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Fracture resistance of roots obturated with three different materials

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Objective. The aim of this study was to compare the fracture resistance of roots obturated with different materials.
Study design. Sixty root canals were instrumented and divided into 4 equal groups (n = 15 each). The root canals in group 1 were filled with AH26 sealer and gutta-percha, in group 2 with Resilon and Epiphany, and in group 3 with Ketac-Endo Aplicap and gutta-percha. Fifteen root canals had no obturation. The force required to fracture was recorded. The data was analyzed with analysis of variance and Duncan test.
Results. The mean force of fracture for group 1 was significantly higher than for the other 3 groups ($P < .05$). There was significant difference between group 2 and group 3 ($P < .05$). Group 2 and group 3 were not significantly different from the control group ($P > .05$).
Conclusion. The use of AH26 + gutta-percha increased the fracture resistance of instrumented root canals compared with Resilon + Epiphany and Ketac-Endo Aplicap + gutta-percha. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;104:705-8)**

It is known that endodontic treatment results in reduction of fracture strength of teeth.[1,2] Biomechanical preparation and dehydration effects of the irrigant solutions are the causative factors that weaken the tooth structure.[3,4] Therefore, one of the aims of filling the root canals must be to reinforce the root canal dentin to increase the fracture resistance.

It is suggested that materials that can adhere the root canal dentin surface will strengthen the remaining tooth structure.[5] It is thought that the adhesion and mechanical interlocking between the material and the root canal dentin prevents mikroleakage and reduces the risk of fracture.[6-10] Gutta-percha has been the filling material of choice for root canals for years. AH26 (Dentsply De Trey, Konstanz, Germany) is a representative of epoxy resin sealers and is commonly used with gutta-percha. In recent years, a new resin-based obturation material has been introduced: Resilon (Epiphany; Pentron Clinical Technologies, Wallingford, CT), a dual-curable thermoplastic synthetic resin material, is used with a self-etching primer and a new thermoplastic filled polymer to create a solid monoblock.[7,11] The handling properties of this system is similar to that of gutta-percha,[12] so it can be used with the techniques that are common for gutta-percha.

Ketac-Endo Aplicap (3M-ESPE, Maplewood, MN), a glass ionomer–based sealer, is one of the materials thought to increase the resistance of the root to fracture.[13] This material has been shown to adhere to the hydroxyapatite component of enamel and dentin.[8,14]

The present study compared the fracture resistances of endodontically treated teeth obturated with AH26 + gutta-percha, Resilon + Epiphany, and Ketac-Endo Aplicap + gutta-percha combinations.

MATERIALS AND METHODS

Sixty freshly extracted single-rooted human mandibular premolars were included in the study. All teeth were examined with a dental operating microscope to

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Table I. Mean, standard deviation, and minimum and maximum values of forces for experimental groups (in Newtons)

Group	n	Mean	SD	Min	Max
1 (AH26 + gutta-percha)	15	1021.04	226.74	684.31	1365.01
2 (Resilon + Epiphany)	15	886.33	175.15	600.00	1223.96
3 (Ketac-Endo Aplicap + gutta-percha)	15	741.38	175.46	426.73	1053.56
4 (No obturation)	15	831.40	163.07	598.00	1202.00

detect any pre-existing fractures, and only intact teeth were included. They were stored in distilled water at room temperature until use. Teeth were sectioned from the cementoenamel junction with a diamond bur used at high speed. The working length was established 1 mm short of the apical foramen using a size of 15 K file (Dentsply Maillefer, Ballaigues, Switzerland). All of the root canals were instrumented to an apical size of 30 with rotary ProTaper system (Dentsply Maillefer) using crown-down technique. Along with this instrumentation, 5.25% NaOCl irrigation was applied between each file. At the end of the instrumentation, all canals were irrigated with 10 mL 17% EDTA solution (pH 7.4) followed by 10 mL NaOCl to remove the smear layer. Then the canals were dried with paper points. The teeth were divided into the four groups containing 15 teeth each.

Group 1

Root canals were obturated with .04 tapered gutta-percha master points (Diadent, Chongju, Korea) dipped in AH26 sealer that was mixed according to the manufacturer's instructions. Lateral compaction was performed using medium-fine gutta-percha accessory cones coated slightly with AH26 and appropriate finger spreaders (Dentsply Maillefer).

Group 2

Root canals were obturated with .04 tapered Resilon cones and Epiphany sealer that was mixed according to the manufacturer's instructions. After self-etching primer (Epiphany Primer; Pentron) was added into the canal using applicator brushes, a master Resilon cone coated with Epiphany sealer was inserted into the canal. Lateral compaction was performed using Resilon cones. Material in the root canal was light cured for 30 seconds with a light-curing unit (Hilux UltraPlus; Benlioγlu Dental, Ankara, Turkey).

Group 3

Root canals were obturated with master gutta-percha cone and Ketac-Endo Aplicap root canal sealer using cold lateral condensation technique as in groups 1 and 2.

