The effect of bur preparation on the surface roughness and reline bond strength of urethane dimethacrylate denture base resin

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ABSTRACT

Background: The clinical success of relining depends on the ability of reline resin to bond to denture base. Surface preparations may influence reline bond strength of urethane-based dimethacrylate denture base resin.

Aim: To investigate the effect of bur preparation on the surface roughness ($R_a$) of eclipse denture base resin and its shear bond strength (SBS) to an intra-oral self-curing reline material. The mode of reline bonding failure was also examined.

Materials and Methods: Twenty-four cylindrical Eclipse™ specimens were prepared and separated into three groups of eight specimens each. Two groups were subjected to mechanical preparation using standard and fine tungsten carbide (TC) burs and the third group (control) was left unprepared. The $R_a$ of all specimens was measured using a contact stylus profilometer. Subsequently, relining was done on the prepared surface and SBS testing was carried out a day later using a universal testing machine.

Results: One-way ANOVA revealed significant differences ($P<0.05$) in $R_a$ and SBS values for all the groups. Post-hoc Tukey’s HSD test showed significant differences ($P<0.05$) between all the groups in the $R_a$ values. For SBS also there were significant differences ($P<0.05$), except between standard bur and control.

Conclusions: 1) There was a statistically significant difference in the $R_a$ of Eclipse™ specimens prepared using different carbide burs ($P<0.05$). 2) There was a statistically significant difference in the relined SBS ($P<0.05$) when prepared using different burs, but the difference between the standard bur and the control group was not statistically significant.

Key words: Denture base resin, reline bond strength, surface roughness, urethane dimethacrylate

Visible light-polymerized urethane dimethacrylate (UDMA) denture base resin (Eclipse™; Dentsply Int, York, USA) is reported to possess favorable mechanical properties.[1] However, its reline bond strength is a concern.[2] Modification of the denture base through grinding with burs has been suggested for polymethyl methacrylate resins to improve bonding of denture reline,[3,4] with coarser burs producing rougher surfaces.[5] Bonding between two materials improves because of micromechanical retention. Eclipse™ resin has been shown to exhibit poorer reline bond strength when abraded with rough silicon carbide paper,[2] but the effect of bur preparation has not been examined. Hence, the objective of this study was to evaluate the effect of preparation using tungsten carbide (TC) burs that are commonly used in clinical practice on the surface roughness ($R_a$) and reline shear bond strength (SBS) of UDMA Eclipse™ denture base resin. The null hypothesis tested was: ‘bur preparation would have no effect on surface roughness and shear bond strength of relined Eclipse™ denture base resin.’

MATERIALS AND METHODS

Twenty-four Eclipse™ specimens (15-mm diameter and 4-mm height) were prepared and polymerized for 10 min using visible light (the equipment and procedures employed have been described in a previous paper[1]) and immersed in distilled water for 30 days at 37°C. They were then
divided into three equal groups according to the type of bur preparation: standard carbide, fine carbide (Edenta; Hauptstrasse, Switzerland), and control (no preparation). All specimens were prepared by the same operator by running a bur at 20,000 rpm along the surface of the specimen for 1 min.

Surface roughness (Ra) of the specimens was measured using a contact stylus profilometer (Ambios XP-1; Santa Cruz, USA). The cutoff length was 2 mm, with a measuring length of 10 mm. Three measurements were made for each specimen and the mean Ra values were used for the statistical analysis.

Reline resin (Kooliner; GC America, Alsip, USA) (15 mg powder/6 ml liquid monomer) was mixed and poured into a brass ring (internal diameter 6 mm) placed on the specimens. After polymerization, the specimens were stored for 24 h in water at 37°C. SBS testing was then done on a universal testing machine (Shimadzu, Tokyo, Japan) at 1.0 mm/min crosshead speed. Specimens were examined under a stereomicroscope (Kyowa SD-2PL; Tokyo, Japan) at a magnification of ×10 to examine the nature of the bonding failure.

