Resistance of Teeth with Simulated Incomplete Rhizogenesis with Intraradicular Post or Root Canal Filling

ABSTRACT

Aim: The aim of this study was to evaluate the fracture strength (FS) of bovine incisors with simulated incomplete rhizogenesis (IR) after different intraradicular treatments.

Materials and methods: Incomplete rhizogenesis was simulated by sectioning the crowns and roots of 40 bovine incisors. Root canal preparation was performed and the samples divided into 4 groups (n = 10): GI-negative control with intra-radicular preparation; GII-positive control without intra-radicular preparation; GIII-glass fiber post cemented with resin cement and GIV-root canal obturation with Epiphany/Resilon system. In GII and GIV, 4.0 mm apical plugs of mineral trioxide aggregate (MTA) were done. The samples were embedded into cylinders with polystyrene resin, and the periodontal ligament was simulated with a medium-viscosity polyether-based impression material (Impregum Soft). The specimens were submitted to compressive fracture strength test (0.5 mm/min at 135° in relation to the long axis of the tooth) in a mechanical testing machine MTS 810. Data were submitted to ANOVA and Tukey's test (α = 0.05).

Results: GIII produced the highest FS values (p<0.05). GI and GIV showed similar FS results (p>0.05) but smaller than GII (p<0.05).

Conclusion: Glass fiber intraradicular posts provided the FS increase of teeth with simulated incomplete rhizogenesis. Epiphany/Resilon root canal filling with MTA plug did not provide the increase of the fracture strength to teeth with simulated incomplete rhizogenesis.

Clinical significance: The fiber post reinforces the root structure of teeth with incomplete rhizogenesis.

Keywords: Post and core, Root canal treatment, Incomplete rhizogenesis, Intraradicular post, Root canal obturation.

INTRODUCTION

Caries or tooth trauma may occur in teeth with incomplete rhizogenesis (IR), leading to endodontic treatment. Calcium hydroxide has been indicated as intracanal medication for endodontic therapy of teeth with IR. Calcium hydroxide dissociates into calcium and hydroxyl ions favoring its properties for clinical use. Calcium hydroxide exhibits important advantages as intracanal medication: antimicrobial activity, root resorption inhibitory effect, and ability to stimulate the deposition of apical mineralized tissue in teeth with IR, promoting the periapical repair. However, calcium hydroxide maintenance for long periods can promote the weakening of dentine walls, reducing root fracture strength (FS), and inducing changes in the physical properties of the dentine. Also, calcium hydroxide treatment delay the placement of final restoration.

Teeth with IR present thin root walls with divergent morphology in apical third, making them more susceptible to root fractures, especially during traumas. The use of intraradicular posts and prosthetic reconstruction has been recommended in cases with large crown destruction to increase root strength. In teeth with IR, it has been evidenced that root FS increases when intraradicular posts and luting agents are employed. The cementation may be performed with resin composite, glass ionomer cement and resin cements aiming to a greater adhesion between post and dentine wall of root canal. Glass fiber posts are an alternative for the restoration of teeth with IR due they have modulus of elasticity similar to dentine.

The use of an apical plug with MTA has been suggested for endodontic therapy of teeth with IR, resulting in a faster treatment and inducing the mineralized tissue formation in the root apex. The root canal filling using Epiphany/
Resilon system was proposed to provide a greater bonding between filling materials and root canal wall.\textsuperscript{25,26} Therefore, the use of the MTA plug and root canal filling with Epiphany/Resilon system could lead to a higher root resistance in teeth with incomplete rhizogenesis.

The aim of this study was to in vitro evaluate the fracture strength of bovine incisors, using a model of simulated incomplete rhizogenesis, after different intraradicular treatments.

**MATERIALS AND METHODS**

Forty bovine teeth with straight roots and similar root canals were selected for the study. The specimens were kept in 2.5\% sodium hypochlorite for 7 days and then in 0.9\% saline solution. The teeth were examined under ×4 magnifying and radiographed to evaluate the tooth anatomy and internal morphology of pulpal cavity. The crowns and roots of the teeth were sectioned, respectively, at 8.0 mm above and 12 mm below the cementoenamel junction. The pulp tissue was removed using a #60 Hedstrom file (Dentsply Maillefer, Ballaigues, Switzerland). Root canals were irrigated with 1.0\% sodium hypochlorite solution.

The specimens were randomly distributed into four experimental groups (n = 10), according to Table 1. Thirty roots were prepared with a size 703 carbide bur (Jet-Set Beavers Dental Products Ltd, Morrisburg, ON, Canada) at crown-apex and apex-crown directions to standardize the internal diameter at 2.1 mm. The remaining ten teeth received no preparation. During these procedures, the teeth were kept in moist gauze and the root canals were irrigated with 1.0\% sodium hypochlorite solution.

According to Bramante et al 2004,\textsuperscript{27} 4.0 mm thickness MTA apical plugs were prepared in GIII and GIV, MTA (Angelus Soluções Odontológicas, Londrina, PR, Brazil) powder was mixed with distilled water according to the manufacturer’s instructions. MTA was inserted up to the apical length using a Lentulo spiral and condensed with cotton pellet moistened in distilled water, and a #70 K file (Dentsply Maillefer, Ballaigues, Switzerland).

In GI (negative control), root canals were submitted to intraradicular preparation with no treatment and in GII (positive control), the root canals were not submitted to intraradicular preparation.

In GIII, after intraradicular preparation and MTA apical plug, the conical-shape glass fiber post (Exacto - Angelus Soluções Odontológicas, Londrina, PR, Brazil) was placed into the root canal according the root canal design. Root canal was submitted to 37\% phosphoric acid for 15 seconds. Following, the root canals were washed with water and dried with absorbent paper points. A chemically-activated adhesive agent was applied onto the root canal/post, according to the manufacturer’s instructions. The posts were luted with resin cement (Cement-Post, Angelus Soluções Odontológicas, Londrina, PR, Brazil).

