Fracture resistance of endodontically treated molars restored with horizontal fiberglass posts or indirect techniques

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ABSTRACT

Background. Because of the many possibilities for endodontically restoring the posterior teeth and the high prevalence of restoration failures, this topic continues to be of major concern. A composite resin (CR) restoration reinforced by a horizontal fiberglass post may improve the fracture resistance of endodontically treated teeth. The authors investigated this possibility by comparing the fracture resistance of molars restored with direct techniques with that of molars restored with indirect techniques.

Methods. The authors divided 50 extracted sound third molars into 5 groups: sound teeth, onlay (ON), inlay (IN), direct CR, and transfixed fiberglass post (TFP) plus direct CR. The authors performed standardized mesio-occlusodistal cavity preparations and endodontic treatments. The authors cemented indirect restorations of Lava Ultimate (3M ESPE) adhesively in the ON and IN groups. The authors restored CR group teeth directly with Filtek Z230 XT (3M ESPE). In the TFP group, the authors transfixed 2 fiberglass posts horizontally and restored the teeth directly with CR. Thereafter, the authors submitted the teeth to cyclic fatigue loading with 500,000 cycles at 200 newtons. The authors tested fracture resistance in newtons in a universal testing machine. The authors analyzed data with 1-way analysis of variance and a Tukey test ($P < .05$).

Results. Sound teeth had the highest fracture resistance. ON had the highest recovery of resistance, followed by TFP. CR had the lowest recovery, which was similar to that of IN.

Conclusions. Endodontically treated molars restored with TFP plus CR had fracture resistance similar to those restored with ON, which was higher than that for IN or CR only.

Practical Implications. Horizontal TFPs placed inside a composite restoration had the same performance as did ON restorations.

Key Words. Fracture resistance; molar; endodontic treatment; composite resin; CAD/CAM; fiberglass post.
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Endodontic treatment should be completed as soon as possible by means of a permanent coronal restoration to prevent tooth fractures, recurrent carious lesions around provisional restorations, and marginal leakage.[1] The quality of the coronal reconstruction directly affects the success and the longevity of endodontic treatment.[2,3] Parameters for an acceptable restoration include adequate anatomy, function, proximal contacts, and occlusal stability.[3] However, the type of material and restoration technique are still controversial for endodontically treated teeth. What is known is that a well-done final restoration involves tooth form, function, proximal contacts, and occlusal stability.[3]

Possible causes of tooth fracture are coronal destruction by caries, excessive removal of dentin during therapeutic procedures, trauma, previous restorations, prolonged use of sodium hypochlorite and ethylenediaminetetraacetic acid, and endodontic over-instrumentation.[2,4] There seems to be a direct relationship between the number of residual walls and fracture resistance[5,6] because the removal of 1 marginal ridge results in 46% loss of tooth rigidity and removal of 2 marginal ridges leads to a 63% loss of rigidity.[7] Therefore, the residual coronal tooth structure is a key factor for the choice of restorative material and technique.[5,8]

Preservation of tooth structure and adequate adhesion between restorative material and the tooth are important elements for the success and longevity of restorations.[9] Proper adhesion eliminates the need for macro-mechanical retention, enabling more conservative cavity preparations. In this sense, direct composite restorations

are a viable treatment, avoiding the removal of healthy tooth structure that occurs in cavity preparation for onlays (ONs).[3,10] Direct composite restorations seem to increase fracture resistance in endodontically treated teeth and have a low cost.[10,11] Plotino and colleagues[7] observed similar fracture resistance of molars with extensive loss of tooth structure when restored with direct or indirect composite, reinforcing the possibility of direct composite restorations as an option for teeth with great loss of tooth structure.[12] However, indirect composite restorations seem to provide better distribution of tension in mesio-occlusodistal (MOD) caries.[13] Ilgenstein and colleagues,[14] comparing the fracture resistance of composite and ceramic ONs manufactured by means of a computer-aided design and computer-aided manufacturing (CAD/CAM) system, observed higher fracture resistance with the former.

