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Fracture Resistance of Root Canal Dentin Using Resin Versus Bioceramic Based Sealers with different disinfection protocols

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Abstract

Background:

Root canal filling with obturating materials and sealers that can reinforce the tooth is a good manner to increase fracture resistance in endodontically treated teeth. Otherwise, tooth fracture can lead to extraction. Aims and Objectives: To evaluate the effect of different disinfection protocols on fracture resistance of root canal dentine using Resin Versus Bioceramic Based Sealers. Materials and Methods: A 42 extracted human teeth were decoronated 1 mm coronal to the cementoenamel junction with length 16 ± 1 mm. Mechanical preparation of the root canal were completed with M-Pro rotary Ni-Ti files using different irrigations. They were divided according to the sealers into two main groups: G1; gutta percha + AH Plus sealer, G2; gutta percha + MTA Fillapex sealer. Then each group subdivided into 3 subgroups using Sodium Hypochlorite (NaOCl), Chlorohexidine (CHX) and ethylenediaminetetraacetic acid (EDTA) irrigations. All samples were subjected to fracture resistance test using Universal Testing Machine (Lloyd LR 5K). Results: G1; AH Plus sealer with irrigation NaOCl had a higher fracture resistance than with CHX and EDTA irrigations. While in G2; MTA Fillapex sealer with EDTA irrigation had a higher fracture resistance than with NaOCl and CHX. Conclusion: both Sealers had no statistically significant effect on fracture resistance, while irrigation type had a statistically significant effect.

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Keywords:
AH Plus sealer, MTA Fillapex sealer, Sodium Hypochlorite(NaOCl), Chlorohexidine (CHX), ethylenediaminetetraacetic acid (EDTA), Fracture resistance (FR), Gutta percha (GP).

Introduction:

The main goal of the root canal treatment is the mechanical preparation by eliminating the components of the pulpal tissue, calcification and bacteria, the placement of a seal to prevent infection or re-infection and to promote healing of the surrounding tissues (1). In addition to cleaning, irrigation is a must. Complete root filling is done by three-dimensional obturation of the root canal system with the solid filling material to the endodontic sealer (2).

The most common irrigation is sodium hypochlorite (NaOCl). It has strong antibacterial effect, flushing of debris from the canal, ability to dissolve vital and necrotic tissues by breaking down proteins into amino acids by its free chlorine, antimicrobial action of the solution and the lubricating action (3, 4, 5). Chlorohexidine has a broad-spectrum antimicrobial activity and can provide a substantivity that can last up to 72 hours (6, 7). EDTA is a chelating agent that is used to remove the inorganic portion of the smear layer (8).

The Sealers act as barrier to avoid leakage of bacteria into or from the tooth. They are an important component in improving the bond between the dentinal walls and the obturation material and sealing of voids, patent accessory canals and multiple foramina. The goal is to obtain a magic seal after adequate cleaning and shaping of the canal. This hermetic and strong seal cannot be obtained without the use of a sealer because gutta percha does not bond to the dentin walls (9, 10). AH plus sealer was used because of its highest bond strength to dentin and GP. In addition, it had a great penetration into the irregularities because of its creep ability and long setting time, which increased the mechanical interlocking between sealer and root dentin so it increased the fracture resistance (11). MTA Fillapex sealer was used as it had an optimized flow due to the nanoparticles, excellent filling and sealing of the main and lateral canals. The nanoparticles leaded to a homogeneous mixture and better flow (12).

The purpose of this study was to evaluate the effect of different disinfection protocols on fracture resistance of root canal dentine using Resin Versus Bioceramic Based Sealers.

Material and methods:

42 extracted human teeth were used. They were divided into 2 main groups of 21 teeth per each group. Then each group were subdivided into 3 subgroups of 7 teeth per each one.

In this study, I used 2 types of sealers: AH Plus and MTA Fillapex with different irrigation protocols: chlorohexidine, sodium hypochlorite and ethylenediaminetetraacetic acid (Figure 1). Each tooth was decoronated 1 mm coronal to the cementoenamel junction by using a cylinder diamond bur under copious air water spray. All sectioned roots were adjusted to 16 ± 1 mm of root length. Cleaning and shaping of the root canals were completed with M-Pro rotary Ni-Ti files. Teeth were obturated with GP and two types of root canal sealers by using the lateral condensation technique. All samples were mounted in acrylic blocks. First, the apical one third of all roots were covered with wax to act as a thick layer to simulate a periodontal ligament. Then they are embedded vertically into cold cure acrylic resin and left to polymerize for one hour before starting the fracture test.

