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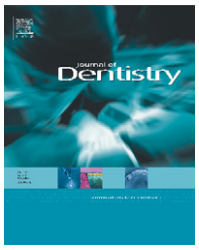

Performance of techniques used for re-attachment of endodontically treated crown fractured teeth

Alessandro Dourado Loguercio [a,*], *Gilmara Leski* [b], *Daiana Sossmeier* [b], *Alexander Kraul* [c], *Margereth Oda* [c], *Rafael Tiago Patzlaff* [b], *Alessandra Reis* [a]

[a] *Department of Restorative Dentistry, Universidade Estadual de Ponta Grossa Rua Carlos Covalcanti 4748 Bloco M, Sala 64 A, Vvaranas, Ponta Grossa, 84030-900 PR, Brazil*

[b] *Department of Dental Materials and Operative Dentistry, School of Dentistry, Universidade do Oeste de Santa Catarina, Brazil*

[c] *Department of Operative Dentistry, School of Dentistry, Universidade de São Paulo, São Paulo, SP, Brazil*

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ABSTRACT

Objectives: The aim of this study was to compare the fracture strength of three techniques used to re-attach tooth fragments in sound and endodontically treated fractured teeth with or without fiber post placement.

Material and methods: Ninety human lower incisors were randomly divided into three groups of 30 teeth each. In group A teeth were not subjected to endodontic treatment; while teeth from groups B and C were endodontically treated and the pulp chamber restored with a composite resin. All teeth were fractured by an axial load applied to the buccal area in order to obtain tooth fragments. Teeth from each group were then divided into three subgroups, according to the re-attachment technique: bonded-only, buccal-chamfer and circumferential chamfer. Before the re-attachment procedures, fiber posts were placed in teeth from group C using dual cure resin luting cement (Duo-Link). All teeth (groups A–C) had the fragments re-attached using a same dual cure resin luting cement. In the bonded-only group, no additional preparation was made. After re-attachment of the fragment, teeth from groups buccal and circumferential chamfer groups had a 1.0 mm depth chamfer placed in the fracture line either on buccal surfaceor along the buccal and lingual surfaces, respectively. Increments of microhybid composite resin (Tetric Ceram) were used in subgroups buccal chamfer and circumferential chamfer to restore the chamfer. The specimens were loaded until fracture in the same pre-determined area. The force required to detach each fragment was recorded and the data was subjected to a three-way analysis of variance where factors Group and Re-attachment technique are independent measures and Time of fracture is a repeated measure factor (first and second) and Tukey's test ($\alpha = 0.05$).

Results: The main factors Re-attachment technique ($p = 0.04$) and Time of fracture ($p = 0.02$) were statistically significant. The buccal and circumferential chamfer techniques were statistically similar ($p > 0.05$) and superior to the bonded-only group ($p < 0.05$). The first time of fracture was statistically superior to second time of fracture ($p < 0.001$).

Conclusions: The use of fiber post is not necessary for the reinforcement of the tooth structure in re-attachment of endodontically treated teeth. When bonding a fractured fragment, the buccal or circumferential re-attachment techniques should be preferable in comparison with the simple re-attachment without any additional preparation. None of the techniques used for re-attachment restored the fracture strength of the intact teeth.

* *Corresponding author*. Tel.: +55 49 554 4452.
E-mail address: aloguercio@hotmail.com (A.D. Loguercio).

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1. Introduction

Recent studies on the incidence of dental trauma, mainly among children and teenagers have shown that trauma affects between 17 and 35% of patients at this age.[1–3] Crown fractures have been documented to account for up to 92% of all traumatic injuries to the permanent dentition.[1–3]

The most affected teeth are the upper incisors due to their anterior position and their protrusion caused by the eruptive process. Uncomplicated fracture by trauma is the most frequent type of dental injury in the permanent dentition; however complicated fractures can also occur.[4] Under the latter circumstance, when dealing with extensive and complicated fractures, multidisciplinary approaches are required with consideration of periodontal, endodontic, restorative and occlusal factors.[5] For instance, endodontic treatment might be required prior to restorative measures when vitality of the teeth is affected by the trauma *per se*.

Under this case, there is a doubt of whether a post placement is required or not prior to the re-attachment of the fracture teeth. There are many case reports published in the literature where fiber posts were luted inside root canal, after endodontic treatment, as a result of trauma.[5–10] Usually, in case of traumatized teeth having the tooth fragment, the use of re-attachment techniques should be preferable.

