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A comparative evaluation of the fracture resistance of endodontically treated teeth using different sealers: An in-vitro study

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Abstract

Aims: Aim of the study was to compare the effect of different sealers and instrumentation technique on the fracture resistance of the endodontically treated teeth.

Material and method: Seventy freshly extracted human mandibular premolars were used. The length was standardized to 14 mm and the teeth were divided into four groups based on the technique of instrumentation. Group I-Teeth instrumented with stainless steel files; Group II-teeth instrumented with protaper rotary gold; Group III-Positive control (unprepared, unfilled); Group IV-Negative control (prepared, unfilled) and further divided into subgroups based on the type of sealer used**.** Sub group I-AH Plus and gutta percha, Sub group II-MTA Fillapex and gutta percha, Sub group III- Apexit Plus and gutta percha, Sub group IV-ZOE and gutta-percha. The teeth were embedded in acrylic resin blocks and compressive strength were measured using universal testing machine (Instron).Statistical analysis was done using One way ANOVA, Shapiro-Wilk test.

Results: The fracture resistance of the teeth instrumented with stainless steel was higher than that of teeth instrumented with protaper rotary gold

Conclusion- It was concluded that epoxy resin-based sealers showed higher fracture resistance than MTA based sealers. However, no significant results were obtained when the comparison was made between ZOE and the control group.

Keywords: Endodontically, MTA, Apexit Plus.

Introduction

Endodontically treated teeth are more prone to fracture than the vital teeth because of reduced amount of tooth structure, dehydration of dentin, extensive restoration and excessive pressure during obturation.(1-3) The main

aim of obturating the root canal is to increase the strength of the root canal wall to increases the resistance of the tooth to compressive stresses. Therefore the root canal sealers with additional quality of strengthening the root against fracture should be used (4). All these factors with an increase in occlusal load together influence and increase the possibility of root fracture. Fractures may result from undue lateral condensation forces during obturation and restorative procedures, following root canal treatment. To provide hermetic seal, the bonding of root canal sealer to dentin is of paramount importance in maintaining the integrity of the seal in root canal filling. Present goal of the root canal obturation is, therefore not just to acheive the three dimensional (3D) sealing of the root canal but also to reinforcement of radicular dentin. A root canal sealer which only helps in achieving good hermetic seal but also has antibacterial properties is considered ideal.

Material And Method

water and any soft tissue were scraped from the root surface using ultrasonic scaler, and stored in 10% buffered formalin solution. Teeth were divided into two control groups and two experimental group.

Group	Sample size	Instrument used for biomechanical preparation	Sealer used
I	20 teeth	SS K File 2%	AH plus, MTA Fillapex, Apexit Plus, Zinc oxide Eugenol
II	20 teeth	ProTaper file 6%	AHplus, MTAFillapex, Apexit Plus, Zinc oxide Eugenol
III	20 teeth	Positive control	Unprepared, Unfilled
IV	10 teeth	Negative control i)Stainless steel 2% ii) Protaper gold 6%	Prepared, Unfilled

Table1-Grouping of the specimen

GROUP I- 20 teeth prepared with stainless steel K files were randomly divided into 4 group with 5 teeth in each group

Master cone was selected and the canals were coated with the sealers with the slow speed lentulospirals and master cone is placed. Using the lateral compaction technique space is created for the accessory cones. The accessory cones are placed until there is no space for the spreaders. The gutta-percha is cut up to the cement enamel junction and sealed with the temporary restoration Cavit G (3M ESPE)

GROUP II- 20 teeth prepared with Protaper rotary gold were divided randomly into 4 groups with 5 teeth in each group and obturated using single cone technique.

Fig 1: Preparation using stainless steel file

Fig 2: Preparation using protaper rotary gold

- Group 1: AH Plus (Dentsply) with Guttapercha
- Group 2: MTA Fillapex (Angelus) with Guttapercha
- Group 3: Apexit Plus (Ivoclar Vivadent) with Guttapercha
- Group 4: Zinc oxide eugenol with Guttapercha

GROUP III- Positive control –teeth were not prepared not filled (intact tooth)

GROUP IV-Negative control-

- Sub group I: Teeth prepared using manual instrumentation and were not filled after instrumentation.
- Sub group II: Teeth prepared using rotary instrumentation and were not filled after instrumentation

Periodontal ligament simulation was done to reproduce the clinical situation and to provide accurate assessment of human root fracture strength. Fracture resistance of the tooth was tested using universal testing machine.

