Atatürk Üniv.Diş Hek.Fak.Derg.
Cilt:14, Sayı 3, Sayfa: 24-30 , 2004

THE EFFECT OF DIFFERENT POLYMERIZATION TECHNIQUES ON THE POSTERIOR PERIPHERAL SEAL DISTORTION OF THE DENTURE BASE*

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ÖZET

Bu çalışmada, farklı polimerizasyon tekniklerinin ve damak şeklinin posterior periferal bölgedeki açıklığa etkisi incelendi.

Farklı damak şekilli (sığ, V şekilli, orta derin) 3 dişsiz maksiller model seçildi. Her bir damak şeklinden 20 tane olacak şekilde modeller çoğaltıldı. Elde edilen modeller numaralandıktan sonra iki tabaka bazplak mumu ile kaplandı. Her bir damak şeklinden eşit sayıda olacak şekilde hazırlanan mum örneklerin yarısına kısa süreli polimerizasyon tekniği, diğer yarısına ise uzun süreli polimerizasyon tekniği uygulandı. Polimerizasyon tekniğine ve damak şekline bağlı oluşan kontraksiyon miktarı, kaide plakları ile alçı modeller arasındaki açıklık olarak üst protezin posterior peripheral bölgesinde orta hatta bir mikroskop aracılığıyla aynı araştırmacı tarafından ölçülerek saptandı.

Elde edilen sonuçların değerlendirilmesi için varyans analizi kullanıldı. Posterior periferal bölgedeki açıklık üzerinde, polimerizasyon tekniği ve damak şeklinin etkisinin önemli olduğu ($p< 0.001$) istatistiksel olarak tespit edildi.

Damak derinliğinin protezin posterior periferal bölgesindeki açıklığı etkilediği, uzun süreli polimerizasyon tekniğinin de diğer tekniğe göre açıklık üzerinde daha az etkili olduğu görüldü.

Anahtar Kelimeler: Akrilik polimerizasyon teknikleri, ısı ile polimerize akrilik, posterior periferal bölge açıklığı

ABSTRACT

This study was carried out to examine the influence of different polymerization techniques and shapes of palatal vault on the posterior peripheral seal distortion.

Three edentulous maxillary casts with different palatal vault shapes (flat, V-shaped, medium depth) were chosen. The casts were duplicated in such a way that there would be 20 for each palatal vault shape. Then the casts were numbered and covered with two layers of baseplate wax. A short-term polymerization technique was applied to half of the waxed samples which were prepared to be of equal number for each palatal shape, while a long-term polymerization technique was applied to the other half. The amount of the contraction due to the polymerization technique and the palatal shape was determined by a measurement of the gap between the base plates and the casts. The measurements were made by the same investigator on the midline of the posterior peripheral seal of the specimens using a microscope.

Analysis of variance was used for the evaluation of the results obtained. The effect of polymerization techniques and palatal vault shapes on the posterior palatal seal distortion was found to be statistically significant ($P< 0.001$).

It was found that palatal depth influenced the distortion in the posterior peripheral seal and the long-term polymerization technique produced less dimensional change than the other one.

Key Words: Acrylic polymerization techniques, Heat-cured acrylic, Posterior peripheral seal distortion.

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* Presented as a poster at the 27 th Annual Conference of the European Prosthodontic Association, Geneva, Switzerland, 4-6 September 2003.
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INTRODUCTION

Many variables influence dimensional changes that occur in a denture and these factors need to be considered both during the processing phase and patient use. Examples of these factors are thick and thin sections of the denture, thermal expansion and contraction of acrylic resin and gypsum, polymer and monomer systems, packing pressure, curing, investments, internal stresses, water sorption and desorption, water content of gypsum and polymerization shrinkage.[1-5]

The retention of dentures is greatly dependent on capillary forces.[6] These forces are at a maximum level while the distance between the denture surface and supporting tissues is at a minimum level.[7]

