A comparative study of changes in vertical dimension of occlusion using four different investing methods

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Citation

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Abstract

Statement of problem
Acrylic resin complete dentures undergo dimensional changes during polymerization. Alternation in type of investment mediums and laboratory procedures can affect vertical dimension of occlusion.

Purpose
The purpose of this study was to compare changes in vertical dimension of occlusion of simulated complete dentures using four different investing methods in compression molding technique.

Materials and Methods
Four test groups with 10 sets of complete dentures each were evaluated. Flasking were done in four groups: Group 1: Plaster- Mixed, Group 2: Plaster- Stone- Mixed, Group 3: Plaster- Mixed- Stone, Group 4: Plaster- Stone- Plaster. All experimental groups were compression molded with denture base resin. Changes in occlusal vertical dimension were measured before and after denture processing. Collected data were analyzed with analysis of variance and Tukey's test at 95% level of confidence (p=0.05).

Results
The Mean of VDO changes in different groups were: group 1 (0.860 ± 0.839), group 2 (0.710 ± 0.585), group 3 (1.548 ± 0.951) and group 4 (0.578 ± 0.686).

Conclusion
There was significant difference between all tested groups. Less dimensional change was observed in the simulated dentures tested when they were invested with Plaster- Stone- Plaster than when flasked with other investing techniques.

INTRODUCTION

Poly (methyl methacrylate) is the usual resin employed for manufacturing dentures. Since its introduction over six decades ago, there has been a continual search to modify the processing procedures of the resin to improve not only physical and mechanical properties, but also the working properties that facilitate laboratory techniques of denture construction ([1]). Rudd indicated that an accurate technique using artificial stone as investing medium can significantly reduce tooth movement ([2]). The artificial stone cores used in the flasking procedure make trial packing possible without distorting the acrylic resin of the veneers ([3], [4]). But processing the denture base materials may produce unequal deformation in different dimensions ([5]), especially a clinically significant incisal pin opening may occur after processing complete dentures if a compression molding technique is used. To recover the proper vertical dimension of occlusion, a time-consuming occlusal adjustment is necessary that often destroys the anatomy of the artificial teeth ([6]). Many attempts have been made to improve the accuracy of reproduction of a waxed trial denture in an acrylic resin. ([7]). Dimensional changes in the base can be influenced by polymerization shrinkage, the resin flasking method, and the time-temperature correlation during the polymerization procedure ([8]). Also deformation on removal of a polymerized denture base from its stone cast has been reported in several studies ([9]) and is considered the major disadvantage of the compression techniques for making

complete dentures. In spite of improvements in acrylic resin properties, the problem of undesirable dimensional shrinkage remains unresolved ([10,11,12,13,14,15]). Several studies have been performed to identify improved materials and processing techniques to minimize changes in the occlusion ([16,17,18]). Techniques with injection molding and polymerization and microwave polymerization are reported to reduce these changes and thereby improve clinical fit ([16]). Although there are some priorities for these new techniques over the conventional packing method but some investigators found no significant advantages over conventional packing ([16,17,18]). Furthermore many of these new techniques did not gain popularity and still many commercial laboratories use compression molding method ([16]). So many methods of processing complete dentures have been described to overcome this problem ([3]). In the literature, there is very conflicting data about investing materials and methods ([2, 7, 14, 15]). The purpose of this study was to compare changes in vertical dimension of occlusion of simulated complete dentures using four different investing methods in compression molding technique.

MATERIAL AND METHODS

Forty complete dentures were fabricated according to the methodology described by Nogueira et al. ([6]). For this reason, forty sets of identical maxillary and mandibular stone casts (Moldana- Pars Dandan- Tehran- Iran) were obtained from a silicone mold (Elite Double; Zhermack, Rovigo, Italy). One set of casts was mounted on a semi-adjustable articulator (Dentatus ARL; AB Dentatus, Hagersten, Sweden). Master maxillary and mandibular dentures were waxed with acrylic resin denture teeth (Marjan, Ideal Makou, Tehran, Iran) arranged in conventional balanced occlusion. The palatal thickness of the maxillary master waxed denture was maintained at 2 mm. The simulation dentures were duplicated using a pourable silicone duplicating material (C&J Pourable Silicone; Chaperlin and Jacobs Ltd, Sutton, United Kingdom) supported by a custom flask fabricated from auto-polymerizing poly (methyl methacrylate) (Meliodent, Bayer UK Limited, Bayer house- New bury) to provide rigidity for the duplicating material. Two sprue holes were prepared in the each resulting mold. After placing teeth and prepared stone casts in the silicone molds, molten base plate wax was poured into the molds and allowed to cool at room temperature (21° ± 2° C) for 2 hours before removal. This provided 40 standard wax simulations of dentures that minimized variation in polymerization changes, because of the effects of the shape and size of the denture specimens ([18]).

