HEAT GENERATED BY RESIDUAL ADHESIVE REMOVAL AFTER DEBONDING OF BRACKETS

Aim: To measure the rise in temperature during mechanical removal of residual adhesive after debonding of brackets in vitro. Methods: Different carbide burs on a high-speed handpiece were tested. Acrylic on the buccal surfaces of recently extracted human maxillary incisors was removed using 3 types of carbide burs (6-, 12-, 40-fluted) with a varying number of windings relative to the long axis of the shaft. The temperature was measured using a thermocouple probe in the pulp chamber of the extracted teeth. Results: The highest mean rise in temperature was measured using a 6-fluted bur (+9.4°C, P < .001), followed by the 12-fluted bur (+6.5°C, P < .001). The lowest rise in temperature (+1.2°C, not significant) was seen with a 40-fluted bur. After 3 to 8 seconds of continuous grinding, the rise in temperature seems to slow down. Conclusion: The removal of residual adhesive after debonding is best performed with fine burs. If 6-fluted burs are used, a pause after 5 to 10 seconds of continuous grinding is recommended, especially in the mandibular anterior area. World J Orthod 2006;7:357–360.

Most clinicians use a direct or indirect bonding technique to place fixed appliances in the mouth. This bonding procedure requires debonding at the termination of treatment. The objectives of debonding are to remove the attachment and all adhesive resin from the tooth and to restore the surface as closely as possible to its pretreatment condition.1–4 Several techniques to remove attachments have been described, including the use of pliers, electrothermal debonding, and the laser.5–8 A common outcome of all these techniques is that some composite will remain on the tooth surface. Tungsten carbide burs running at high speeds have proven to be efficient in removal of residual resin, but they fail to produce a satisfactory enamel surface when used alone. After the removal of residual resin, graded medium, fine, and superfine Sof-Lex finishing disks (Unitek, Monrovia, CA, USA) produce smooth surfaces.9,4 Jonke et al10 demonstrated that fine carbide burs with more windings produce a smoother enamel surface than burs with less windings. This is advantageous for achieving a high-gloss surface during the next polishing step. Grinding ceramic brackets near the tooth surface may lead to a rise in temperature of the tooth surface and the pulp.10 A literature search did not reveal any equivalent data for removal of residual adhesive after debonding.

The goal of the present investigation was to evaluate the effect of the use of differing tungsten carbide burs on the generation of heat near the tooth surface and in the dental pulp, and to compare pulp temperature elevation with previously published critical values for pulp survival.
MATERIAL AND METHODS

Thirty extracted human maxillary incisors were used. The roots were cut approximately 4 mm from the apex using a diamond disk with copious water cooling. The pulp tissue was removed. A thermo-couple probe with a thickness of 0.3 mm was inserted into the tooth and attached with a heat-conducting paste. The accuracy was checked against a calibrated water bath and found to be correct within 0.5°C. Using a square 3.5 × 3.5-mm template, approximating the size of a bracket base, a light-cure adhesive (Light Bond; Reliance, Itasca, IL, USA) was bonded to the surface using an acid-etch technique according to the instructions given by the manufacturer. The bonding material was cured with a halogen light-bulb (Optilux 501; Demetron/Kerr, Danbury, CT, USA) for 10 seconds. The template was removed after curing. After 24 hours, the resin was removed with a carbide bur at 150,000 rpm with continuous water cooling. Room temperature was 26°C. Three carbide bur designs with a different number of windings relative to their long axis were tested (Fig 1): 6-fluted carbide bur (F6; FG 1171Lc, Ormco, Glendora, CA, USA), 12-fluted carbide bur (F12; FG 7480c, Ormco, Glendora, CA, USA), 40-fluted carbide bur (F40; 118Ld, Reliance).

Each experimental group consisted of 10 incisors. New burs were used for every test run. The temperature was registered for 20 seconds, with 20 measurements made every second. The data were stored on a personal computer.

Means and standard deviations were calculated. Temperature changes within each group were tested with a t test. Differences between the groups were tested with the chi-square test for independent samples. The level of significance was set at $P < .05$.

RESULTS

A temperature rise in the pulp chamber was seen with all burs. After grinding continuously for 20 seconds the following mean changes in temperature were observed: +1.2°C ($P > .05$), +6.5°C, and +9.4°C (both $P < .001$) when using 40-, 12- and 6-fluted burs, respectively (Table 1). The difference between the 6- and 12-fluted burs was statistically significant at the 5% level. Both the 6- and the 12-fluted burs produced significantly more heat when compared to the 40-fluted burs ($P < .001$). In particular, the 6- and 12-fluted burs showed a rapid rise in temperature within the first 3 to 8 seconds.

