

A Comparative Evaluation of Fracture Resistance of Endodontically Treated Teeth Obturated with Different Root Canal Sealers - An In-Vitro Study

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Citation this Article: Dr. Anil K. Tomer, Dr. Shivangi Jain, Dr. Hysum Mushtaq, Dr. Lungdin Leima Cecilia, Dr. Sachin Poonia, Dr. Ayushi Khandelwal, Dr. Kanika, “A Comparative Evaluation of Fracture Resistance of Endodontically Treated Teeth Obturated with Different Root Canal Sealers - An In-Vitro Study”, IJMSIR- October - 2021, Vol – 6, Issue - 5, P. No. 30 – 35.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: The aim of this study is to compare the fracture resistance of endodontically treated teeth obturated using TotalFill® BC™, MTA-Fillapex and AH Plus sealers.

Materials and methods: 30 mandibular incisors were used in the study. The roots were prepared by using the ProTaper System. Obturation was done with single cone obturation technique of all experimental teeth. Then, the teeth were divided into three groups (n = 10) based on the type of sealer to be used. Group I: AH Plus sealer + GP, Group II: MTA-Fillapex sealer + GP and Group III: TotalFill BC sealer + GP. All teeth were embedded in acrylic resin blocks and fracture force was measured using a universal testing machine (Instron Corp., Canton, MA, USA) at a crosshead speed of 1.0 mm/min until the root fractured. The force required to

fracture each specimen was recorded, and the data were analyzed statistically.

Results: Group III showed higher resistance to fracture than other groups significantly. There was a non-significant difference in fracture force between Group I and Group II.

Conclusion: Based on this in vitro study, TotalFill bioceramic-based sealer was more effective when compared with other sealers. Clinical significance: The use of bioceramic sealer enhanced the fracture resistance of endodontically treated teeth.

Keywords: AH Plus, TotalFill bioceramic-based sealer, MTA-Fillapex, Fracture resistance.

Introduction

The strength of endodontically treated teeth depends on the remaining amount of tooth structure after canal preparation. Various factors affecting root fracture after

endodontic therapy are over instrumentation, dehydration of dentin, occlusal load, uncontrolled pressure during obturation¹⁻³ and synergetic actions of intracanal irrigants and medicaments may also influence the physical and mechanical properties of the root dentin, which may lead to fracture of endodontically treated teeth.⁴ Obturation materials are the key elements in supporting strength of the endodontically treated teeth. Gutta-percha and sealer, is the most commonly used root canal filling material, however, GP has a low elastic modulus than dentin, therefore has a little effect in reinforcing roots after root canal treatment.⁵ Therefore, the use of sealer with the ability to bond to the root canal dentin surface strengthens the remaining tooth structure, thus increasing resistance to fracture.⁶

AH Plus sealer (Dentsply, Konstanz, Germany) is an epoxy resin-based sealer. Its properties include easy handling, potential for better wettability of the dentin and GP surfaces and good sealing property due to their ability to penetrate dentinal tubule.⁷

MTA-Fillapex (Angelus, Londrina, Brazil) is a mineral trioxide aggregate (MTA)-based salicylate resin root canal sealer containing 13% MTA and salicylate resin. It has antimicrobial properties and is biocompatible.⁸ It has high radiopacity, low solubility, and low expansion during setting, cementum regeneration with good sealing property and bactericidal property. MTA-Fillapex releases free calcium ions (Ca²⁺) which help in the healing process by stimulating tissue regeneration.⁹

TotalFill (FKG Swiss Endo) sealer is a premixed bioceramic obturation material. It is dispensed using a syringe in cases of root canal obturation, and with either a syringe or as a putty when doing root repair and

retrograde fillings, TotalFill BC sealer forms hydroxyapatite upon setting and chemically bonds to both dentin and to bioceramic points (TotalFill BC Points). BC sealer is antibacterial during setting due to its highly alkaline pH and unlike traditional sealers and exhibits absolutely zero shrinkage.¹⁰

The aim of this study was to compare forces at fracture of endodontically treated teeth obturated with gutta-percha in conjunction with three different types of sealers (AH Plus, MTA-Fillapex, and TotalFill BC).

