups. On comparison of Inter molar displacement of two denture base resins with two pour technique, Lucitone (Group 2A)proved to be significantly better than DPI group ('p' value- 0.038). On comparison of inter incisor displacement of two denture base resins with three pour technique, Lucitone (Group 2B) proved to be significantly better than DPI ('p' value- 0.009). There was no significant difference ('p' value- 0.053) on comparing inter molar displacement between groups 1A and 1B. On comparison of inter incisor displacement between groups 2A and 2B, group 2B proved to be significantly better than group 2A ('p' value- 0.016) [Graph 1]. Hence, Group 1A i.e DPI with two pour investment technique showed the greatest change (0.123±0.0554) especially in the inter-molar region. Group 2B showed least amount of tooth movement (0.024±0.0158) especially in the inter-incisor region. The study also revealed that there was more tooth movement seen in the transverse linear direction compared to the anteroposterior linear direction. Further multiple comparison gave the following results- I-I (inter-incisor) -1B>1A>2A>2B; M-M (inter-molar) -1A > 2A > 1B > 2B; LI-LM (left incisor- left molar) -1A > 2A > 1B>2B ; RI-RM (right incisor- right molar) -1A > 2A > 1B > 2B [Graph 2].

Discussion

The null hypothesis was rejected as tooth movement was seen after polymerization of heat cure denture when using different investment methods and different heat cure denture base resin. Results revealed that using three pour technique with lucitone during investing procedure resulted in less denture teeth displacement. Various studies have proven that tooth movement occurs during and after the processing of complete dentures, an understanding of thisphenomenon may permit one to construct functional complete dentures that require less occlusal adjustment in the articulator and in the patient's mouth[13,14].

Atkinson and Grant[15],were one of the first to mention the term tooth movement. From a series of experiments it was found that all teeth moved during processing and that movement was not regular or uniform, but could consist of tilting or twisting about the general axis of movement. Many factors such as polymerization shrinkage, thermal contraction by flask cooling, and strain caused by stress release during deflasking affect tooth movement.

Polymethylmethacrylate was introduced as a denture base material by Dr. Walter Wright in 1937. Although

some properties of acrylic denture base resins are not ideal, it is the combination of the virtue rather than one single desirable property that accounts for their popularity and universal use. Almost 99.5% of all complete dentures inserted are with heat cure resin base[15].

The present study was conducted to evaluate the effect of two different investment methods i.e. two pour and three pour investment methods using two different heat cure denture base resin materials i.e. DPI and Lucitone heat cure denture base resin on tooth movement for complete denture construction.

Comparison of tooth movement occurring when using two pour and three pour investment techniques showed that the maximum tooth displacement was seen in DPI two pour investment technique in the inter-molar region (0.123±0.0554), followed by DPI two pour investment technique in the right incisor- molar region (0.093±0.0615). Tooth movement results from the setting expansion of a gypsum mold and not by the thermal expansion of the wax produced by the heat liberated from the setting expansion[16]; the disparity observed among the two groups in this study may be attributed to differences in setting expansion. The effect of change in the W: P ratio on tooth movement, thicker the mix , the less will be the resulting movement[15]. Gypsum's setting expansion can also be reduced by confining it within a flask[16]. Harder investment materials increase the difficulty of deflasking, which generates additional stress within the resin that is released after decasting, as well as water storage; together, these factors result in tooth displacement[17]. Thus, the restrictive effect of investing plaster on tooth position may be less than that of dental stone throughout the resin polymerization and cooling processes which is in conjunction with the results of this study where using dental stone with three pour investment technique during investing procedure resulted in smaller denture teeth displacement. This dental stone core method issuperior in view of the fact that it produces significantly less artificial teeth movement than the conventional method[18].

Comparison of tooth movement occurring when using DPI and Lucitone heat cure denture base resin showed that the maximum tooth displacement was seen in DPI two pour investment technique in the inter-molar region (0.123±0.0554) and Lucitone with three pour investment technique showed least tooth displacement in the inter-incisor region (0.024±0.0158). PMMA does not fulfil all requirements for an ideal denture base material. It was shown that the Lucitone showed the more dimensional stability compared to denture base processed with DPI. Similar result was seen in another study which showed that Lucitone shows lesser dimensional changes compared to DPI, as high-impact resins that contain copolymers of low molecular weight butadiene- styrene-b copolymer which reinforce Lucitone, reducing polymerization shrinkage and also adding strength and hardness to the material[19]. Lucitone showed better transverse strength as well as impact strength when compared to DPI[20]. The results of the above study conducted were in close proximity with studies conducted by Vallittu[21] and Sinha[19].

