



# Influence of Five Different Root Canal Sealers on Root Fracture Susceptibility

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## ABSTRACT

**Aim:** The purpose of the study was to compare the fracture resistance of roots filled with one of the following five root canal sealers: AH Plus, EndoRez, RealSeal, MTA Fillapex, and AcroSeal. The null hypothesis was that the type of root canal sealer would not influence the fracture resistance of root-filled teeth.

**Methods:** Sixty-five maxillary central incisors were sectioned 1 mm below the cemento-enamel junction (CEJ) to obtain roots 14 mm in length. Roots were subjected to chemomechanical preparation using the rotary instruments of the Profile system. The obturation of root canals was performed with the following filling materials (n = 12): group I: AH Plus and gutta-percha (GP), group II: EndoRez and GP, group III: RealSeal and GP, group IV: MTA Fillapex and GP, group V: AcroSeal and GP, group VI: roots were instrumented but not filled (control; n = 5). After the appropriate setting time, each root was embedded in acrylic resin. The specimens were then subjected to fracture resistance testing using an Instron testing machine at 1 mm/min.

**Results:** The Mann-Whitney test indicated no significant differences ( $p > 0.05$ ) among groups I ( $379.10 \pm 57.64$  N), II ( $374.32 \pm 101.61$  N), III ( $309.06 \pm 87.10$  N), IV ( $305.99 \pm 76.67$  N), V ( $362.91 \pm 91.23$  N) and VI ( $213.711 \pm 51.85$  N). Groups I to V were all significantly better than the control, but no difference between them.

**Conclusion:** All of the root canal sealers used in this study increased the fracture resistance of instrumented root canals.

**Keywords:** Fracture resistance, Reinforce, Root canal sealers.

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## INTRODUCTION

Tooth fracture has been described as a major problem in dentistry; it is the third most common cause of tooth loss after dental caries and periodontal disease.<sup>1,2</sup>

It is commonly believed that endodontically treated teeth are weaker and more prone to fracture than vital teeth.<sup>3</sup> Several factors are known to be associated with root fractures in endodontically treated teeth, including excessive loss of tooth structure because of caries or trauma, dehydration of dentin, access cavity preparation, instrumentation and irrigation of the root canal, excessive pressure during root obturation, and preparation of intraradicular post space.<sup>4,5</sup> Therefore, one of the objectives of root canal obturation is to reinforce the root canal and increase root fracture resistance. It is thought that adhesion and mechanical interlocking between the root canal filling material and radicular dentin reduce the risk of fracture and strengthen the remaining tooth structure.<sup>6</sup>

The purpose of this study was to compare the fracture resistance of roots filled with gutta-percha (GP) and sealed with one of the following five root canal sealers: epoxy resin-based AH Plus, resin-based EndoRez, resin-based RealSeal, MTA-based MTA Fillapex, and calcium hydroxide-based AcroSeal. The null hypothesis was that the type of root canal sealer would not influence the fracture resistance of root-filled teeth.

## METHODS

Sixty-five freshly extracted, intact, human maxillary central incisors with single straight root canals were selected for this study. Teeth were stored in distilled water until use. To ensure that incisor roots with standardized dimensions were used, the buccolingual and mesiodistal dimensions of the root canals were measured using a digital calliper. Preoperative radiographs were taken in the mesiodistal and buccolingual directions to evaluate the presence of a single canal, resorptions, or calcifications. The crowns were removed at the cemento-enamel junction (CEJ) to standardize the root length (14 mm) with a high-speed bur under water cooling. The working length was determined by subtracting 1 mm from the length of an inserted #15 K-file (Dentsply Maillefer, Ballaigues, Switzerland) with its tip visualized at the apical foramen. All of the root canals were instrumented to an apical size of F3 (30) with the rotary ProTaper system (Dentsply Maillefer) using the crown-down technique. Along with this

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instrumentation, 5.25% NaOCl irrigation was applied between each file. Following instrumentation, all canals were irrigated with 5 ml of 17% EDTA solution followed by 5 ml of NaOCl to remove the smear layer. The canals were finally rinsed with 5 ml of distilled water, dried using paper points, and divided into five experimental groups of 12 teeth each according to the obturating materials and the root canal sealers used. Root canals of all teeth were obturated using the lateral condensation technique. The groups were classified as follows: group I, AH Plus (Dentsply DeTrey, Konstanz, Germany) sealer and GP; group II, EndoRez (Ultradent, South Jordan, UT, USA) sealer and GP; group III, RealSeal (SybronEndo, Orange, CA) sealer and GP; group IV, MTA Fillapex (Angelus Industria de Produtos Odontologicos S/A, Londrina, Brazil) sealer and GP; group V, AcroSeal (Septodont, Saint-Maur-des-Fosses, France) sealer and GP; group VI, roots were instrumented but not filled (control).

Mesiodistal and buccolingual radiographs were taken to verify complete filling. After root filling, the coronal 2 mm of the filling materials was removed, and the spaces were filled with a temporary filling material (Cavit; 3M ESPE, Seefeld, Germany). The teeth were stored at 37°C with 100% humidity for 7 days to allow the sealers to set.