The posterior palatal seal contributes significantly to the retention of maxillary complete dentures. The purpose of the posterior palatal seal on maxillary complete dentures is to (1) create a seal along the posterior border of the denture at the junction of the hard and soft palates (immovable and movable tissues) to enhance retention of the maxillary denture; (2) provide the dentist or laboratory technician a distinct land-mark for finishing the posterior border of the denture, and (3) compensate for the volumetric shrinkage of the acrylic resin in this area during the processing.[8] Good border seal relates to good adaptation of the completed denture.[9]

It was observed that the posterior peripheral seal area displayed the greatest discrepancy of adaptation after processing because of shrinkage of the acrylic resin denture base and the strain induced by thermal changes. The amount of heat associated with processing of polymethyl methacrylate can be correlated with the adaptation of the processed denture base to its supporting tissues.[10]

After the denture had been completely cured, the flask was removed from the water and allowed bench cooled in room temperature.[5] Rapid cooling after processing was not recommended to avoid high residual stresses generated by the thermal expansion differences between the cast and denture base.[5,11-13] During the cooling process, thermal shrinkage took place in addition to the previous polymerization shrinkage.[5]

The distortions in a denture base made of polymethyl methacrylate are the results of shrinkage of the monomer during polymerization (21 % of volume) and the stress induced on cooling. The shrinkage and distortion can be reduced by decreasing the amount of monomer.[14]

The water sorption can cause 3.3 % expansion of acrylic resin, which partially counteracts the distortion associated with processing.[15]

The expansion of acrylic resin was considered not clinically detectable during the process of moving from room temperature to mouth temperature.[10] The discrepancy between the cast and the denture bases can be easily measured in the region of the posterior palatal seal.[9,10,16]

Using computer analysis, an equation and a curve were derived for the values of an expected dimensional change in the posterior peripheral seal region related to various ridge heights.[9] Some investigators used a microscope to determine the effects of the processing technique on dimensional change.[14,17]

The purpose of this study was to determine the influence of different polymerization techniques on the posterior peripheral seal distortion in different palatal vault forms.

MATERIAL AND METHODS

Three maxillary edentulous casts with different shapes of palatal vault (flat,V-shaped, medium depth) 18 were selected; these were duplicated in such a way that there would be 20 casts for each one for two polymerization techniques (Fig 1). The master casts were duplicated with silicone impression materials (Optosil-Xantopren, Bayer Dental, Germany). Sixty casts were prepared with dental stone (Bego Bremer Gold Schlogere, Herbst Gmbh Co, Emil-sommer Bremen,Germany). Each cast was removed from the mold after 1 hour and allowed to dry for 24 hours. Each duplicated cast was marked for identification and covered with two layers of baseplate wax. The molar and premolar teeth were placed. Thirty wax denture bases were processed with heat-cured acrylic resin (QC-20 De Trey, Dentsply, England).

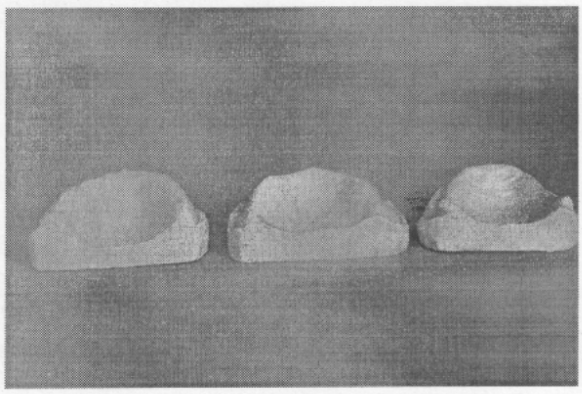

Figure 1. The maxillary edentulous casts with different shapes of palatal voult (Flat, V-Shaped, medium depth)

Two polymerization techniques were used:[19]

1. Long-cure method: The flasks were immersed in cold water, the temperature of the water was slowly increased to 70°C ±1°C, and they were left for about 8 hours.

2. Short-cure method: The flasks were immersed in cold water, the temperature of the water was slowly increased to 70°C ±1°C, and then the flasks were left at this temperature (70°C ±1°C) for 1.5 hour.