Group 4

Root canals were not obturated and served as control.

All of the root canals were enlarged and obturated by only 1 operator. In groups 1, 2, and 3, excess material was seared off and condensed with pluggers, and the access cavities were sealed with Cavit.

The root canal fillings were checked for their obturation quality using periapical radiographs. All roots were stored at 37°C in 100% humidity for 1 week to allow complete setting of the sealers.

Preparation of the mechanical test

All of the roots were mounted vertically in self-cure acrylic resin (Meliodent; Bayer Dental, Leverkuser, Germany) blocks exposing 8 mm of the coronal part. The acrylic blocks were placed on the lower plate of the Universal testing machine (LR 30K, Lloyd, U.K.). The upper plate included a steel spherical tip with a diameter of 5 mm. The tip was lowered to contact the entire coronal surface of the roots and subjected to a gradually increasing force (1 mm/min) which was directed vertically parallel to the long axis of the roots. The force when the fracture occurred was recorded as Newtons.

Statistical analysis

The data were analyzed using a 1-way analysis of variance (ANOVA) test for the experimental groups. Significance between the groups was tested with Duncan test. All statistical analyses were performed using the SPSS software package (version 10.0; SPSS, Chicago, IL). A P value below .05 was considered to be significant.

RESULTS

All the roots fractured when subjected to the testing. The majority of the fractures were vertically oriented. Table I shows mechanical test results derived from the mechanical testing. According to the 1-way ANOVA results, there was a statistically significant difference among the experimental groups ($P < .05$). Duncan test revelaed that group 1 showed significantly higher resistance than the other 3 groups ($P < .05$). There was significant difference between group 2 and group 3

($P < .05$). Group 2 and group 3 were not significantly different from the control group ($P > .05$).

DISCUSSION

Comparative in vitro studies have been done for evaluation of root-strengthening effect of different root canal fillings.[10,13,15] Resin-based dental materials have been proposed to adhere the root canal dentin and therefore to reinforce an endodontically treated tooth.[5,16]

There has been much controversy regarding the relative bonding power of the Resilon system compared with AH26 + gutta-percha. Although it is suggested that use of Resilon showed stronger adhesion to the dentinal walls compared with gutta-percha,[17] some authors have disagreed and found a greater bonding strength of gutta-percha.[7,16,18] Our present results confirm those of the latter authors, showing a lower resistance with the Resilon system compared with the AH26 + gutta-percha group.

Shafer et al.[5] and Teixeira et al.[10] reported that dual-curing resin-based root canal sealers increased the fracture strength more than AH26. Contrary to those results, Sagsen et al.[15] reported no difference between AH26 and Epiphany groups. We used cold lateral condensation technique in the present study in all experimental groups and found AH26 to be the most resistant group, followed by the Resilon and Ketac-Endo Aplicap groups, respectively. In addition, forces that caused fracture were substantially higher for all groups in our study compared with earlier studies.[5,10] This discrepancy may be due to the differences in extraction time, dimensions of the teeth, biomechanical instrumentation, experiment design, and operator influence. Though it has been admitted that it is difficult to achieve standardization in this kind of mechanical test, tests are used on teeth extracted for orthodontic reasons with similar age groups and dimensions.

There are different studies that tested Ketac-Endo for fracture strength with contradictory results. Trope and Ray[13] reported that Ketac-Endo sealer used with single cone technique enhanced the fracture strength of the instrumented root canals. Apicella et al.[19] showed that the use of Ketac-Endo sealer with lateral compaction or single-cone obturation did not increase the fracture strength of root-filled teeth. Similar results were obtained from the study of Çobankara et al.,[20] who reported no difference between Ketac-Endo and AH26 groups.

The removal of smear layer is thought to be important for resin-based and glass ionomer–based materials to form adhesion and thus increase the fracture strength.[8,21] The best composition suggested for removing smear layer is using EDTA followed by NaOCl.[8] We used these materials respectively before filling the canals.

In the present study, the materials except AH26 + gutta-percha did not seem to increase the fracture resistance compared with the instrumented but unobturated group. This finding is in agreement with the results of Apicella et al.[19] and Johnson et al.,[22] who reported no significant difference in fracture strength between Ketac-Endo and unobturated control groups. However our findings with Resilon + Epiphany contradict an earlier study where this material was found to restore the fracture resistance of instrumented roots.[15] The difference between the studies may be attributed to the length of the specimens exposed to force, which was 8 mm in the present study and 6 mm in the study of Sagsen et al.[15]

The remaining dentin thickness was not evaluated in the present study; however, it can be considered as one of the factors that may effect the results of such mechanical tests. This is a limitation of this study.

The advantages of gutta-percha such as its availability, ease of manipulation, and relative reinforcement effect may make this agent still the first-choice filling material.

CONCLUSION

AH26 + gutta-percha–obturated roots showed higher fracture resistance compared with Ketac-Endo Aplicap + gutta-percha and Epiphany + Resilon combinations and control when subjected to vertical loading.

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