The aim of this study was to determine the effect of autoclave polymerization on the transverse strength of denture base polymers. To this end, 30 rectangular test specimens were fabricated of two heat-polymerized denture base polymers. The test groups were: (I) control, i.e., conventional water bath to polymerize resins by heat at 100°C for 30 minutes; (II) autoclave polymerization at 60°C for 30 minutes followed by 130°C for 10 minutes; and (III) autoclave polymerization at 60°C for 30 minutes followed by 130°C for 20 minutes. The specimens were tested with three-point bending test at a crosshead speed of 5 mm/min. It was revealed that the transverse strength of specimens increased with statistical significance when the autoclave was used for polymerization.

**Key words:** Denture base resins, Polymerization, Autoclave

**INTRODUCTION**

Poly(methyl methacrylate) resin has many favorable properties, and is thus well established as a reliable material for use in removable dentures. Its meritorious working characteristics include ease of manipulation, polishability, seamless use with inexpensive equipment, stability in the oral environment, and optimum esthetic results. By virtue of these characteristics, this material has been extensively used as a denture base polymer. However, acrylic resin denture base polymer does not fulfill all the requirements in terms of optimum mechanical properties due to its brittle nature.

Over the years, curing procedures have been modified with a view to improving the physical and mechanical properties of resin materials. Different polymerization methods have been used: heat, light, and microwave energy. However, no studies have been conducted to investigate the effect of varied autoclave polymerization conditions on the final properties of acrylic resins.

Therefore, the aim of the present study was to investigate the effect of different time durations of autoclave application on the transverse strength of two denture base resins.

**MATERIALS AND METHODS**

**Experimental groups**

Two denture base resin materials were used in this study: QC-20 (Dentsply De Trey GmbH, Germany) and Paladent (Heraeus Kulzer GmbH, Wehrheim, Germany). Of each material, rectangular specimens with dimensions of 3.3×10×64 mm were produced using a stainless steel mold.

For the two control groups (QC-20, n=5; Paladent, n=5), conventional polymerization was represented by preparing the control specimens in conventional metal flasks and then polymerized in water bath for 30 minutes at 100°C according to manufacturers’ instructions.

For autoclave-polymerized (Ar-El Group SAN Kosmos, Greece) specimens, a dough prepared from powder/liquid mix was packed into the metal mold invested within flask. Under 3 atm pressure, the specimens were subjected to one of the processing cycles: autoclave-cured for 60°C/30 minutes followed by 130°C for 10 minutes; or autoclave polymerization at 60°C for 30 minutes followed by 130°C for 20 minutes. The flasks were allowed to bench cool before opening.

**Three-point bending test**

The three-point bending test was performed with a universal testing machine (Lloyd LRX, Lloyd Instruments, Fareham, Hants, UK) to measure transverse strength. The device consisted of a loading wedge and a pair of adjustable supporting wedges placed 50 mm apart. The specimens were centered on the device in such a way that the loading wedge, set up to travel at a crosshead speed of 5 mm/min, engaged the center of the upper surface of the specimens. Specimens were loaded until fracture occurred. Transverse strength (Ts) (MPa) was calculated using the following formula:
Ts = (3PmI) (2bh²)^-1

where Pm is the maximum load (N), I is the span length (mm), b is the width of the specimen (mm), and h is the thickness of the specimen (mm). Statistical analysis was performed with Kruskal–Wallis test followed by Mann–Whitney U test (α = 0.05).

**RESULTS**

Table 1 shows the transverse strength results of the denture base resins when cured using different methods. It was revealed that polymerization in an autoclave led to a statistically significant increase (p<0.05) in transverse strength for the two materials evaluated when compared to the control. However, there were no statistically significant differences in transverse strength between the two time durations of autoclave polymerization system. There were also no statistically significant differences between the two acrylic resin control groups.

**DISCUSSION**

An autoclave is a pressurized device designed to heat aqueous solutions above their boiling point to achieve sterilization. It was invented by Charles Chamberland in 1879. Autoclaves are widely used in microbiology, medicine, dentistry and metallurgy. For example, the large carbon-fiber composite parts of Boeing 787, such as the wings and fuselage subassemblies, are cured in large autoclaves.

The term "autoclave" is also used to describe an industrial machine in which elevated temperature and pressure are used in processing materials. Under ordinary circumstances (at standard pressure), liquid water cannot be heated above 100°C in an open vessel. Further heating results in boiling, but does not raise the temperature of the liquid water. However, when water is heated in a sealed vessel such as an autoclave, it is possible to heat liquid water to a higher temperature. As the container is heated, the pressure rises due to the constant volume of the container. The boiling point of water is then raised because the amount of energy needed to form steam against the higher pressure is increased.

Xia and co-workers cured 10 acrylic resin specimens of 6×50×60 mm in a pressure cooker at 0.58 MPa (5.80 atm). The water temperature was raised to 120°C. Temperature and pressure were held for 10 minutes before the heat was turned off. No significant differences were found between the pressure cooker method and the conventional method for surface hardness and porosity.

Soares et al. investigated the microhardness and diametral tensile strength of two hybrid resin composites subjected to conventional light curing, and which were subsequently post-cured with autoclave curing for 15 minutes at 100°C. It was found that post-curing increased the hardness and diametral tensile strength of conventional composites.

Results of this study showed that when the acrylic resin material was subjected to autoclave polymerization, a statistically significant increase occurred in the transverse strength of both denture base materials tested in this study as compared to the control specimens. The observed improvement in transverse strength as a result of high heat treating could be attributed to increased crosslinking. Indeed, this could be the reason for the change in mechanical properties. To further investigate the effect of autoclave curing on various resins, as well as the influences contributed by time and temperature of autoclave curing, more detailed studies should be carried out in the future.

**CONCLUSION**

Under the conditions of this study, it could be concluded that autoclave polymerization was a potential method for increasing the transverse strength of denture base resins. Autoclave polymerization can be easily performed in laboratory conditions. Moreover, it can be routinely used in dental practice after mechanical and biological tests to reveal the effect of autoclave polymerization on denture base resins. This would markedly contribute to the longevity of denture bases.
REFERENCES