Another frequent discussion is the need of cusp coverage in endodontically treated teeth, with controversial results. According to Jiang and colleagues,[13] a tooth restored with ON has a more favorable stress distribution than with inlay (IN), regardless of the material used. Teeth with cusp coverage restored with composite resin (CR), either directly or indirectly, have a higher fracture resistance than do teeth without cusp protection.[11] Conversely, Stappert and colleagues[15] observed that total coverage of the cusp for ceramic restorations did not increase fracture resistance compared with less invasive restorations that covered only the functional cusp.

A restorative alternative that aims to increase the fracture resistance of endodontically treated teeth is the use of fiberglass posts horizontally transfixed to the buccal and lingual walls. Beltrão and colleagues[16] and Favero and colleagues[17] advocated that transfixing posts with composite restorations enhances the fracture resistance of the tooth when compared with restorations with no post transfixed.

Considering the lack of consensus on the restorative alternatives for endodontically treated teeth, we aimed in this in vitro study to assess the maximum fracture load of endodontically treated molars restored with indirect techniques with or without cusp coverage and with direct techniques involving with or without transfixation of fiberglass posts. The initial null hypothesis was that there is no statistically significant difference in the fracture resistance of endodontically treated teeth restored with INs, ONs, or direct CR with or without a transfixed fiberglass post (TFP).

METHODS

The local ethics committee approved the protocol of this study (ethics committee certificate of approval, 52088315000005336). We calculated sample size on the basis of a pilot study and considered the following parameters: type I error probability of .05, nominal test power of 0.8, difference between groups of 230 newtons, and average standard deviation of 90 N. The minimum sample size was of 10 specimens per group.

We cleaned 50 human third molars extracted for a therapeutic indication and stored them in a 0.5% chloramine solution for 24 hours for disinfection. After this period, we recorded the buccolingual and mesiodistal dimensions of each tooth with a digital caliper. The selected teeth had a mean (standard deviation) mesiodistal distance of 10.81 (1.14) millimeters and a buccolingual distance of 10.55 (0.82) mm, with coefficients of variation of 10.59 and 7.78, respectively. We divided the teeth randomly into the study groups described in Table 1.

We embedded the teeth and prepared their cavities on the basis of the protocol described by Beltrão and colleagues.[16] We labeled each specimen as described in Table 1 and stored the specimens in distilled water at 4°C.

MOD cavity preparation. We prepared cavities with a device adapted to a microscope table in which a high-speed dental handpiece was adapted. We defined references for each tooth to receive a MOD cavity preparation standardized in width and depth. The buccolingual width corresponded to two-thirds of the intercuspal distance, and we set the depth at 4 mm.

We selected an 845 KR diamond bur (Gebr. Brasseler) to perform the cavity preparation, which consisted of buccal and lingual walls, a common floor extended from the mesial to distal aspects, and internal rounded angles. We replaced the diamond bur after every 5 preparations, which a single operator (C.R.B.) performed. After preparing the teeth, we stored them in distilled water at 4°C.

Endodontic therapy. An endodontics specialist (C.B.A.) performed the endodontic treatments. The specialist opened the crown with 1012 and 1014 round diamond burs (KG Sorensen) at high speed under water and air cooling. She performed stepback shaping by using burs (Endo-Z, Dentsply Maillefer) at high speed under water and air cooling. She used 1% sodium hypochlorite for irrigation. Next, she explored the canals with a file (15 Flexofile, Dentsply Maillefer) and prepared for access to the canals with drills (01 and 02 Gates Glidden, Dentsply Maillefer) with irrigation with 1% sodium hypochlorite. She eliminated the hypochlorite through abundant irrigation with saline solution. She dried the root canals with paper cones. She vertically condensed the gutta-percha with a condenser (2 Paiva, S.S. White Duflex). She filled the pulp chamber with a resin-reinforced glass ionomer cement (Riva Light Cure,

ABBREVIATION KEY. **CAD/CAM:** Computer-aided design and computer-aided manufacturing. **CR:** Composite resin. **IN:** Inlay. **MOD:** Mesio-occlusodistal. **ON:** Onlay. **SBU:** Single Bond Universal. **TFP:** Transfixed fiberglass post.