Acrylic resin blocks were prepared 10 mm in height and 20 mm in diameter. All of the roots were mounted vertically in self-cure acrylic resin (Meliodent; Bayer Dental, Leverkusen, Germany). The apical root ends were embedded vertically in 5 mm of the acrylic resin, exposing 9 mm of the coronal portion of each root. A universal testing machine (Instron Corp, Canton, MA, USA) was used for the strength test. The acrylic blocks were placed on the lower plate of the machine. The upper plate consisted of a spherical steel tip with a diameter of 2 mm. The tip was centered over the canal orifice, and a slowly increasing vertical force was exerted (1 mm/min) until fracture occurred. The maximum force required to fracture each specimen was recorded in Newtons (N) and the results were compared. Statistical analysis was performed using Kruskal-Wallis and Mann-Whitney tests.

## RESULTS

Table 1 shows the mechanical testing results. According to the Kruskal-Wallis tests, there were statistically significant differences among the I to VI groups ( $p < 0.05$ ). The Mann-Whitney U-test revealed no significant differences among groups I to V ( $p > 0.05$ ). Groups I to V were all significantly better than the control, but no difference between them.

**Table 1:** Minimum, maximum, and mean values of fracture strength (in Newtons) for both experimental and control groups

Groups	N	Mean value	Min.	Max.	SD
I (AH Plus)	12	379.10	297.41	451.80	57.64
II (EndoRez)	12	374.32	149.63	532.89	101.61
III (MTA Fillapex)	12	309.06	148.45	374.04	87.10
IV (RealSeal)	12	305.99	208.46	492.52	76.67
V (AcroSeal)	12	362.91	233.23	588.86	91.23
IV (Control)	5	213.71	157.69	290.84	51.85

## DISCUSSION

Standardization of the samples is an important factor in mechanical testing. Variations in the dimensions of the roots, extraction time, and storage conditions may affect the results.<sup>7</sup> According to Versluis et al<sup>8</sup> root canal preparations that resulted in a round cross-section led to more uniform stress distributions within a root during filling, thereby reducing fracture susceptibility.

In this study, we used standardized instrumentation, irrigation and obturation procedures. To standardize the apical canal diameter of the enlarged root canal, all roots were prepared to ProTaper size F3, corresponding to an apical size 30. A standard irrigation regimen, using EDTA and sodium hypochlorite, was used to remove the smear layer because this combination has been shown to enhance bonding of the materials tested to the dentinal surface of the root.<sup>9</sup>

Lertchirakarn et al<sup>10</sup> evaluated the vertical fracture resistance with different root filling materials and sealers. Their study demonstrated that the sealer type did not significantly influence fracture load with the same core material; the core material was more important in terms of strengthening or reinforcing the root filling.<sup>10</sup> For this reason, was used as the core material to assess the impact of root canal sealers in the current study.

For fracture strength measurement, in many studies, loading force was applied in a vertical direction because a vertical force applied parallel to the long axis of a tooth produces a more uniform stress distribution.<sup>11,12</sup> Therefore, in the current study, a single load to fracture was applied in the vertical direction with a cross-head speed of 1 mm minute<sup>-1</sup> using a universal testing machine.

In this study, filling of the root canals with AH Plus sealer did not significantly strengthen the roots compared with other sealers; in fact, no differences were detected among root canal sealers ( $p > 0.05$ ). These results corroborate previous findings.<sup>13,14</sup>

The epoxy resin-based sealers penetrate micro-irregularities better due to their creep capacity and high polymerization time.<sup>15</sup>

Materials that adhere to the root canal dentin surface will reinforce an endodontically treated tooth

structure.<sup>6,16,17</sup> All of the experimental groups I to V showed significantly superior fracture resistance compared with the control group. This result is consistent with those of Karapinar et al<sup>18</sup> and Sagsen et al<sup>14</sup> and verifies the reinforcing effect of the filling materials.

Hammad et al compared vertical forces at fracture of teeth obturated with Endorez, RealSeal and Guttaflow; they found that forces at fracture were significantly higher in the Realseal and EndoRez groups than Guttaflow.<sup>19</sup> We also found no significant differences between EndoRez and RealSeal, but the Endorez fracture load values were higher than those of RealSeal. This difference between studies may be caused by RealSeal being used with.

In other studies, MTA as a root canal filling material strengthened the root against fracture.<sup>20,21</sup> In the current study, the MTA-based root canal sealer MTA Fillapex showed significantly higher fracture resistance compared with the negative control group, although it was not significantly different from the other root canal sealers tested. This may be due to the presence of resins in MTA Fillapex.

## CONCLUSION

Within the limitations of this study, we concluded that the obturation of roots with resin-based materials increased the resistance of root-canal-filled teeth to vertical root fracture. Use of adhesive resin-based sealers will prolong the clinical usage of such teeth.

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