To reproduce the 40 sets of test dentures in the same spatial position that the master dentures occupied on the articulator, a special jig were made with the master maxillary denture mounted on the articulator as a guide (Fig. 1). Each test denture was mounted on articulator with this mounting jig. Some small corrections were needed to completing occlusion of denture teeth. The obtained denture occlusion had at least 10 contact points on each side of the arch. The articulator was positioned on a table and a digital caliper, capable of registering changes as small as 0.01 mm was used to measure the distance between upper and lower members of the articulator. Two vertical measurements were made: the initial one with the experimental denture waxed-up and the final one after the dentures had been processed. Changes in occlusal vertical dimension in this report correspond to the difference between the final and initial measurement. Dentures were flasked in four groups: In group 1, the lower part of flask was filled with type II dental plaster (Dental Plaster- Pars Dandan- Tehran- Iran) and the upper portion was filled with 50-50 mixture of plaster and type II dental stone in one layer (Moldana- Pars Dandan- Tehran- Iran) (Fig. 2). In group 2, the lower part of flask was filled with dental plaster and the second layer of investing media was made with pure type III dental stone up to occlusal surface of denture teeth and the remaining part of flask was filled with third layer that was made with 50-50 mixture (Fig. 3). Groups 3 and 4 were the same as group 2 except for the third layer that was made of pure dental stone in group 3 and pure dental plaster in group 4 (Figs.4-5).

All experimental groups were compression molded with denture base resin (Meliodent, Bayer UK Limited, Bayer house- New bury) and cured in a curing machine (Automatic curing device, KAVO EWL type 5518, Germany) in accordance with the manufacturers' instructions and with conventional flask pressure technique at165°F (72°C) for 9 hours. A pneumatic press (KAVO EWL, Germany) was used for trial packing each denture initially at 1500 psi and with the final closure of 3500 psi maintained for 30 min. After curing and cooling to room temperature, the processed dentures were removed from the investing material. The adherent stone was cleaned on the teeth and mounting rings. The upper cast and denture was then repositioned on the articulator using the split cast technique to facilitate accuracy of the final measurement. Collected data were analyzed with analysis of variance and Tukey's test at 95% level of

confidence (p=0.05).

RESULTS

All groups produced some small incisal pin opening. The Mean of VDO changes in different groups were: group 1 (0.860 ± 0.839), group 2 (0.710 ± 0.585), group 3 (1.548 ± 0.951) and group 4 (0.578 ± 0.686). Group 4 had the lowest mean and Group 3 had the highest mean value of increased incisal pin separation

The results were analyzed by ANOVA at 95% level of confidence (p=0.05) and showed significant interaction between the investing method for changes of incisal pin opening of the processed complete dentures (P=0.04). The Tukey's test for multiple comparisons (Table 1) was applied and it was revealed that, the incisal pin opening was significantly less in group 4 than in group 3 (P=0.04).

