ABSTRACT

Endodontically treated teeth are widely considered to be more susceptible to fracture than are vital teeth. Aims: To assess the in-vitro fracture resistance of root canal treated teeth with or without smear layer removal. Materials and Methods: Thirty six freshly extracted human maxillary central incisor teeth were selected. Crowns were removed at cemento-enamel junction. The samples were then biomechanically prepared using step back technique. In 20 samples the smear layer was preserved using sodium hypochlorite. In 20 samples smear layer was removed by EDTA. The remaining samples were served as controls. Samples were obturated with Resilon and Epiphany and AH-Plus and gutta percha by lateral condensation technique. Teeth were then tested by Instron testing machine. Results: Resilon and Epiphany shows the higher fracture resistance when compared with AH-Plus and gutta percha. Positive control shows the highest fracture resistance. Group with smear layer removed were showed better resistance to fracture load when compared with smear layer intact group. Conclusion: Resilon and Epiphany shows the higher fracture resistance when compare with AH-Plus and gutta percha.

Keywords: Resilon/Epiphany; AH-Plus; EDTA; Instron; smear layer.

Introduction

Endodontically treated teeth are considered to be more susceptible to fracture than are vital teeth. The reasons most often reported have been the dehydration of dentin after endodontic therapy, excessive pressure during obturation and the removal of tooth structure during endodontic treatment.1-4 The strength of an endodontically treated tooth is related directly to the method of canal preparation and to the amount of remaining sound tooth structure.5 It commonly is believed that the loss of dentin creates an increased susceptibility to fracture.3,6 The greatest incidence of vertical root fracture occurs in teeth that have undergone endodontic therapy.7 Even though fractures results from excessive lateral compaction forces during the root filling8 the root canal instrumentation is an unavoidable step in endodontic therapy and which in turn indicate any material that can compensate for this weakening effect. This leads to the development of sealer used in conjunction with a core filling material to reinforce the instrumented teeth against fracture. The bonding of endodontic sealers to intraradicular dentin after root canal obturation might possibly enhances the resistance of fracture of endodontically treated teeth. This study was conducted to assess the in-vitro fracture resistance of root canal treated teeth with or without smear layer removal.

Materials and Methods

For this in vitro study 36 extracted human central incisors were randomly selected. After removal of debris the teeth are kept in sodium hypochlorite for 24 hours for removal of stains. The samples were sectioned from cemento-enamel junctions using a diamond disk and water spray. The sectioned teeth were assessed for the working length i.e., 1mm short of the apical foramen using a No. 20 k-file. Further, the samples were divided in to 3 groups.

Group 1: Twenty roots were taken and canals were instrumented with step back technique till the 3 size larger than apical master file 1 mm short of apical foramen. Smear layer were intact and irrigation was done using 15 ml of 6% sodium hypochlorite.

Group 2: Twenty teeth are prepared as describe in group 1, smear layer were removed by using 10 ml of 17% EDTA solution, followed by final irrigation with 10 ml of 5% sodium hypochlorite.

These groups are subdivided into two subgroups of each group.

Subgroup 1a: Ten root canals were filled with Resilon and Epiphany sealer. The sealer was placed using Lentulo spiral fill er. A master Resilon cone was placed into the root canal and with cold lateral compaction technique filled using accessory Resilon points. The excess was sealed off with the help of plugger 1 mm below the canal opening and coronally cured for 40 seconds and canal opening was sealed with cavit.

Subgroup 1b: Ten root canals were filled using gutta-percha with AH plus sealer. The master cone was dipped in the sealer and placed in the canal and filled with gutta-percha of smaller sizes. Excess gutta-percha was sheared off and condensed 1 mm below the canal opening with a plugger and the opening was sealed with cavit.

Subgroup 2a: Ten root canals were filled with Resilon and Epiphany sealer. The sealer was placed using Lentulo spiral filler. A master Resilon cone was placed into the root canal and with cold lateral compaction technique filled using accessory Resilon points. The excess was sealed off with the help of plugger 1 mm below the canal opening and coronally cured for 40 seconds and canal opening was sealed with cavit.

Subgroup 2b: Ten root canals were filled using gutta-percha with AH plus sealer. The master cone was dipped in the sealer
and placed in the canal and filled with gutta-percha of smaller sizes. Excess gutta-percha was sheared off and condensed 1 mm below the canal opening with a plugger and the opening was sealed with cavit.

Group 3 (positive control): 4 roots were taken and instrumented using step back technique but were not obturated.

Group 4 (negative control): 4 roots were taken were neither instrumented nor obturated.