All polymerization techniques should end with a boiling period to remove the excess monomer. Accordingly, in our study the polymerization technique ended with a boiling period and the excess monomer was removed. Then the casts were removed from the flasks without any damage to them. Acrylic base plates were separated from the casts, cleaned and washed in cold water with the casts. After that, these base plates were combined with their casts and put in a damp jam.[20]

The denture bases were seated and luted to the cast with sticky wax to prevent movement during mounting on the microscope.[11,12] Each cast was reduced almost to the posterior border of the denture base, using a water-cooled model trimmer. The cast and denture bases were then sanded with decreasing grades of wet or dry sandpaper (Waterproof silicon carbide paper P320A atlas brand, England) on a flat surface to expose the center of the posterior palatal seal (Fig 2). The cast and denture bases were washed again and dried with compressed air. The specimens were measured immediately for dimensional discrepancy. A measuring microscope equipped with a filar unit measuring eyepiece was used.[11,12] The distance between each cast and the denture base was enlarged as much as 40 times and measured at the midpalatal region (B point) (Fig.3) with a biocular microscope (Olympus, Tokyo, Japan) equipped with a tolerance of 0.01 mm. Each measurement was repeated three times, and the average was used as a value of the

amount of distortion for that cast. The measurements were made by the same investigator.

The analysis of variance and Duncan's multiple range test were used to find the significance of two polymerization techniques at the midline according to different vault forms.

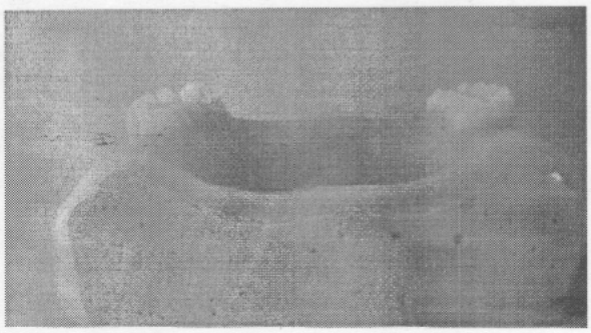

Figure 2. Distortion of sample denture base.

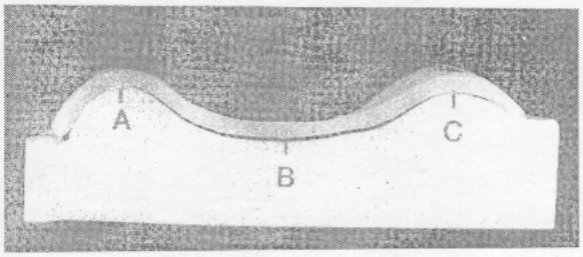

Figure 3. Point B on the cast of maxillary denture base.[11]

RESULTS

The results of the variance analysis used in the evaluation of the data are given in Table 1. The effect of polymerization techniques and shape of palatal vault on the posterior palatal seal distortion was found to be significant at a level of confidence of 0.001. Mean and standard deviations are shown in Table 2.

Table 1. Analysis of Variance

Source	df	Sum of Squares	Mean Square	F
Polymerization techniques	2	6.385	6.385	870.464***
Shape of palatal vault	2	4.199	2.099	286.206***
Polymerization techniques/ Shape of palatal vault	2	2.327	1.164	158.640***
Error	24	0.176	0.007	

***: $P < 0.001$

Table 2. Means and standard deviations of distortion according to the shape of palatal vault and processing techniques (N=10, X=mm)

	Processing Technique	
Shape of palatal vault	Long-cure method (Mean ± SD)	Short-cu (Mear
V-shaped	0.42 ± 0.004	1.86 ± (
Flat	0.16 ± 0.01	0.31 ±
Medium depth	0.20 ± 0.005	1.38 ±

As a result of the Duncan's multiple range test, it was found that each shape of palatal vault and different polymerization technique had a statistically different effect on posterior palatal seal distortion.