Materials and Methods

Thirty extracted human mandibular incisors with a single root canal were collected and stored in normal saline solution until use. The root surfaces were cleaned thoroughly. Radiographs were taken to confirm that each tooth had a single canal, no previous root canal treatment, and no root resorption. Each tooth was sectioned 1-mm coronal to the CEJ by using a cylinder diamond bur and access was opened to the root canal. A size 10 K-file (MANI) was placed into the canal until it was seen at the apical foramen. The working length was set 1-mm short of the root length. The teeth were randomly categorized into three groups of 10 teeth each as follows:

- Group 1: 10 teeth were instrumented and obturated with gutta percha in conjunction with AH Plus sealer (Dentsply DeTrey GmbH, Konstanz, Germany).
- Group 2: 10 teeth were instrumented and obturated with gutta percha in conjunction with MTA Fillapex (Angelus, Londrina, Brazil).
- Group 3: 10 teeth were instrumented and obturated with guttapercha in conjunction with TotalFill BC sealer (FKG Swiss Endo).

The teeth were instrumented to a master apical file size of F1 using crown down technique with ProTaper

rotary instruments by using a torque controlled and speed controlled Endomotor (X Smart DENTSPLY, Maillefer, Ballagigues, Switzerland). The speed and torque values were set as recommended by the manufacturer. Copious root canal irrigation using 5ml of 3 % sodium hypochlorite solution using a syringe and 27-gauge needle was performed after each instrumentation. Final flush with 5ml of 17% EDTA was done in order to remove the smear layer for 1-2 minutes. This was followed by a final irrigation with 5ml of 0.9% Normal saline. Each of the root canal specimens were dried with sterile Protaper paper points. The teeth were obturated with gutta-percha and three different types of root canal sealers. The sealers were mixed according to the manufacturer's directions and applied to the canal wall with a lentulo spiral (DENTSPLY Maillefer). Obturation was completed by placing sealer-coated single cone gutta-percha points (ProTaper -F1) (Dentsply Maillefer). Radiographs of the roots were then taken in both labiolingual and mesiodistal directions, and it was considered adequate if homogeneous guttapercha without voids could be observed. All roots were kept at 37°C with 100% humidity for 72 h to allow the sealer to set completely. The root surface of the samples were wrapped around by an aluminium foil to simulate the periodontal ligament. All the roots were then mounted vertically in copper blocks and filled with self-curing acrylic resin (Imicryl, Konya, Turkey), exposing 7 mm of the coronal parts of the roots. As soon as the acrylic hardened, blocks were removed from the copper blocks. A universal testing machine (Instron Corp, Canton, MA) 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 3mm. The tip was centred over the canal orifice, and slowly increasing vertical force was exerted (1 mm/min) until fracture occurred. The fracture moment was determined when a sudden drop in force occurred that was observed on the testing machine display. The maximum force required to fracture each specimen was recorded in Newtons. The data thus obtained was recorded, tabulated and subject to statistical evaluation. Analysis of variance was used to analyze the difference between various test groups. It was seen that there was a statistically significant difference within the groups ($P = 0.001$).

Results

The mean values and their respective standard deviations of the force required to fracture the roots are presented in Table 1. The mean fracture resistance using Universal testing machine was found to be highest in TotalFill BC Sealer (361.84+/-73.04) followed by AH Plus (299.93+/-63.27) and the MTA Fill apex (287+/-68.99).

On comparing the fracture resistance between the 3 groups of sealants, MTA Fill apex showed the least fracture resistance among all the groups. AH Plus sealer showed higher fracture resistance than MTA Fillapex but lower than TotalFill BC Sealer.