In the present study, significant results were seen with respect to the inter incisor and inter molar distances. The results of the present study were in conjunction with various other studies[5,22,23] according to which greatest magnitude of tooth movement has been seen in the posterior teeth[23]. An increase in molar-to-molar distance was found in both the thin and thick dentures but the magnitude was more in thick dentures[5]. This may be due to the heat evolved during the polymerization reaction

which would cause the thicker specimen to reach higher temperature and result in greater degree of polymerization. On the contrary, Chen et al[24] reported decrease in molar-to-molar distances when measured before and after processing (decasting). Molar-to-molar distances across the arch increased in the case of high palatal form index value i.e. in dentures of casts with deep palates, the thermal shrinkage occurred at an angle along the palatal slopes[14]. After deflasking, the release of stresses caused the denture to be pulled away from the cast.

Despite the use of 2 mm thick-bases, a long polymerization cycle and slow cooling in a water bath, which has been associated with reduced dimensional change in the denture base[20, 25, 26], tooth movement was detected in all four groups after processing in this study.

Two aspects that need to be considered are 1) polymerization shrinkage of the resin may partly be compensated by the thermal expansion of the resin itself during processing 2) the restrictive effect of investing plaster on keeping the tooth in position when the resin induces polymerization and cooling stresses.

The results of this study are not consistent with the concept that teeth always tend to move toward the midline section of the palate[27]. The present findings are in agreement with those of Turakhia and Ram[28] and Negreiros et al[26], who showed that the use of dental stone contributes to the reduction of tooth movement.

The limitations of the present in vitro study include the focus on the effects of two investing methods, as tooth displacement during denture construction is affected by various factors. Moreover, the study was performed using only maxillary dentures.

Further scope of this research will help in evaluating the effects of different investing methods on the retention and stability of complete dentures during use.

Conclusion

Within the limitations of this in vitro study results suggest that the investing method and heat cure material used appear to be important factors in efforts to control the magnitude of tooth movement. Three pour technique for investing with lucitone heat cure material led to lesser tooth displacement.

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Legend Figure , Graph and Table