In GIV, the root canals received intraradicular preparation and MTA apical plug as previously described. Epiphany/Resilon system (Pentron Clinical Technologies, LLC, Wallingford, CT, USA) was used for root canal filling according to the manufacturer’s instructions. The root canals were dried and then the lateral condensation technique was performed. The Resilon point #80 was covered with Epiphany sealer and placed up to MTA plug, followed by lateral compaction using Resilon accessory points until the complete root canal filling.

The access cavities were sealed with glass ionomer cement (Vidrion R - SS White, Rio de Janeiro, RJ, Brazil) and the specimens were stored in an incubator at 37°C and relative humidity of 100\% for 48 hours.

All teeth were embedded in polystyrene resin (Cristal, Piracicaba, SP, Brazil) into polyvinyl chloride (PVC) cylinders. During the phase of tooth inclusion, periodontal ligament was simulated as previously described.\textsuperscript{27,28} The teeth were immersed into melted wax (Horus; Herpo Produtos Dentários, Petrópolis, RJ, Brazil), at 2.0 mm below the cementoenamel junction. An average thickness of 0.25 mm of wax was obtained around the roots. Then, the teeth were removed from the PVC cylinders and the wax eliminated from both the root surface and resin cylinders sockets using warm water. Then, the resin cylinders were filled with a medium-viscosity polyether-based impression material (Impregum Soft 3M ESPE AG, Seefeld, Germany) using a syringe for elasto-

<table>
<thead>
<tr>
<th>Groups</th>
<th>Intraradicular preparation</th>
<th>MTA apical plug</th>
<th>Intraradicular post</th>
<th>Cementation</th>
<th>Root canal filling</th>
</tr>
</thead>
<tbody>
<tr>
<td>GI (– Control)</td>
<td>Yes</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>GII (+ Control)</td>
<td>No</td>
<td>—</td>
<td>—</td>
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<tr>
<td>GIII</td>
<td>Yes</td>
<td>Yes</td>
<td>Glass fiber posts</td>
<td>Resin Cement</td>
<td>Epiphany/Resilon</td>
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<td></td>
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<td>Exacto</td>
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<td>Cement-Post</td>
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<tr>
<td>GIV</td>
<td>Yes</td>
<td>Yes</td>
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</table>
**Resistance of Teeth with Simulated Incomplete Rhizogenesis with Intraradicular Post or Root Canal Filling**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean (N)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>GI (– Control)</td>
<td>717.9</td>
<td>176.0</td>
</tr>
<tr>
<td>GII (+ Control)</td>
<td>1361.0</td>
<td>200.1</td>
</tr>
<tr>
<td>GIII</td>
<td>2052.0</td>
<td>190.4</td>
</tr>
<tr>
<td>GIV</td>
<td>872.3</td>
<td>129.2</td>
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</table>

Means designated with different capital letters (A, B and C) were statistically different (p < 0.05).

The present study used a size 12-scalpel blade. Thus, a simulated periodontal ligament was achieved with a thickness of 0.25 to 0.30 mm of polyether-based impression material.

**Fracture Strength Test**

All specimens were submitted to fracture strength test in a mechanical testing machine (MTS 810 MTS Systems Corp, Eden Prairie, MN, USA), using a load cell of 10 kN, at a crosshead speed of 0.5 mm/min. Each specimen was positioned into a cylindrical device as described by Melo et al 2007 and Bortoluzzi et al 2007, which enables an angle of 135º in relation to the long axis of the tooth.

The obtained data of fracture strength were statistically evaluated by using one-way analysis of variance (1-way ANOVA), and the Tukey test (α = 0.05).

**RESULTS**

Table 2 described the means and standard deviations of data from different experimental groups. GIII produced the highest values of fracture strength (p < 0.05). GI and GIV had similar results (p > 0.05) but smaller than GII (+ control) (p < 0.05).

**DISCUSSION**

Bovine root dentine has dentinal tubules with morphology similar to human dentine. For this reason, the bovine teeth have been largely used in researches as alternative to human teeth.

The present study used an IR simulated model in bovine teeth according to Bortoluzzi et al in 2007. A periodontal ligament was simulated to distribute the tension during the mechanical test. The plug of MTA has been employed to induce apexification in teeth with IR, as well as to act as protection to root canal filling.

The results of this study evidenced that intraradicular glass fiber post in association with MTA apical plug reinforces the root with incomplete rhizogenesis, according to other results. The greatest fracture strength in this group could be related to the low elasticity modulus of glass fiber post promoting load distribution along the post length. GII (positive control without preparation of the dentine walls) exhibited fracture strength smaller than GIII, and greater than GI and GIV.

Both GIV (apical MTA plug in association with root canal filling with Epiphany/Resilon system) and GI (negative control group with only intracanal preparation) showed the smallest root fracture strength. The root canal filling with Epiphany/Resilon system in an IR simulated model did not promote the increase of root fracture strength. These results are not in accordance with previous studies, in which a model with single-rooted human teeth with complete rhizogenesis was employed.

However, the results of the present study are in accordance with Hemalatha et al 2009, who studied the fracture strength of human teeth with simulated IR and observed that the root canal filling with Resilon/Epiphany system did not increase the root resistance.

**CONCLUSION**

Taking into consideration the evaluation method, the use of MTA apical plug associated with intraradicular glass fiber posts promotes root reinforcement for teeth with IR. The MTA apical plug associated with the root canal filling with Epiphany/Resilon system did not increase the resistance of teeth with IR.

**REFERENCES**