After this, the temperature changed more gradually, resulting in almost stable values after approximately 12 to 15 seconds (Fig 2).

DISCUSSION

After debonding of orthodontic brackets, the enamel surface has to be restored to its original luster without damaging either the surface or the pulp tissue. In a former experiment, it was shown that a 40-fluted carbide bur used on a high-speed hand-
A piece produced a smoother enamel surface than either a 12- or 6-fluted bur. In the present in vitro study, the heat generated within the pulp chamber of extracted maxillary incisors was measured when removing bonding adhesive using these burs. Despite water cooling, the rise in temperature was more pronounced when using coarser burs, whereas the temperature hardly changed with the 40-fluted bur. The differences between the 3 burs were statistically significant.

Pohto and Scheinin showed in an in vivo experiment that an elevation in temperature from 37°C to 42°C resulted in vasodilatation of dental pulp tissue. Temperatures at and above 44°C caused aggregations of red blood cells. If temperatures of 46°C to 50°C were maintained for 30 seconds, thrombosis was the consequence. Zach and Cohen carried out an in vivo animal study on Macaca monkeys. They found that an increase in pulp temperature to 42.2°C caused pulpal necrosis in 15% of teeth. A rise in temperature to 47.7°C caused necrosis in 60% of teeth. When there was a 16.6°C elevation in pulpal temperatures, pulpal necrosis occurred in all teeth. Jost-Brinkmann et al found obvious alterations of the pulp tissue in areas close to the former bracket position in 50% of the teeth after thermodebonding of brackets using several heating cycles. In the present study, the authors found a rise in temperature of up to 9.4°C within the

Table 1  Means and standard deviations of the intrapulpal temperature changes in °C

<table>
<thead>
<tr>
<th>Type of bur</th>
<th>T0</th>
<th>T20</th>
<th>T</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>F6</td>
<td>26.0</td>
<td>35.4</td>
<td>9.4***</td>
<td>0.05</td>
</tr>
<tr>
<td>F12</td>
<td>26.0</td>
<td>32.5</td>
<td>6.5***</td>
<td>0.13</td>
</tr>
<tr>
<td>F40</td>
<td>26.0</td>
<td>27.2</td>
<td>1.2 (ns)</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Differences between groups: F6 vs F12*; F6 vs F40***; F12 vs F40***.
T0, temperature at start of measurement; T20, temperature after 20 seconds; T, rise in temperature within 20 seconds; F6, 6-fluted bur; F12, 12-fluted bur; F40, 40-fluted bur; SD, standard deviation; ns, not significant; *P < .05; ***P < .001.
pulp chamber of extracted maxillary incisors when removing bonding material with a 6-fluted carbide bur in a high-speed handpiece. Taking into account that the starting temperature of 26°C is lower than body temperature, the resulting temperature of approximately 46°C in vivo would be potentially hazardous to the pulp tissue. It has been shown that mandibular anterior teeth are most susceptible to thermal damage, probably due to dentin and enamel being thinner than in other teeth. Using thin hydroxyapatite disks, the rise in temperature was clearly higher than within the extracted teeth in the authors’ previous experiment. Extrapolating these data to an in vivo situation, the rise in temperature using coarse burs for a prolonged period of time may have a bearing on the pulp, especially in the mandibular anterior area. Compromised teeth that have large restorations or a questionable pulpal status could behave more adversely to this significant amount of heat produced. On the other hand, the healing potential of the human pulp is excellent. Nevertheless, the fact that finer burs produce smoother enamel surfaces with less development of heat is advantageous when residual adhesive is removed after debonding.

CONCLUSION

In this in vitro experiment it was shown that the removal of residual adhesive after debracketing with carbide burs in a high-speed handpiece may generate a rise in temperature within the tooth. The coarser the bur, the more heat will develop. After 10 seconds of continuous grinding with a 6-fluted bur, potentially hazardous temperatures were registered in the pulp chamber of extracted teeth. Using finer burs, the rise in temperature was less dramatic; in particular, the 40-fluted bur never led to critical heat development. When using carbide burs for adhesive removal, it is suggested that fine burs be used. If 6-fluted burs are used, a pause after 5 to 10 seconds of continuous grinding is recommended, especially in the mandibular anterior area.

REFERENCES