EFFECT OF TWO GUTTA-PERCHA SOLVENTS AND TWO SEALERS ON FRACTURE RESISTANCE OF ENDODONTICALLY TREATED TEETH

ABSTRACT

Background and Aim: The purpose of this study was to evaluate the effect of gutta-percha solvents on fracture resistance of endodontically treated roots.

Materials and Methods: A total of 72 decrowned single canal human teeth were used. Eight of specimens were selected as a control group. Thereafter, the specimens were randomly divided into 2 groups (n= 32) according to gutta-percha solvent which used: 1) chloroform, 2) eucalyptol. Specimens were further subgrouped according to the application time: a) 5 min, b) 10 min. Then roots were obturated with AH26/gutta-percha and iRoot SP/gutta-percha combinations (n= 8/group). The specimens were mounted in an acrylic resin and loaded to failure by using an universal testing machine.

Results: The statistical analysis was completed using three-way ANOVA and Student's t-Test (p<0.05). iRoot SP showed higher fracture resistance values than that of AH 26 (p<0.05). The fracture resistance values of chloroform groups were higher than eucalyptol groups (p<0.05). In both groups, extended application time resulted in decreased fracture resistance.

Conclusion: The type of gutta-percha solvents and root canal sealers may differentially affect the fracture resistance of endodontically treated roots. Extended application of gutta-percha solvents to dentin could have adverse effect on the fracture resistance of endodontically treated roots.

Key words: Bioceramic Based Sealer, Chloroform, Eucalyptol, Fracture Resistance

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INTRODUCTION

Removal of gutta-percha from the root canal is required when creating space for post placement or endodontic treatment that fails to heal and requires nonsurgical retreatment. Root filling materials are removed by means of several methods including hand or rotary instruments (alone or combined with heat or solvents), ultrasonic instruments, and paper points with chemicals. The removal of gutta-percha is greatly simplified by using organic solvents that soften gutta-percha and sealers in the root canal and facilitate their removal. Chloroform is a commonly used solvent because it solubilizes gutta-percha rapidly. However, the U.S. Food and Drug Administration discourages the use of chloroform because of its potential carcinogenicity. Despite this, it is still in judicious use today in endodontics to remove gutta-percha. Thus, alternatives have been recommended, and essential oils, such as eucalyptol, have been among the compounds used. During gutta-percha removal the radicular and coronal parts of the root dentine are exposed to the solvents. This procedure is clinically significant as these solvents are capable of altering the chemical composition of the dentine surface and affecting its interaction with materials used for root canal obturation and coronal restoration. The alterations may change the organic and inorganic components of dentine, which changes the permeability and solubility of dentine and affects the adhesion of dental materials to root canal dentin. The effects of gutta-percha solvents on the microhardness of crown enamel and dentin and root dentin and on the bonding of dental materials to root canal dentin have been studied however these studies have not yet determined the effects of gutta-percha solvents on the fracture resistance of endodontically treated roots. The purpose of this in-vitro study was to evaluate the effect of two different gutta-percha solvents and sealers on fracture resistance of endodontically treated roots.

MATERIALS AND METHODS

Tooth selection

Freshly extracted mandibular single canal incisors with similar size and straight roots were reduced to a standardized root length of 14 mm. All specimens were examined under a stereomicroscope to ensure the absence of cracks. The mesiodistal and buccolingual diameters of the coronal planes were measured with a digital caliper; the mean diameters were 3.83 and 6.03 mm, respectively. Roots presenting a difference of 20% from the mean were discarded, leaving a total of 72 mandibular incisor roots.

Specimen preparation

Canal length was determined using #10 K-file, and the working length was determined by subtracting 1 mm from the canal length. The roots were prepared with the ProTaper rotary system (Dentsply Maillefer, Ballaigues, Switzerland) up to size F2 instrument for the primer enlargement. To avoid the effects of sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) on fracture resistance of endodontically treated teeth 2 mL of distilled water was used between each file size during the cleaning and shaping of the root canals. Eight of the specimens were used as the control group (unfilled; no solution applied). Thereafter, the remaining specimens were randomly divided into the 2 groups (n = 32) according to the gutta-percha solvent used as chloroform and eucalyptol (Sultan Healthcare, Inc.). Specimens were further subdivided according to exposure time as 5 min and 10 min. Additional root canal preparation was performed with Mtwo instrument (VDW, Munich, Germany) up to size 40 0.04 taper as a retreatment procedure. Solvents were allowed in contact with the root canal dentine during and after preparation. After solvent treatment the root canals were flushed with 10 mL of distilled water to avoid prolonged solvent effects. The canals were subsequently dried with paper points. Thereafter, the roots were randomly divided into two groups (n=8/group) according to root filling system used. Group 1: Gutta-percha+AH 26 (Dentsply-Maillefer, Tulsa, OK, USA); Group 2: Gutta-percha+ iRoot SP (The compound is based on bioceramic composition: zirconium oxide, calcium silicates, calcium phosphate, calcium hydroxide, filler, and thickening agents) (Innovative BioCeramix, Vancouver, Canada). The sealers were applied in strict adherence to the manufacturers’ recommendations. In both groups, size 40, 0.04 taper single cones were used. Following the obturation the specimens were stored at 37°C and 100% humidity for 1 week to allow the materials to set completely.

