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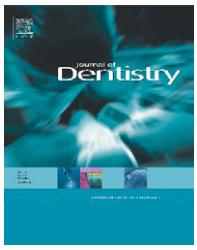

Comparative study of the transverse strength of three denture base materials

Camilo Machado [a], Eliana Sanchez [b], Shereen S. Azer [a,*], Juan M. Uribe [c]

[a] Section of Restorative and Prosthetic Dentistry, The Ohio State University College of Dentistry, 305 West 12th Avenue, #191, P.O. Box 182357, Columbus, OH 43218-2357, USA

[b] Section of Primary Care, The Ohio State University College of Dentistry, Columbus, OH, USA

[c] Advanced Education in General Dentistry, University of Missouri-Kansas City School of Dentistry, Kansas City, MO, USA

ARTICLE INFO

Article history:
Received 9 May 2007
Received in revised form
27 August 2007
Accepted 5 September 2007

Keywords:
Denture base materials
Transverse
Flexural strength
Acrylic resin
Light polymerization

ABSTRACT

Objectives: Fracture resistance of recently introduced denture base resins has not been compared to traditional denture base materials. This study compared the transverse strength of three denture base materials, namely, Lucitone 199, Triad VLC, and the newly introduced Eclipse.

Materials and methods: A total of 30 specimens (50 mm × 25 mm × 2.5 mm) were fabricated, 10 from each material. The specimens were loaded until failure on an Instron universal testing machine using a three point flexural test. One-way analysis of variance (ANOVA) was used to compare the mean transverse strength between the three materials tested.

Results: The transverse strength values showed significant differences between the three denture base materials ($P < 0.0001$). The mean transverse strength and standard deviations (MPa) were as follows: Eclipse 116.13 ± 17.7, Lucitone 87.12 ± 8.1, and Triad VLC 57.96 ± 7.3.

Conclusions: Within the limitations of this study, Eclipse showed the highest transverse strength among the materials tested. Eclipse denture base material may provide a stronger alternative to traditional denture base resins.

Published by Elsevier B.V.

1. Introduction

Denture base materials have progressed through various stages of development over the past century. In 1855, vulcanized rubber (vulcanite) was introduced to the dental profession. However, this material presented esthetic as well as fabrication challenges.[1] In 1937, polymethyl methacrylate (PMMA) replaced vulcanite enhancing both physical and esthetic properties, in addition to being inexpensive and easily manipulated. Since then, additional polymers have been evaluated for denture base applications, such as polystyrene, poly (vinyl acrylic), polyamides (nylons), and light-activated urethane dimethacrylate resins.[1–4] Although these materials exhibited desirable properties, none has proven superior to PMMA.[5]

The fracture resistance of denture base polymers has been the subject of many investigations. A number of clinical reports have demonstrated that midline fracture of maxillary complete dentures present a common problem.[6,7] Several approaches have been utilized to reinforce acrylic resins for dentures. PMMA resins have been shown to exhibit higher levels of impact and flexural fatigue strengths than other polymers.[8–12] Polymer transverse strengths of PMMA resins such as Lucitone 199 (Dentsply Trubyte, York, PA), which is a high-impact resin with butadiene and styrene additives, and light-activated resins such as Triad VLC (Dentsply Trubyte,

* *Corresponding author*. Tel.: +1 614 292 7467; fax: +1 614 292 9422.
E-mail address: azer.1@osu.edu (S.S. Azer).

0300-5712/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.jdent.2007.09.006

York, PA), have been evaluated by several investigators, showing conflicting values with but generally without significant material strengthening.[13–17]

Advances in polymer science have developed new molding and activation techniques, such as injection-molding and microwave activation.[8,12,14,18,19] Recently, a new methyl methacrylate-free denture base material (Eclipse) was introduced by Dentsply Trubyte, York, PA. In this system, the baseplate resin is used to fabricate the record base, which later becomes the definitive denture base. This system is composed of three types of resins; baseplate resin, setup resin and contour resin. Each type is typically available in four shades (original, light pink, reddish pink and dark pink). The baseplate resin is used to fabricate the denture record base that, after light polymerization, will also become the permanent denture base of the finalized denture. The setup resin is used to attach the denture teeth to the polymerized baseplate resin. Finally, the carvable contour resin is overlaid over the baseplate resin and the setup resin as well as the necks of denture teeth, and carved similarly to wax, before being finally light-polymerized. However, there is no chemical bond between denture teeth and Eclipse resin, so mechanical retention is necessary. This material is highly polishable.