Samples of all groups were tested using Universal Testing Machine (Lloyd LR 5K). A pointed metal rod was attached to the upper fixed part of the universal testing machine to apply vertical force directly on the root. All teeth were loaded vertically until fracture occurred. The data was evaluated statistically using One-Way ANOVA and Tukey's Post Hoc tests to determine the level of significance between different groups.

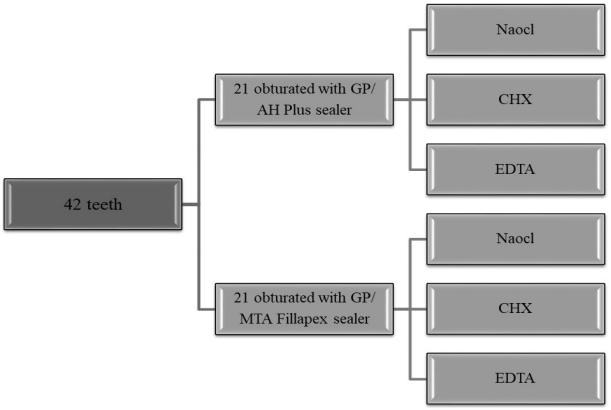

Figure (1): Classification of teeth

Result:

The mean and standard deviation values were calculated for each group in each test. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests, data showed parametric (normal) distribution (Figure 2).

One-way ANOVA followed by Tukey post hoc test was used to compare between more than two groups in non-related samples. Two-way ANOVA was used to test the interaction between the two variables (Figure 3).

1. **Effect of irrigation (Figure 4)**

A. AH Plus sealer: (Group 1)

A statistically significant difference was found between subgroup a (NaOCl) and each of subgroup b (CHX) and subgroup c (EDTA) where ($p<0.001$) and ($p=0.011$) respectively.

No statistically significant difference was found between subgroup b (CHX) and subgroup c (EDTA) where ($p=0.068$).

B. MTA Fill-apex sealer: (Group 2)

No statistically significant difference was found between subgroup a (NaOCl), subgroup b (CHX) and subgroup c (EDTA) where ($p=0.833$).

2. **Effect of sealer (Figure 5)**

A. Sodium Hypochlorite: (Subgroup a)

No statistically significant difference was found between group 1 (AH Plus) and group 2 (MTA Fill-apex) where ($p=0.316$).

B. Chlorohexidine: (Subgroup b)

A statistically significant difference was found between group 1 (AH Plus) and group 2 (MTA Fill-apex) where ($p=0.010$).

C. Ethylenediaminetetraacetic Acid: (Subgroup c)

No statistically significant difference was found between group 1 (AH Plus) and group 2 (MTA Fill-apex) where ($p=0.194$).

Variables	Fracture resistance				P-value
	AH Plus		MTA Fill-apex		
	Mean	SD	Mean	SD	
NaOCl	286.74	59.33	240.92	99.51	0.316ns
CHX	147.92	22.35	227.09	65.21	0.010*
EDTA	206.66	47.83	253.67	76.77	0.194ns
p-value	<0.001*		0.833ns		

Figure (2): The mean, standard deviation of fracture resistance in different groups

*significant ($p<0.05$) ns; non-significant ($p>0.05$)

Figure (3): Results of Two-way ANOVA for the effect of different variables on fracture resistance

Source of variation	Type III sum of squares	df	Mean Square	*F* - value	*P* - value
Sealers	7534.06	1.00	7534.06	1.72	0.200ns
Irrigation	40963.78	2.00	20481.89	4.66	0.020*
Sealers x Irrigation interaction	29482.97	2.00	14741.49	3.36	0.050ns

*df: degrees of freedom = (n-1), Significant at $P \leq 0.05$

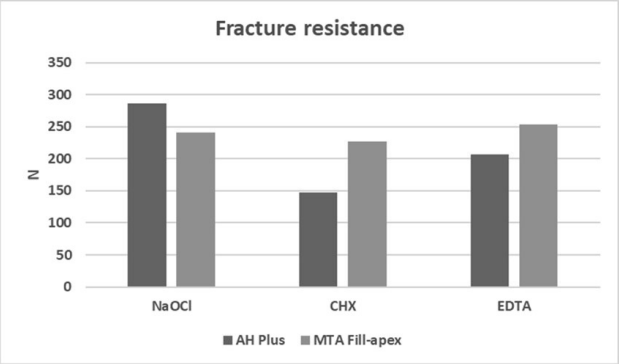

Figure (4): Bar chart representing fracture resistance of irrigations in different groups

