An evaluation of the Flexural Properties of Meliodent and Acropars Heat Polymerized Acrylic Resins

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Abstract:
Objective: The aim of this study was to measure and compare the transverse strength and deflection of two acrylic resins.
Method and Materials: A total of 30 samples, with dimensions of 2.5×10×65mm, were prepared with Acropars and Meliodent acrylic resins according to ADA specification No. 12. The specimens were divided into two groups of 15 samples each. A three-point bending test was carried out using a universal testing machine. Differences between the means of the two groups were analyzed with Student's t-test.
Results: The mean (SD) transverse strength was 81.55 (1.54) Mpa in the Meliodent and 73.58 (0.6) Mpa in the Acropars samples, which showed a significant difference (P<0.001). The mean (SD) transverse deflection was 3.86 (0.09) mm and 4.96 (0.06) mm in the Meliodent and Acropars samples, respectively. A significant difference was found between the two groups (P<0.001).
Conclusion: In the present investigation, the transverse strength of the Acropars specimens was smaller than that of the Meliodent samples and ADA specifications. However, the mean transverse deflection was larger in the Acropars group as compared to the Meliodent group.

Key Words: Heat polymerized acrylic resin; Transverse strength; Transverse deflection

INTRODUCTION
Poly methyl methacrylate (PMMA) is one of the most widely used denture base materials with numerous advantages [1,2]. However, poor mechanical properties like susceptibility to fracture due to unsatisfactory transverse strength, impact strength or fatigue resistance have also been reported in this acrylic resin [3]. Considerable progress has been made in the development of new acrylic resins with improved qualities. Vallittu [4-7] has established the usefulness of glass fiber roving as a strengthener of dental resins. Other attempts have been made to enhance the mechanical properties of acrylic resins by changing the processing methods [8]; copolymerization and cross linking [9-11], giving maximum bulk to the material in the regions most heavily stressed [3]; and reinforcement with glass [12-15], carbon [16,3], polyethylene [17] or methyl methacrylate fibers [18,19].

Acropars (Marlic Co. Tehran, Iran) is an Iranian heat polymerized acrylic resin which has become available in recent years. Various factors can affect the physical properties of acrylic resins such as dimensional stability, weight and volume stability, molecular structure of the polymer, color stability, surface
roughness, the amount of porosity, residual monomer and strength of the acrylic resins (i.e., transverse strength, fatigue strength, flexural strength, impact strength, tensile strength, etc.) [1,2]. The aim of the present investigation was to determine the transverse strength and deflection of Acropars acrylic resin and to compare it with ADA specification [20] and Meliodent acrylic resin (Bayer Co. Germany).

MATERIALS AND METHODS
Two acrylic resins were examined in this laboratory experimental study, based on American Dental Association (ADA) specification (No. 12), with minor modifications. Acropars (Marlic Co. Tehran, Iran), an Iranian acrylic denture base material, and Meliodent (Bayer Co. Germany) were selected for evaluation. The reason for choosing Meliodent was that it was an ADA-approved and available heat polymerized acrylic resin.

Fifteen samples were tested in each group. Three 2.5×10×65mm stainless steel master dies were prepared and invested in conventional denture flasks with dental stone (Hinrizit stone, Ernst Hinrichs GmbH, Germany). Finally, fifteen molds were made for each material and randomly coded. All samples were prepared using the conventional compression molding technique and processed according to the manufacturers’ recommendations. They were then carefully removed from the metal molds, wet-polished with no. 400 sandpaper and stored in distilled water at 37°C for 48 hours prior to testing. The specimens were randomly selected and subjected to a three-point bending test with a constant crosshead speed of 5mm/min using a universal testing machine (Instron 4301, Instron Corp. Canton, MA, USA). Transverse deflection was recorded at 48 N and fracture force was registered in Newton. All measurements were obtained on the same day. The transverse strength of each specimen was calculated using the following formula, [1]:

\[ S = \frac{3fL}{2bd^2} \]

S was transverse strength or modulus of rupture (MPa), f was fracture force (N), L was the distance between the supports (length of specimen) (mm), b was the width of the specimen (mm) and d was specimen thickness (mm). Mean values and standard deviations were calculated for transverse deflection and strength. Student’s t-test was used for statistical analysis. P-values less than 0.05 were considered to indicate significant differences.