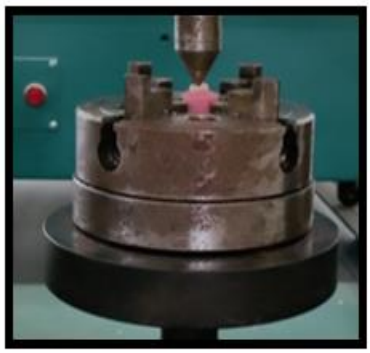
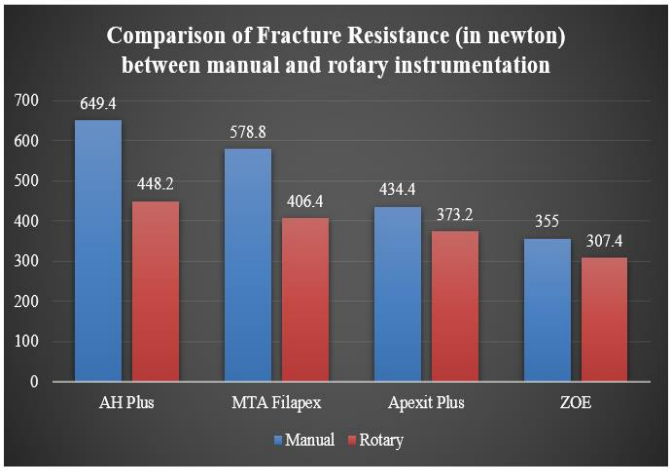


Fig 3: Specimen loaded under universal testing machine

Fig 4: Specimen after fracture

Results

The normality testing of data was done using Shapiro-Wilk test. The comparison of mean fracture resistance (in Newtons) of teeth with various root canal sealers was done using Analysis of Variance (ANOVA) followed by Tukey's post-hoc test for multiple comparisons. Comparison of fracture resistance using manual and rotary instrumentations was done using independent t-test. When the fracture resistance of the teeth prepared using manual instrumentation and rotary instrumentation was compared. The fracture resistance of the teeth prepared using manual instrumentation is found to be higher than that of rotary instrumentation and the results were statistically significant.



Graph 1

Discussion

Obturation of the root canal systems is done to achieve a three-dimensional, fluid tight or hermetic seal throughout the canal including the apical foramen and canal irregularities and minor discrepancies between the dentinal wall of the root canal and the core filling materials. Sealing ability, biocompatibility and antimicrobial activity probably influence the success of the root canal treatment. Mandibular premolars are narrower mesiodistally with an oval diameter in buccolingual direction. Moreover, they are located in the

transition zone of the dental arches, wherein they are more susceptible to compressive and shear stresses, thus making them ideal candidates for testing fracture resistance under load.[6] In present study, intact tooth showed highest fracture resistance of all the groups and was statistically significant because of the rigidity and integrity of tooth structure. In our study, teeth with AH Plus showed higher fracture resistance. This is due to the formation of covalent bond by an open epoxide ring to any exposed amino groups in the collagen. AH Plus has better penetration into the micro-irregularities because of its creeping property and long polymerization period, which increases the mechanical interlocking between the sealer and root dentine.[7] Nagas et al. [8] related fracture resistance of AH Plus to its low shrinkage while setting and long-term dimensional stability. It is resilient, and in combination to gutta percha, it forms a perfect seal with dentinal walls giving it a good strength and resistance to fracture. Reyes Carmona et al. [11], also showed that the apatite formed by MTA and phosphate salts is deposited among collagen fibrils, resulting in a controlled increase in the formation of inorganic nucleation on the dentine, which are seen in interfacial layer with tag-like features. The low fracture resistance of MTA fillapex than AH Plus might be due to lower adhesion capacity of tag like structures are related by Nagas et al.[8] and Amin et al.[12]Apexit Plus showed lower fracture resistance which may be due to greater solubility which leads to substantial breakdown in its seal, thereby hampering the sealing capability of the root canal sealer.[13] In the study by McMichen et al[14],it was seen that the solubility values for Apexit plus were approximately 200 times greater than that of AH Plus, which suggested that there may be substantial breakdown. Studies of Rotheir et al. [15],Siqueria et al.[16] and Limkangwalmongkol et al.[17], which stated that the physicochemical properties of calcium hydroxide based root canal sealers were equal to or slightly superior than of ZOE sealer.The fracture resistance of prepared unfilled group was lower than other sealer groups. This could be explained that the preparation of the root canal weakened the roots as the amount of remaining dentin thickness was reduced, and there was no filling material to reinforce the tooth structure. On intergroup comparison between the teeth instrumented with manual and rotary instrumentation. The fracture resistance of the teeth instrumented with manual instrumentation was found to be higher than the teeth instrumented with rotary instrumentation. The reason for lowered fracture resistance after rotary instrumentation is because of the increased risk of craze lines and dentin cracks as compared to instrumentation with hand files. Furthermore, instrumenting apical third with large sized and taper files has increased risk of reducing fracture strength of the teeth.

Conclusion

On intergroup comparison, the fracture resistance of the teeth instrumented with manual instrumentation showed higher fracture resistance than teeth instrumented with rotary files.

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