RESULTS

The Ra and relined SBS values for different groups of Eclipse™ specimens are shown in Table 1. For Ra values, one-way ANOVA and post-hoc Tukey’s HSD test revealed significant differences between the groups (P<0.05). The highest Ra was recorded with the standard bur. One-way ANOVA for relined SBS showed significant differences (P<0.05) and post-hoc Tukey’s HSD test also showed significant differences (P<0.05), except between standard bur and control (P>0.05). The lowest SBS was observed with fine bur. The mode of bonding failure for all groups was 100% adhesive. Figure 1 is a schematic illustration and Figure 2 is the SEM (Scanning electron microscopic) view showing Eclipse™ surface configuration with different TC bur preparations and in the control.

DISCUSSION

The data obtained support rejection of the null hypothesis for the effect of bur preparation on the Ra and SBS of Eclipse™ resin. However, there was no significant difference in SBS values between standard bur and control; thus, for this variable, the data do not support rejection of the null hypothesis.

Preparation with carbide burs produced rougher surfaces than that seen on unprepared specimens; this is in agreement with an earlier study[5] where trimming with rotary instruments was used to roughen the acrylic resin surface. The difference in the appearance of the surface was also evident from the SEM views [Figure 2].

Increase in Ra due to bur preparation did not offer any additional advantage in terms of improved reline SBS. One plausible reason for this could be that due to the composite nature of Eclipse™ resin, more fillers were likely to be exposed to the surface after removal of the resin matrix–rich outermost layer by trimming [Figure 1]. Less areas of bonding were therefore available between the UDMA matrix and the reline resin. This might also explain the lower SBS values with fine bur preparation [Figure 2b]. However, in the standard bur group, where higher SBS values were observed, it may well be that the deeper part of the organic resin matrix may also have got roughened with the grinding [Figure 2c]. The additional roughening of resin matrix produced by the coarser bur may have increased the surface area for bonding and contributed to the higher reline SBS values for the standard bur group in this study.

A limitation of this study was that only one type of reline resin was tested and, hence, the results cannot be generalized to other materials. Further studies are recommended to investigate different types of commercially available reline resins.

Table 1: Mean surface roughness, Ra (µm) and relined SBS (MPa) of Eclipse™ specimens with different TC bur preparations, and control specimen

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Surface roughness (Ra) (in µm) Mean (S.D)</th>
<th>SBS (MPa) Mean (SD)</th>
<th>Mode of bonding failure % (A / C / M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (no preparation)</td>
<td>3.57 (0.23)</td>
<td>6.00 (2.00)*</td>
<td>100 / 0 / 0</td>
</tr>
<tr>
<td>Fine bur</td>
<td>5.96 (0.31)</td>
<td>2.20 (0.62)</td>
<td>100 / 0 / 0</td>
</tr>
<tr>
<td>Standard bur</td>
<td>6.92 (0.67)</td>
<td>4.80 (0.97)*</td>
<td>100 / 0 / 0</td>
</tr>
</tbody>
</table>

A - Adhesive; C - cohesive; M – mixed; *P>0.05

Figure 1: Schematic diagram illustrating the surface configuration of Eclipse™ specimen prepared with different TC burs. (i) Control specimen showing resin matrix–rich surface layer. (ii) Removal of outermost resin matrix–rich layer with fine bur preparation. (iii) Removal of outermost resin matrix–rich layer with additional roughening using standard bur. (a) Resin matrix–rich surface layer, (b) filler particle (c) resin matrix.
REFERENCES


Figure 2: SEM views, with original magnification of ×6000: (a) Control Eclipse™ specimens processed against glass showing smooth surface appearance. (b) Irregular areas created by fine bur preparation, with some smooth surfaces retained. (c) More irregular areas with lesser smooth surfaces, created by standard bur preparation (arrows show exposed filler particles)

CONCLUSIONS

- There is a statistically significant difference in the $R_a$ of Eclipse™ specimens prepared using different carbide burs ($P<0.05$).
- There is a statistically significant difference in the relined SBS ($P<0.05$) when prepared using different burs, but no significant difference between standard bur and control group.

Thus, we conclude that the type of bur used to prepare the denture for relining may affect the surface roughness and the resultant reline bond strength of Eclipse™ denture base resin.

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Conflict of Interest: None declared.

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