The purpose of this in vitro study was to compare the transverse strength of the newly introduced Eclipse denture base material with more commonly used resins, namely, Lucitone 199 and Triad VLC. The null hypothesis was that there would be no statistically significant difference in the transverse strength of these materials.

2. Material and methods

A total of 30 specimens (50-mm in length, 25-mm in width and 2.5-mm thick) were fabricated from three different denture base materials. The specimens were divided into three groups; 10 each according to the material tested; Group 1 specimens were fabricated from Eclipse. The specimens prepared for this study were fabricated solely from the Eclipse original-pink shade fibered baseplate resin for standardization purposes.

Group 2 specimens were fabricated from Triad VLC regular pink material and light-polymerized in the Triad visible light curing unit (Triad 2000, Dentsply International Inc., York, PA). Group 3 specimens, which were used as a heat-polymerized control, were fabricated from Lucitone 199 original-pink shade, which is a high-impact thermopolymerized material.

All the specimens were fabricated utilizing stone molds made by investing brass blocks of dimensions 50 mm × 25 mm × 3.5 mm in dental stone. The Lucitone 199 specimens were fabricated by packing the acrylic resin into these stone molds contained in denture flasks and curing for 9 h at 165 °F in a Hanau denture curing unit (Hanau Engineering Company Inc., Buffalo, NY) following the manufacturer's recommendations. The cycle was completed by boiling for additional 30 min. Similar stone molds were used for packing of the Triad and Eclipse denture base specimens prior to light polymerization according to the manufacturer's instructions for 5 and 10 min, respectively, utilizing light intensity 400–500 nm and 90 MW. The temperature inside the curing unit was 165–170 °F. All specimens when initially fabricated were 3.5 mm thick to allow for finishing and polishing procedures which were done only on one surface, simulating oral conditions, using a series of silicone carbide paper abrasive discs starting at 120 grit and ending with 320 grit to obtain a polished surface. The prepared specimens (2.5 mm thick) were then stored in distilled water at 37 °C for 48 h prior to testing.

Transverse strength testing was performed using an Instron universal testing machine (Norwood, MA, USA) utilizing maximum fiber stress according to the American Society for Testing and Materials (ASTM) standard D790 for flexural testing of reinforced plastics.[18,20] A 3-point testing design was used, whereby the simple specimen beam was centrally loaded at a crosshead speed of 5 mm/min over a 2-point support span set at 40-mm. The specimens were deflected until rupture occurred. The stress was calculated by means of the following equation:[20]

$$S = \frac{3PL}{2bd^2}$$

where S is the stress in the outer fibers at midspan, expressed in MPa; P: load at a given point on the load-deflection curve, expressed in N; L: support span length, expressed in mm; b: width of beam tested, expressed in mm; and d: depth of beam tested, expressed in mm.

Fractured segments from two randomly selected specimens of each study group were prepared by sputter-coating with gold–palladium alloy, and examined with a scanning electron microscope (JSM-820 JEOL-USA Inc, Peabody, MA, USA) at 250× magnification power.

The mean transverse strength values and standard deviation were calculated for each group, and the data were analyzed by means of one-way analysis of variance (ANOVA), followed by Tukey-Kramer HSD post hoc test using JMP 6.0.3 statistical software (SAS, Cary, NC, USA) at a 95% confidence level to determine the mean differences for each study group.

3. Results

The mean transverse strength values in MPa of the three denture base materials tested are presented in Table 1. The one-way analysis of variance indicated there were significant differences in the resin transverse strength between each of the three groups ($P < 0.0001$). Eclipse showed the highest mean transverse strength (116.13 ± 17.7 MPa) followed by Lucitone 199 (87.12 ± 8.1 MPa), and finally Triad VLC (57.96 ± 7.3 MPa). The Triad material exhibited almost half of mean transverse strength value compared to Eclipse.

Table 1 – Mean transverse strength and standard deviation in MPa for each study material

	Eclipse	Triad	Lucitone 199
Mean (MPa)	116.13	57.96	87.12
S.D.	17.68	7.31	8.08

All materials were significantly different ($P = 0.0001$).