Only the canal opening was sealed with cavit and was used as control group. Then cylindrical moulds of 20 mm in diameter and 20 mm in length were prepared using elastomeric impression material (Provil P – Soft, Heraeus – Kulzer, Domagen, Germany) and then self-cure acrylic was placed in the mould and apical 6 mm of the root were embedded individually with 7 mm remaining exposed. The acrylic blocks including the specimens were placed on the lower plate of the machine (Universal Testing Machine, Instron), the upper plate of the machine included a round tip that had a diameter of 4 mm. This round tip contacted the coronal surface of the specimen and was subjected to slowly increasing vertical force of 1 mm per minute until the fracture occurred and the values were recorded in Newton.

**Results**

The mean fracture resistance values of group 1 were 1283.60 N, group 1b were 1197.40 N, group 2a were 1725.80 N, group 2b were 1550.60 N, positive control were 8214.20 N and negative control were 2550.80 N.

**Discussion**

As root canal therapy has become well established as a viable clinical treatment to retain a tooth where by the dental pulp has become necrotic, irreversibly inflamed or infected.9–14 But it is generally accepted that several endodontic procedures such as access preparation15,16, instrumentation and even irrigation with sodium hypochlorite lead to reduction in fracture resistance of instrumented teeth.17 Enlarged but unfilled roots are significantly weaker than filled roots thus more susceptible to fracture.18,19 Therefore, there is a general trend of restoring endodontically prepared teeth to reinforce them against fracture.20 In the present study to create uniformity of the samples and hence to avoid difficulty in obtaining uniform fracture strength, all the controllable factors like length and size were standardized i.e. roots were kept at 13 mm and enlarged upto size 40. Usually differences exist between fractures occurring intraorally and those induced by a testing machine because forces generated intraorally during function vary in magnitude, speed and duration. Therefore in several studies tests of fracture strength was done using the cyclic loading i.e., applying the forces from different direction thus to simulate the clinical conditions.21,22 But again in many studies it has been reported applying the forces vertically to the long axis of the tooth transmits the force uniformly.23 Hence for this study the force applied was vertical like other studies that evaluated the effect of root canal sealer on the fracture resistance of root filled teeth.17,23,24 Resilon is a synthetic polymer core material and epiphany is dual curable resin composite sealer which provides both mechanical and chemical adhesion.25 Here Resilon with epiphany sealer showed high resistance to fracture. This may be due to “monomono-block” created because of Resilon filling closely adapting to epiphany sealer and in turn epiphany sealer adhering to the dentin walls thus holds the root together and reduces microleakage as compared to gutta-percha fillings. This bond between polyester core materials to dual cure methacrylate based sealer helps to keep Resilon filled roots to increase its fracture toughness. These observations were similar to the other studies26 reported teeth filled with Resilon and Epiphany was more resistant to fracture. Similarly roots filled with gutta-percha with AH plus sealer also showed greater fracture resistance than control group. This may be due to its adhesive properties, as the epoxy resin based sealer is found to have good adhesion to dentin and gutta-percha and is characterized by low shrinkage and high dimensional stability. This finding was similar to studies in literature.17,27 They observed roots obturated with epoxy resin based sealers with lateral compaction technique were significantly stronger than just instrumented roots. Smear layer is an important factor for the final outcome of endodontic treatment which was seen in present study. The samples are removed smear layer with 17% EDTA were higher value of fracture resistance when its compare with the smear layer preserved groups. Because of 5% sodium hypochlorite were depletes the organic phase and cause a mechanical change by release of hypochlorous acid, which reacts with insoluble proteins to from soluble polypeptides, amino acids and other by-products.28,30

It has been shown that the presence of smear layer reduces root dentin permeability by 25%. Sodium hypochlorite also cause decrease of hardness of the dentin because of decreased in the stiffness of intertubular dentin matrix caused by heterogeneous distribution of mineral phase within the collagen matrix.21 While samples in which smear layer was removed showing higher resistance of fracture, this may be due to the demineralizing ability to 17% EDTA and also its ability to remove inorganic components of smear layer. 17% EDTA has been shown to solubilize the higher percentage, which was greater than 70%, of the inorganic portion of root dentin.31 This allowed a greater adhesion of Resilon/Epiphany and AH Plus to root dentin and strengthening of endodontically treated teeth. Moreover, EDTA has low surface tension which allows it to better flow to dentinal tubules.32 As the smear layer was removed the surface energy was altered which will help the sealers to flow the dentinal tubules more easily and increased the adhesion. Teeth that were instrumented but not obturated showed vertical fracture at very less loads in comparison to other experimental groups and the results were statistically significant. This was due to the fact that root canal instrumentation weakened the roots as the amount of reaming dentin...
thickness was greatly reduced and there was obturation also done to provide the strength.

Conclusion
In conclusion the teeth neither bio-mechanically prepared nor obturated had highest recorded fracture resistance and results were statistically significant. The reason behind this observation may be the root canal preparation weakens the root canals, and significant strength could not be attained after obturation. A large size clinical trial is necessary to validate the result of present in vitro study.

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