Figure 1

Figure 1: Mounting jig

Figure 2

Figure 2: Group 1

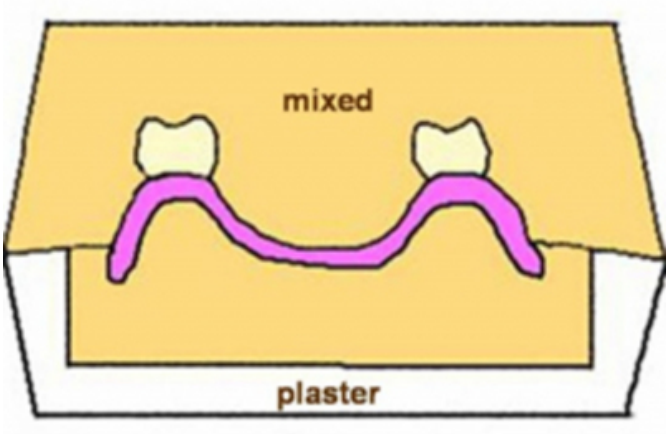

Figure 3

Figure 3: Group 2

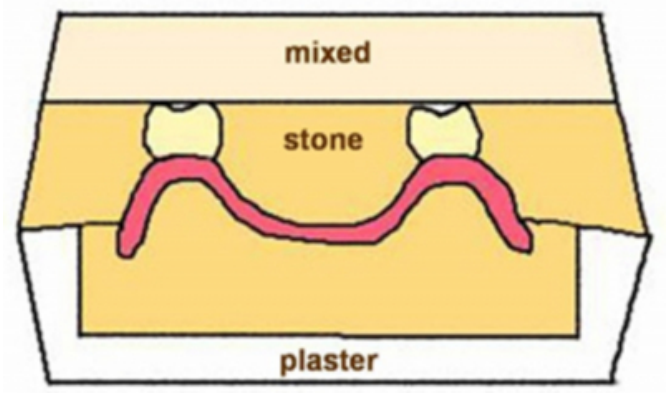

Figure 4

Figure 4: Group 3

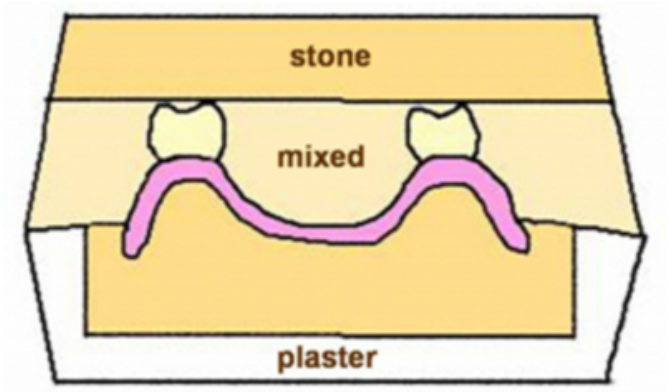

Figure 5

Figure 5: Group 4

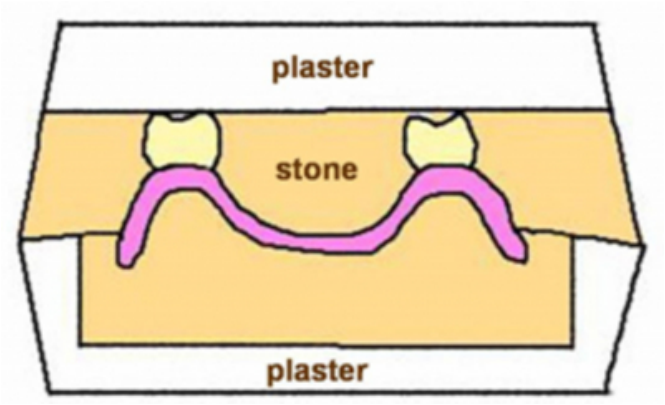

Figure 6

Table 1: Tukey's test.

Comparison	Difference	Standard error	Significance
Group 1 × Group 2	0.1500	0.34811	0.973
× Group 3	-0.6880	0.34811	0.216
× Group 4	0.2820	0.34811	0.849
Group2 × Group 3	-0.8380	0.34811	0.094
× Group 4	0.1320	0.34811	0.981
Group3 × Group 4	0.9700*	0.34811	0.040

The mean difference is significant at the 0.05 level.

DISCUSSION

The changes of vertical dimension of occlusion on removal of a polymerized denture base from its stone cast has been reported in several studies ([16,17,18,19]) and is considered the major disadvantage of the techniques for making complete dentures. In spite of improvements in acrylic resin properties, the problem of undesirable dimensional shrinkage remains unresolved ([4, 14, 15]). In this investigation, the effect of four types of investing methods on the vertical dimension of occlusion was evaluated.

In this study, all investing methods produced a small increase of the incisal pin opening during processing the simulated complete dentures and there was significant differences between all studying groups (P=0.040). The lowest mean value of increased incisal pin separation was seen in group 4 and the highest in group 3 that flasking was done mainly with mixture of dental plaster and dental stone. The statistical difference between these two groups was significant (P=0.04). The lower dimensional changes in groups 1, 2 and 4 may be due to investing the waxed denture with pure dental stone. In the study of Turakhia ([4]) it was observed that, when dentures were flasked in only dental plaster maximum movement of the teeth was measured, whereas dental stone when used as the coring material over the teeth and polished surface showed the least movement of teeth during processing. He said that this is so because dental stone due to its rigidity binds the teeth together and prevents them from the moving ([4]). In the study by Baydas the least dimensional changes observed in the specimens was made with dental stone as flasking material ([14]). Dukes ([20]) and Sinclair ([21]) concluded that the most accurate results in maintaining the vertical dimension of occlusion of dentures during processing were obtained with artificial stone and a layer of silicone rubber. However, Zakhari ([7]) showed that the least vertical opening and a complete absence of occlusal changes occurred in the dentures invested in the plaster of Paris core with an artificial stone cap.

The main difference of group 3 with other groups is the use of mixed gypsum (50% plaster and 50% stone) for investing waxed denture. The significant difference of this group with other 3 groups may be due to this mixture. Mixed gypsum can cause dimensional changes by itself or does not have sufficient strength to prevent teeth movement.

CONCLUSION

Within the limitations of this study, less dimensional change was observed in the simulated dentures tested when they were invested with Plaster- Stone- Plaster than when flasked with other investing techniques. Mixing dental Plaster and dental stone is not recommended for investing waxed dentures.

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