RESULTS
The mean (SD) transverse strength and bending deflection were 81.548 (1.541) Mpa and 3.855 (0.092) mm, in the Meliodent specimens and 73.575 (0.604) Mpa and 4.957 (0.059) mm in the Acropars samples, respectively. The results indicated that Meliodent samples revealed larger transverse strength and smaller transverse deflection values compared to the Acropars samples. A statistically significant difference in transverse strength and bending deflection was observed between the Meliodent and Acropars specimens (P <0.001).

DISCUSSION
Fractures in acrylic resin dentures occur quite often even though metal strengtheners have been incorporated into their designs [3]. Measurement of transverse strength is more commonly used for the evaluation of denture plastics as compared to tensile or compressive strengths. This is due to the fact that transverse strength closely represents the type of loading applied to the denture [1,2].

The aim of this study was to measure and compare the transverse strength and deflection of Acropars and Meliodent acrylic resins. In the present investigation the mean (SD) transverse strength of Acropars and Meliodent samples was 73.575 (0.604) Mpa and 81.548 (1.541) Mpa, respectively. The mean trans-
verse deflection was 4.957 (0.059) mm in the Acropars and 3.855 (0.092) mm in the Meliodent group.

According to ADA specification no 12 [20], the deflection in the center of a specimen should be 2 to 5.5mm for a load of 1500 to 5000 g, and the transverse strength of heat polymerized acrylic resins should be 78 to 92 Mpa. These values are close to those obtained for the Meliodent samples in the current investigation.

Acropars revealed a lower transverse strength compared to previous reports, however the transverse strength and deflection of the Meliodent group was similar to those reported by others [11,12,18,19].

Several factors can influence transverse strength and bending such as degree of polymerization, powder particle size, porosity, polymer molecular weight and the amount of residual monomer, fillers and plasticizers [1,2].

Numerous investigators have evaluated different reinforcement techniques for strengthening PMMA. Yazdanie and Mahood [3] showed that carbon-fiber acrylic resin composites were stronger than unfilled resins. Deboer et al [16] studied the effect of carbon fiber orientation on fatigue resistance and bending of denture resins and demonstrated an improvement in bending strength when the carbon fibers were aligned perpendicular to the stress direction. Stipho [12] and Uzun and Keyf [13,14] found a higher transverse strength in samples treated with glass fiber. Improvement of the transverse strength of PMMA has been reported following addition of dibutyl methacrylate. High esters of this type act as internal plasticizers and prevent release of monomer into the oral cavity [1].

It has been suggested that longer polymerization times can decrease the porosity and increase the polymerization degree and transverse strength of acrylic materials. On the other hand, short polymerization cycles have been reported to increase the amount of residual monomer [21,22]. The plasticizing effects of excess monomer may adversely affect the transverse strength of acrylic resins.

A previous study has shown that the solubility of Acropars acrylic resin was higher than the maximum standard requirements [23]. This may be due to cross-linking agents, plasticizers, unreacted monomer, initiators or soluble materials [1].

Therefore it seems that evaluation of a longer polymerization cycle on Acropars acrylic resins requires further investigation. This processing method would increase the molecular weight and degree of polymerization and decrease the amount of porosity and residual monomer in the samples [1,2,22].

CONCLUSION

A significant difference was found between the mean transverse and bending strengths of Acropars and Meliodent acrylic resins (P<0.001). The mean transverse strength of the Acropars specimens did not meet the ADA specification requirements.

REFERENCES