As previously reported, the fracture resistance of endodontically treated teeth is largely dependent on the amount of remaining dentin.[11,12] However, it is unclear at which degree of substance loss endodontic reinforcement with posts becomes necessary in incisors with part of teeth fractured, mainly in cases of fracture re-attachment. To the author's knowledge, no study has so far addressed whether post placement has any effect on the fracture strength recovery of fractured teeth after re-attachment.

Many techniques have been proposed to re-attach fragments to the remaining tooth[13] and there is no consensus about the best technique to be used for re-attachment. For example, although a chamfer is usually placed to re-attach tooth fragments,[13–17] no study has so far compared the performance of a circumferential or only buccal-chamfer.

De Santis et al.[14] and Demarco et al.[15] compared the simple re-attachment technique with the placement of a circumferential chamfer and concluded that the latter had higher fracture resistance when subjected to static and fatigue bending tests. Reis et al.[13] investigated the fracture resistance of re-attached coronal fragments employing simple re-attachment and buccal-chamfer and reported no significant difference between these two techniques, as reported in other laboratory investigations.[16,17]

While De Santis et al.[14] and Demarco et al.[15] used the circumferential chamfer, which involved both the buccal and lingual surfaces; other studies placed only a buccal-chamfer.[13,16,17] Unfortunately, the literature lacks comparison of buccal and circumferential chamfer techniques for re-attachment of fractured teeth.

Therefore, the aim of this study was to compare the fracture strength of three techniques used to re-attach tooth fragments in sound and endodontically treated teeth either associated or not with fiber post placement.

2. Materials and methods

This study was approved by the Institutional Review Board from the Dental School, Unoesc (Brazil). Ninety human lower incisors, extracted for periodontal disease, were selected under optical magnification (×2). Teeth free from cracks, caries lesions or any other kind of structural defect were selected. The teeth were disinfected in 0.5% chloramina for 15 days and stored for less than 6 months in 0.9% saline solution.[18]

The teeth were randomly divided into three groups of 30 teeth each (Fig. 1). In group A, teeth were not subjected to endodontic treatment; while teeth from groups B and C were endodontically treated. The endodontic treatment was performed by stepwise filling with reamers and hedstrom file to ISO size 35. After intermittent rinsing with 1% sodium hypochlorite all roots were obturated with laterally condensed guta-percha (Tanari, Amazonas, Brazil) and zinc oxide-based cement (SS White, Rio de Janeiro, Brazil). The guta-percha was left 2-mm below the cemento-enamel junction (CEJ) and this space was filled with a resin modified glass-ionomer cement (Vitrebond, 3M ESPE, St. Paul, MN, USA). Then, the pulp chamber was conditioned with phosphoric acid 35% (15 s), rinsed (15 s) and left visible moist. The adhesive system Excite (Vivadent, Liechtenstein, Germany) was applied according to the manufacturer's recommendation and the cavity was incrementally filled with a composite resin (Tetric Ceram, Vivadent, Liechtenstein, Germany).

All ninety teeth were subjected to three sequential procedures: (1) fracture of the sound and endodontically treated teeth; (2) restoration of the fractured teeth using different techniques; (3) fracture of the restored teeth, as in procedure 1.

2.1. *Fracture of the sound teeth*

The buccal surface of each tooth was divided in transversal and longitudinal thirds. The area for application of the perpendicular loading is shown in Fig. 2. In order to obtain tooth fragments, the teeth were confined in a metallic device, slightly modified from Reis et al.[13] that maintained the teeth with a buccal–lingual inclination of 60°. This inclination allowed the application of a perpendicular load to the predetermined site (Fig. 3).

The tooth-device assembling was adapted in a universal testing machine (EMIC, São José dos Pinhais, PR, Brazil) and a compressive load, at a speed of 0.6 mm/min, was applied to each tooth in a buccal to lingual direction by means of a small stainless steel ball (2 mm^2) inserted at the end of a pin which was held in the cross head of the universal testing machine. The force required to fracture the tooth was recorded. Only teeth with a Class II Ellis fracture type were included in the study. This kind of fracture is an enamel–dentin fracture extended crow fracture with noticeable dentinal involvement, without pulp exposition, like a Class IV cavity. When a non-desirable fracture mode occurred, the tooth was discarded and another one was subjected to the same procedures in order to keep the sample size constant.