Short Communication

In Vivo Heat Transfer Capacities of Autopolymerizing, Heat-Polymerizing, and Injection-Molded Acrylic Resins

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The aim of this pilot study was to measure the heat transfer capacities of heat-polymerizing, injection-molded, and autopolymerizing acrylic resins in vivo. Two volunteers used acrylic resin removable plates and consumed hot (69°C) and cold drinks (6°C). Differences between oral temperature and highest and lowest temperature readings were recorded. Temperature changes for the autopolymerizing acrylic resin were found to be significantly higher than the heat-polymerizing and injection-molded acrylic resins for both cold and hot drinks. Despite the disadvantages of autopolymerizing acrylic resins, their high heat transfer capacity may be an advantage. *Int J Prosthodont 2006;19:618–620.*

Acrylic resin represents approximately 95% of the denture base materials used in removable prosthodontics.[1] The main attributes of acrylic resin that have made it successful as a denture base include ease of processing, low cost, light weight, and color-matching ability.[2] However, acrylic resin denture base materials are brittle and low in thermal conductivity.[3] The heat transfer characteristics of the denture base material may be an important factor in determining patient satisfaction,[4] and the acrylic polymer most commonly used for denture bases, polymethyl methacrylate, has a thermal conductivity of approximately 0.2 W/m/°K,[3] which is approximately 3 orders of magnitude less than most metals.

The purpose of this study was to measure the in vivo thermal transfer capacities of 3 different acrylic resins. For the purposes of this study, the null hypothesis assumed that there were no statistically significant differences between the heat transfer capacities of the different acrylic resins tested.

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Materials and Methods

The temperatures in the oral cavity were measured while 2 volunteers consumed hot or cold drinks. Heat-polymerizing, injection-molded, and autopolymerizing acrylic resins were used to prepare removable plates for the maxilla (Fig 1).

Complete-arch impressions, made with irreversible hydrocolloid (CA 37, Cavex), were used to fabricate maxillary casts, using type III dental stone (Elite Model, Zhermack). To ensure equal thickness of the different acrylic resin materials, thermoplastic materials (Raintree Essix, Metairie) were formed on the models under vacuum and then invested in dental flasks. After elimination of the thermoplastic materials, the polymethyl methacrylate was processed, cured, finished, and polished. The heat-polymerizing (Meliodent, Heraeus Kulzer), injection-molded (batch no. 617668, SR Ivocap Plus High Impact, Ivoclar), and autopolymerizing (Orthoacrylic, Vertex) acrylic resins were prepared according to the manufacturer's recommendations.

Heat Transfer Measurement

To record intraoral temperature, a thermocouple wire was inserted into the anterior palatal region through a

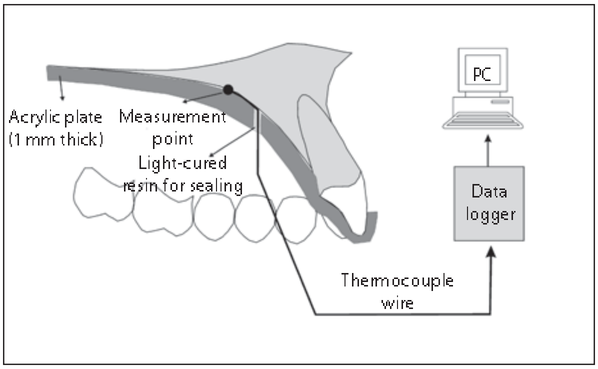

Fig 1 *(left)* Set of acrylic resin appliances used in the study for each material for each volunteer.

Fig 2 *(above)* Schematic representation of the test design.

small opening in the acrylic resin, and the hole was sealed with light-polymerizing acrylic resin (Triad, Dentsply). The thermocouple wire was slightly embedded into the processed acrylic resin. The thickness of the denture base in the locations where temperature measurements were taken was 1 mm. The temperature change was measured in the palatal region with a J-type thermocouple wire that was connected to a data logger (XR440, Pace Scientific) (Fig 2). The volunteers inserted the plates into their mouths and were asked to first drink a hot drink (69°C) and then a cold drink (6°C) after the intraoral temperature was balanced again.

Ten measurements were recorded for each removable plate for each subject. Differences between oral temperature and highest and lowest temperature readings were taken, and the calculated temperature changes were averaged to determine the mean value in temperature change. The values for different acrylic resin plates were compared using one-way analysis of variance at a preset α of .05.

Results

The temperature changes recorded at the palatal region varied significantly depending on the acrylic resin used ($P < .05$). Temperature changes did not differ between subjects ($P > .05$). Temperature changes recorded for the autopolymerizing acrylic resin (8.7°C ± 0.8°C) were found to be significantly greater than those for heat-polymerizing (5.4°C ± 0.4°C) and injection-molded (6°C ± 0.5°C) ($P < .05$) acrylic resins for the hot drink (Fig 3).