Table 1: mean, standard deviation values of each group

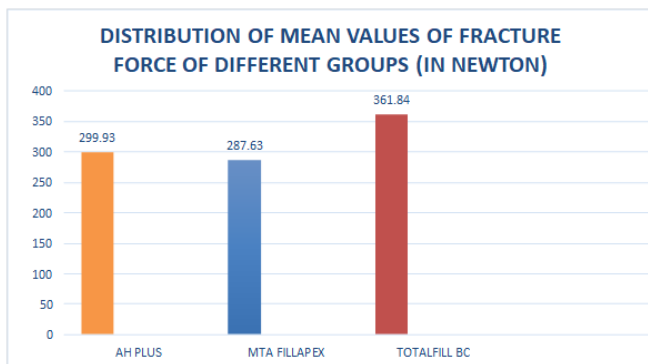
Groups	Mean	Std. Deviation	P Value
AH Plus	299.93	63.27	0.001
MTA Fillapex	287.63	68.99	
TotalFill BC	361.84	73.04	

$P < 0.05$ – Statistically Significant

Analysis of variance was used to analyze the difference between various test groups. It was seen that there was

a statistically significant difference within the groups ($P = 0.001$).

Fig. 1



Discussion

The current study compared three root canal sealers in terms of fracture resistance of root dentin. Based on the results, the highest mean fracture resistance of root dentin was seen in the Total Fill group followed by the AH Plus group and MTA-Fillapex group.

In this study, a root canal sealer reinforced endodontically treated teeth that had been weakened by preparation. Total Fill BC sealer showed significantly better results compared with the other sealers tested ($p < 0.05$). This may be explained as bio ceramic based endodontic sealers exhibit a chemical bond to the radicular dentin due to the production of hydroxyapatite throughout setting.¹¹ Another reason because of its hydrophilic nature, it has low contact angle, thereby allowing an easy spread over the canal walls.

Some studies have claimed the ability of different root canal filling materials to significantly strengthen the roots, where as in other reports these materials did not increase the fracture resistance of root filled teeth.

Cobankara et al.¹¹ reported that sealers exhibiting chemical bonding (such as bioceramic based sealers) enhances the fracture resistance of teeth. Topcuoglu et al.¹² stated that teeth obturated with a chemically

bonding Bioceramic sealer by using single cone technique showed significantly higher fracture resistance than AH plus sealer.

However, according to a study by Dibaji et al.(2017)¹³, bioceramic group showed less fracture resistance than AH Plus. This difference may be related to the differences in methodologies.

AH Plus is an epoxy based endodontic sealer that is used with gutta percha. It has good adhesion to dentin and to gutta percha. Neto et al.¹⁴ and Mamootil et al.¹⁵ showed that epoxy resin-based sealers had higher adhesion to root canal dentin and deeper penetration into dentinal tubules than zinc oxide-eugenol-based and glass ionomer-based sealers

Bioceramic-based materials have been introduced in endodontics mainly as repair cement and as root canal sealer. Studies have showed that bioceramics have enhanced biocompatibility, result in the increased strength of the root after obturation, have a high pH during the setting process (which is strongly antibacterial pH12), are easy to use, (particle size is so small it can be used in a syringe and they set quickly (three to four hours). Bioceramic root canal sealers also exhibit chemical bonding to root canal dentin walls. Therefore, Totalfill BC Sealer (Bioceramic Sealer), has the potential to adhere chemically to dentin decreasing the marginal leakage and gaps and increased fracture resistance of teeth.¹⁶

MTA Fillapex is the first MTA based salicylate resin sealer. It has suitable physiochemical properties such as good radiopacity, flow and alkaline pH. It has a working time of 35 minutes. It is a bioceramic type of sealer that is compatible with moisture and tissue fluids. It can readily set in presence of moisture and is

able to cause cementogenesis and thus helps in repair of apical tissue and is biocompatible.¹⁷

In the present study, the highest mean fracture resistance of root was seen in the TotalFill group followed by the AH Plus group and MTA-Fillapex group which showed the lowest mean fracture resistance compared with other experimental groups. However, further investigation is necessary to confirm the effect of sealers on fracture resistance.

Conclusion

Within the limitations of this study, it can be concluded that root canal sealers increased the fracture resistance of endodontically treated teeth, and the highest fracture resistance within the sealer groups was shown by TotalFill bioceramic, followed by AH Plus, then MTA-Fillapex. The use of bioceramic sealer may enhance the survival of weakened roots by enhancement of fracture resistance of teeth against vertical and horizontal root fractures.

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