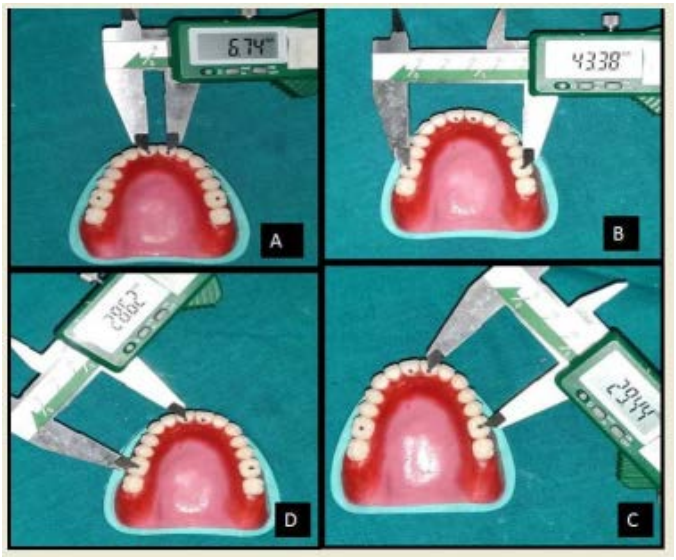


Fig. 1: Measurements at pre-polymerized stage

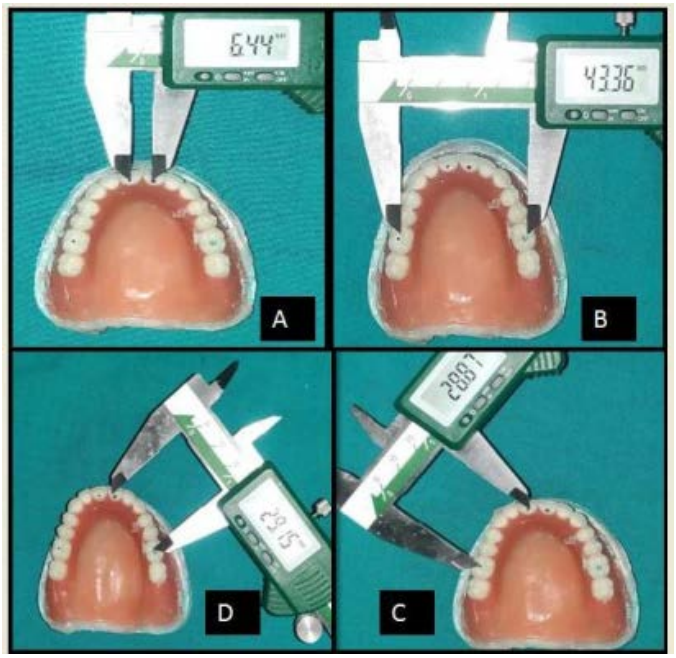
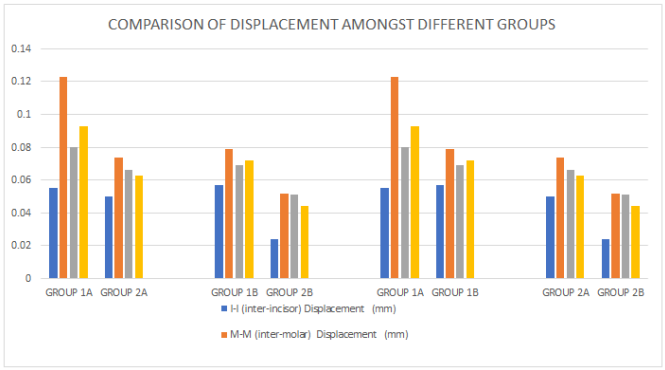
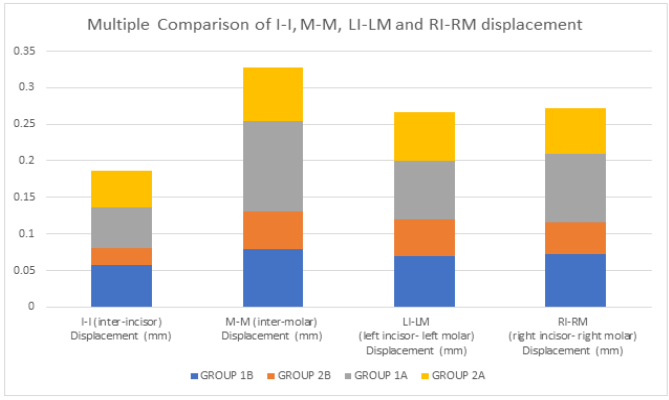


Fig. 2: Measurements at post-polymerized stage



Graph 1: Comparison of displacement amongst different groups



Graph 2: Multiple Comparison of I-I, M-M, LI-LM and RI-RM displacement

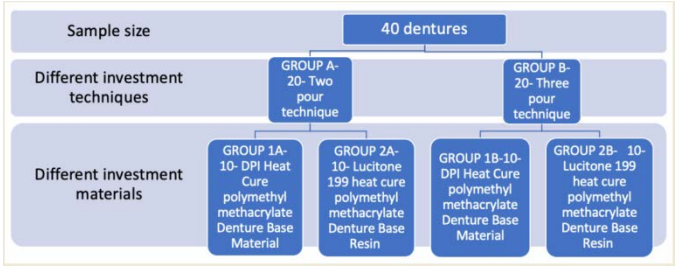


Table 1: Sample size distribution

S.no	Displacement	Description
1	Inter incisor (I–I)	Transverse distance from cingulum of one incisor to the cingulum of second central incisor
2	Inter molar (M-M)	Transverse distance from mesial aspect of central groove of first molar to mesial aspect of central groove of the contralateral first molar
3	Left Incisor- Left Molar (LI–LM).	Anteroposterior distance from cingulum of left central incisor to mesial aspect of central groove of the left first molar
4	Right Incisor-Right Molar (RI–RM)	Anteroposterior distance from cingulum of right central incisor to mesial aspect of central groove of the right first molar

Table 2: Assessment of tooth displacement