It showed a considerably higher distortion in V-shaped palatal vault processed with the short-cure method (1.86 mm), and a considerably less distortion in flat palatal vault processed with the long-cure method (0.16 mm).

DISCUSSION

The midpalatal portion of distortion space is always at least as thick as any other, portion. Rarely if ever does the distortion space thickness exceed 0.6 mm. Posterior palatal relief of all maxillary master casts should provide adequate

compensation for the posterior base distortion space of any denture. This relief should be in excees of modifications made for physiologic displace ability of tissues in this region. The physiologic tolerance of the supporting tissues must be considered as well as the physical processing shrinkage potential of the denture base material.[21,22]

The discrepancy of adaptation of denture base to a maxillary cast was analyzed in this study. As a result of this study, the mean value of palatal base distortion space was 0.26 mm. in long-cure method and 1.18 mm. in short-cure method. The specimens processed with the long-cure method produced the least dimensional change.

McCartney[21] suggested that the acrylic resin left to boiling in the curing bath will adversely affect the accuracy of the palatal base adaptation and increase the average midpalatal base distortion by 25 %. He found that the mean value of palatal base distortion space was 0.28 mm. in long-cure method and 0.36 mm. in short-cure method.

Takamata et al.[23] investigated that the poorest-fitting was seen in the posterior border of specimens which were processed in a brass flask and a water bath at 70-100 °C using a heat-activated resin.

A study by Wolfaardt et al.[24] indicated that dimensional changes in the flask during the processing of heat-cured poly methyl methacrylate denture base resin are not uniform. On the other hand, Becker et al.[4] suggested that the processing techniques demonstrated three-dimensional changes of the internal surface of the denture.

Harwey et al.[22] stated that the polymerization of visible light-cured resin produced the greatest dimensional change, the net change at the center of posterior palatal base being 0.47 mm. Such a size of shrinkage caused a marked degree of pulling away from the cast in the posterior midpalatal region of the maxillary base plate.

Sykora and Sutow[25] reported that the posterior border opening was always smaller for the continuous- injection technique.

O'Toole et al.[15] indicated that denture bases polymerized in monomer vapor and coated with petroleum jelly are dimensionally more stable than those cured by the method recommended by Craig 5 and Morrow et al.[26]

Elahi et al.[11] indicated that acrylic resin processed in 45 °C water under 20 psi pressure for 3 minutes showed the maximum discrepancy at the midpalatal region. (291.7 μ). However, a study by Craig5 showed that autopolymerizing resin processed in 45 °C water vapor under 20 psi pressure showed the minimum distortion.

Firtell et al.[27] noted a statistically significant distortion in the posterior peripheral seal of a denture base when processing was done above the recommended temperature.

Glazier et al.[9] showed that there was a positive relationship between the ridge height of cast dimensional changes in the posterior peripheral seal region of its denture base. This dimensional change might be clinically in significant but it should not be ignored. They also found that in 8.5 mm of change in ridge height, the distortion was only 0.27 mm on the average.

It was shown that dimensional changes were always higher for the flat palate, compared with the high palate.[25] In this study, the mean value of palatal base distortion space was 1.14 mm in

V-shaped vault, 0.23 mm. in flat palatal vault and 0.79 mm. in medium depth form.

The dimensional changes have a statistically significant relationship with the processing variables (double-processing, rapid-cure, long-cure and short-cure method) used in processing the denture base acrylic resin. It would appear that the dimensional changes taking place during polymerization of the conventional heat-cured denture base resins are complex and require further investigation.[21,28,29]

The discrepancies seen clinically when dual curing techniques are used may to be such factors as excess heat application during boil-out procedures or double polishing.[30]

It was statistically determined in the present study that different shapes of palatal vault and different polymerization techniques had a different influence upon the posterior palatal seal distortion. This result is in agreement with the findings of the above researchers.

CONCLUSION

The shape of palatal vault and polymerization techniques were effective on posterior peripheral seal distortion of denture base. The V-shaped vault processed with the short polymerization method showed the highest distortion.

The long-cure technique produced the least dimensional change when compared with the other techniques.

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