There were significant differences among the autopolymerizing (8.9°C ± 0.7°C), heat-polymerizing (5.6 ± 0.3°C), and injection-molded (7.9°C ± 0.7°C) ($P < .05$) acrylic resins for the cold drink. The heat-polymerizing acrylic resin showed the smallest temperature changes ($P < .05$) (Fig 4).

Discussion

In this study, the heat transfer capacities of 3 different acrylic resins were measured. The results obtained do not support the research hypothesis that heat transfer capacities do not differ among the groups. Temperature changes recorded for the autopolymerizing acrylic resin were found to be significantly greater than those recorded for the heat-polymerizing and injection-molded acrylic resins for the hot drink, and there were significant differences among the 3 acrylic resins for the cold drink. The heat-polymerizing acrylic resin showed the smallest temperature changes.

The method used for testing may have some limitations regarding the absolute simulation of clinical conditions. However, standardization between different materials was achieved with a method in which a thermoplastic material was used to ensure equal thickness of the different acrylic resins.

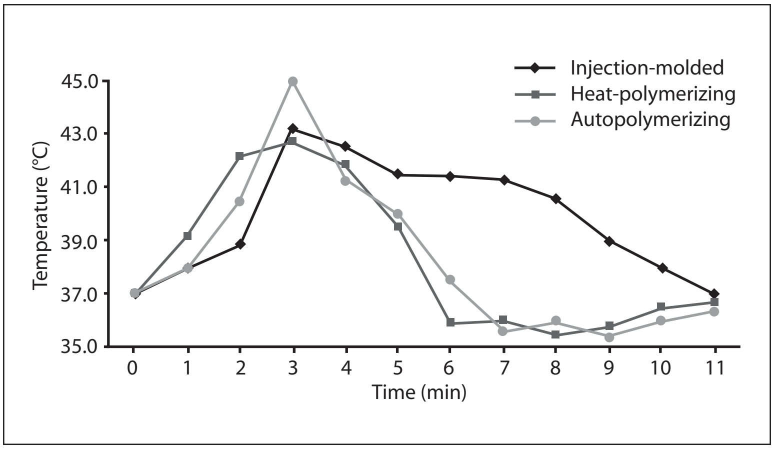

Fig 3 Representative temperature changes for the hot drink (69°C) at the palatal region. The values used were acquired using the average values of 2 subjects at each of 12 data points, which were also averages of 10 repeated measurements.

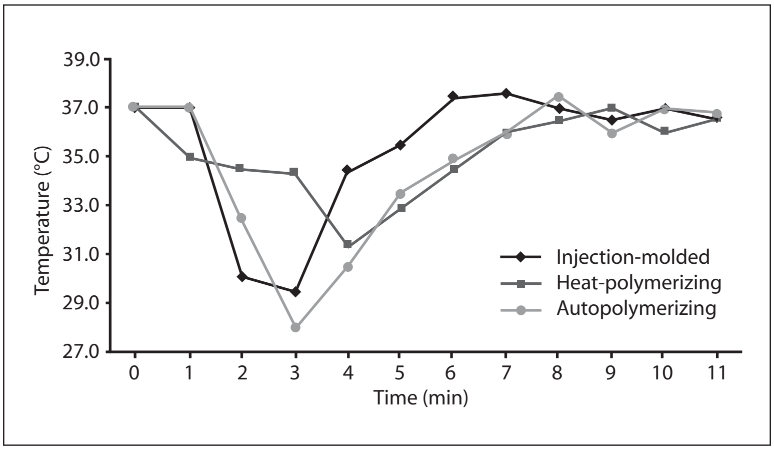

Fig 4 Representative temperature changes for the cold drink (6°C) at the palatal region. The values used were acquired using the average values of 2 subjects at each of 12 data points, which were also averages of 10 repeated measurements.

Despite the disadvantages of autopolymerizing acrylic resins, their high heat transfer capacity may be an advantage. However, they should not be used as denture base materials in the mouth for a long time period. Therefore, the heat transfer capacity of heat-polymerizing and injection-molded acrylic resins may be developed by introducing a more thermally conducting phase within the insulating acrylic resin matrix, which creates a resin composite denture base material, or by adding particles of a conducting material, namely metal, to the powder or liquid resin, and then polymerizing according to established procedures, thus modestly increasing thermal conductivity.[5]

Conclusion

The results of this pilot study suggest that despite the disadvantages of autopolymerizing acrylic resins, their high heat transfer capacity may be an advantage.

References

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