Fracture test

The apical root ends were embedded along the long axis in self-curing acrylic blocks with 9 mm of each root exposed according to the technique described by Texeira et al. The specimens were then mounted in a universal testing machine (Lloyd LRX; Lloyd Instruments, Fareham, UK). A custom
stainless steel loading fixture with a spherical tip (r = 2 mm) was centered over the canal opening, and a compressive force was applied at a crosshead speed of 1 mm/min until a fracture occurred (Figure 1). The forces necessary to fracture each root were recorded in Newtons (N).

**Statistical analysis**

The data were analyzed using three-way analysis of variance (ANOVA) and Student’s t-test.

**RESULTS**

The fracture strength values (N) are presented in Table 1 as mean ± standard deviation. The ANOVA revealed that the effect of the tested root-filling materials on fracture resistance was statistically significant (p < 0.05). The mean fracture strength values of the iRoot SP was significantly higher than that of the AH 26 (p < 0.05). On the other hand, there was no interaction between sealers and solvents (p = 0.299), sealers and exposure time (p = 0.182), solvents and exposure time (p = 0.352). Moreover, there was no interaction among three variables (p = 0.114). The fracture strength of the chloroform group was higher than that of the eucalyptol group (p < 0.05). Additionally, the fracture resistance of chloroform group significantly decreased within time (p = 0.018). However, the exposure time had no effect on fracture resistance of eucalyptol group. The data showed that there was no difference between the control and treated groups except the groups of chloroform in 5 min (p < 0.05).

**DISCUSSION**

The fracture resistance may play an important role in clinical longevity of endodontically treated teeth. Among the methods developed for measuring the fracture resistance of endodontically treated teeth, there is no widely accepted method. Therefore, one of the previous methods was used to evaluate the fracture resistance of endodontically treated teeth.

The results of our study demonstrated that regardless of exposure time and solvent type, teeth treated with iRoot SP had higher mean fracture loads than those treated with AH 26. The enhanced performance of iRoot SP may be explained by its calcium silicate composition, which uses the moisture naturally present in dentinal tubules to initiate and complete the setting reaction so that no shrinkage occurs during setting. Additionally, it has extremely small particle size and excellent level of viscosity which enhances flow of the sealer into dentinal tubules may resulted in effective bonding to root canal dentin. Consequently, the high

Table 1. Fracture Resistance Values (N) of Test Specimens Presented as Mean ± Standard Deviation.

<table>
<thead>
<tr>
<th>Group</th>
<th>Gutta-percha solvent</th>
<th>Application Time</th>
<th>5 min</th>
<th>10 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>AH 26 Chloroform</td>
<td></td>
<td>Mean ± SD</td>
<td>615±61</td>
<td>522±78</td>
</tr>
<tr>
<td></td>
<td>Eucalyptol</td>
<td></td>
<td>423±62</td>
<td>543±59</td>
</tr>
<tr>
<td>iRoot SP Chloroform</td>
<td></td>
<td>Mean ± SD</td>
<td>707±68</td>
<td>601±77</td>
</tr>
<tr>
<td></td>
<td>Eucalyptol</td>
<td></td>
<td>526±58</td>
<td>508±68</td>
</tr>
<tr>
<td>Control</td>
<td>Irrigated with distilled water, unfilled; no solution applied</td>
<td>Mean ± SD</td>
<td>487±34</td>
<td></td>
</tr>
</tbody>
</table>

SD, Standard Deviation
bonding ability of iRoot SP to intraradicular dentin might enhance resistance to fracture.\textsuperscript{18}

Our results also showed that the fracture strength of the tested obturation systems was affected by the solvent applied. The fracture loads of teeth treated with chloroform were higher than those of teeth treated with eucalyptol. The effect of chloroform on increasing fracture strength might be attributed to its role in altering calcium and phosphorus levels of human dentin\textsuperscript{23} and thereby improving the microhardness of root canal dentine. This result is in accordance with previous study which have reported a positive correlation between hardness and the mineral content of the tooth.\textsuperscript{24} Additionally, chloroform may induce considerable changes in the surface morphology of dentine, which may also exert some changes in its mechanical and physical properties.

Apart from the filling material, fracture resistance was also significantly affected by the exposure time. In our study, organic solvents were applied on root canal dentine surfaces for 5 and 10 min. Statistical analysis revealed that extended exposure time had significant effects on fracture resistance of chloroform group. This finding is in accordance with a previous study which showed that the amount of decrease in microhardness was directly related to the exposure time of chloroform.\textsuperscript{25} On the other hand in eucalyptol group, extended application time resulted in decreased fracture resistance, but the differences were not significant.

Many studies have reported a decrease in microhardness and altered physiochemistry in dentine specimens treated with NaOCl\textsuperscript{26}, EDTA,\textsuperscript{27, 28} or both.\textsuperscript{29} Therefore, to eliminate the effects of irrigating solutions, distilled water was used to remove dentine debris during the cleaning and shaping of the root canals. Moreover, the possible effects of gutta-percha removal procedures were also considered and after the primer root canal preparation, the root canals were remained empty, not obturated with gutta-percha. So that, the solvents were achieved to contact with the root canal dentine walls directly as obeying the aim of the study.

**CONCLUSION**

Within the experimental conditions of this in vitro study, it can be concluded that the fracture resistance may be affected by the type of gutta-percha solvent and obturation material applied. On the other hand, fracture resistance is only one of several desirable properties of endodontically treated teeth, and the possible effects of the gutta-percha solvents on bond strength and leakage of root canal sealers should be investigated.

**REFERENCES**

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