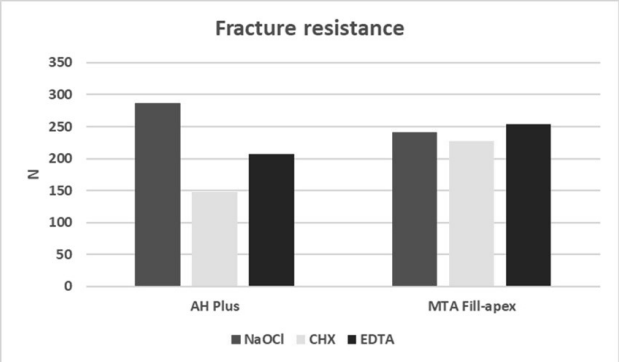

Figure (5): Bar chart representing fracture resistance of sealers in different groups

Discussion:

Cleaning and Shaping of the root canal and loss of moisture caused by the absence of pulp tissue can alter the mechanical integrity of endodontically treated teeth and decrease the fracture resistance of root [13]. Different irrigating protocols may affect the chemical and structural composition of dentin, so changing its solubility and permeability features. Therefore, affecting the adhesion of obturating materials to the dentin surface and fracture resistance [14].

In this study, I evaluated the effect of AH Plus and MTA Fillapex sealers after sodium hypochlorite, chlorohexidine and ethylenediaminetetraacetic acid irrigations on the fracture resistance of root canal. So, I can know which one made uniform stress distributions within the root and reduced fracture susceptibility.

The result was that different sealers had no statistically significant effect on fracture resistance. While irrigation type had a statistically significant effect on fracture resistance. The interaction between the two variables had no statistically significant effect on FR.

Many studies were agreed with these study results. Sagsen et al (2012) proved that MTA Fillapex and AH Plus sealers were the same in FR. They compared the fracture resistance of roots filled with GP and different root canal sealers. Teeth were grouped and subjected to compressive loading using a universal testing machine until fracture happened. Force was applied and recorded as fracture strength of specimen in Newtons. They found that there were no significant differences in fracture strength among the experimental groups [15]. Another study were agreed like Bayram et al (2015) compared the FR of roots filled with five root canal sealers. Teeth were subjected to FR test using an Instron testing machine. They found that no significant differences between groups. They concluded that all the root canal sealers increased the FR of root canals [16].

Studies that were disagreed with the results like Baechtold et al (2018) compared the FR of tooth crowns endodontically irrigated using different protocols. Teeth were grouped and irrigated with distilled water conventional irrigation with positive apical pressure, passive ultrasonic irrigation using continuous flushing and irrigation with positive apical pressure and heated Naocl solution. The force for fracture the crown was measured on a universal testing machine at an angle of 45°. They found that teeth subjected to irrigation with heated Naocl decreased resistance to crown fracture.

The difference may be due to the angle used for fracture, the number of sample or using heated Naocl that can reduce the effect of FR [17].

The type of root canal sealer and irrigation may affect the fracture resistance of the root canal. Therefore, further investigation is necessary to confirm the effect of each sealer on fracture resistance of root canal dentin.

Conclusion:

Bonding of endodontic sealers to the dentine wall of the root canal after obturation enhanced the fracture resistance of endodontically treated teeth. Although the number of samples in this invitro study was small but it was enough to conclude that:

- Both AH Plus and MTA Fillapex sealers had no statistically significant effect on fracture resistance.
- Different irrigation types sodium hypochlorite, chlorohexidine and ethylenediaminetetraacetic acid had a statistically significant effect on fracture resistance.
- No statistically significant difference was found between AH Plus and MTA Fillapex sealers with Naocl and EDTA irrigations.
- A statistically significant difference was found between AH Plus and MTA Fillapex sealers with CHX irrigation.
- A statistically significant difference was found between Naocl, CHX and EDTA irrigations with AH Plus sealer.
- No statistically significant difference was found between Naocl, CHX and EDTA irrigations with MTA Fillapex sealer.

Although the current results concerning the sealers and different irrigation protocols to reinforce the endodontically treated roots were favorable. Care should be taken in transferring these results to the long-term clinical situation. More studies and investigations should be done to prove if the results of this invitro was validated or not and also to know the fracture resistance of the materials used. On the basis of the present and previous studies, AH Plus sealer had many biological and sealing advantages than MTA Fillapex.

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