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RESEARCH ARTICLE

EVALUATION OF THE EFFECT OF DIFFERENT COMBINATIONS OF IRRIGATING SOLUTIONS AND CORE MATERIALS ON THE FRACTURE RESISTANCE OF ENDODONTICALLY TREATED TEETH.

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Abstract

Aim: The aim of this study is to evaluate the effect of using different irrigating solutions (EDTA and Sodium hypochlorite (NaOCL)) during root canal treatment combined with different composite core materials (Multicore Flow (MCF) and SonicFill (SF)) on the fracture resistance of endodontically treated teeth.

Material and Methods: 40 recently extracted mandibular first premolar teeth were selected. Teeth were randomly divided into two groups (n=20) according to the irrigating solution used during root canal treatment; Group I: EDTA, Group II: Sodium hypochlorite (NaOCL). Each main group was further subdivided into two equal subgroups (10 each) according to core material used; Subgroup A: Multicore Flow (Ivoclar Vivadent, Schaan, Liechtenstein) (MCF), subgroup B: SonicFill (SF) (Kerr, Orange, CA, USA). The force in newton (N) was applied obliquely to the buccal cusp tips utilizing a specially designed attachment at cross head speed of 0.5mm/ minute until fracture and the maximum loads at which failure occurred were recorded.

Results: no significant difference among the tested core material was recorded, however a significant difference with irrigating solutions was recorded where sodium hypochlorite significantly decreased fracture resistance more than EDTA with both core materials.

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Introduction:-

Elimination of the micro-organism in the root canal is one of the essential goals to regain health of the periapical tissues. A lot of intra-canal medications and irrigating solutions^(1,2) have been used for this purpose.

A lot of studies have been evaluated the effect of irrigating solutions like EDTA and sodium hypochlorite^(3,4) on the fracture resistance of root dentin combined with different obturating materials.

Effectiveness of irrigation and chemical debridement have been proved to be effective for the removal of the smear layer that is normally formed after root canal instrumentation and also during coronal cavity preparation⁽⁵⁾.

Removal of the smear layer is a must during root canal treatment not only for bacterial elimination and debridement but also for proper bonding with pulpal and coronal dentin to obtain optimum seal that is of a prime importance for optimum success and durability of root canal therapy ⁽⁶⁾.

Sodium hypochlorite (NaOCL) is a widely used irrigating solution among endodontists because of its antimicrobial power and soft tissue dissolving effect ⁽⁷⁾. In addition, EDTA had been used as an antimicrobial irrigation and chelating agent for inorganic materials in root canal therapy ⁽⁸⁾.

These changes made by irrigating solutions and both organic and inorganic materials of dentin affect the physical and mechanical properties of dentin ^(3, 9-11), and the bonding ability to both coronal and root canal dentin which in return affect the final fracture resistance of the whole tooth.

A variety of resin composite core build up materials recently have been introduced in the market with different viscosities. The low viscosity materials may have better adaptation and bonding to post ⁽¹³⁻¹⁴⁾ but have lower strength according to *Naumann et al*, ⁽¹⁵⁾. While high viscosity materials have lower adaptation and usually used in incremental technique but have better strength properties.

The effect of irrigating solutions on root dentin has been investigated in previous studies, yet these effects are also extended to the coronal dentin that was exposed to this irrigating solution during root canal treatment. In addition, it also affects bonding of core materials to the coronal dentin and hence the fracture resistance of the whole tooth may vary.

From this idea, the aim of this study came to investigate the effect of irrigating solutions on the mechanical properties of the whole tooth after using different resin composite restoration systems. So, this study was conducted to evaluate the effect of EDTA and Sodium hypochlorite combined with different viscosity resin composite core material as SF as high viscosity composite core and MCF as low viscosity composite core material on the fracture resistance of root canal treated teeth.

Materials and Methods: -

In the present study, two core build up materials with different viscosities were used, a low viscosity core build up material (Multi core Flow, MCF) that has been used with auto-mix syringe technique. While the other core material SonicFill (SF) (high viscosity material) – was sonically activated by air driven hand piece to lower its viscosity for better manipulation and adaptation. Materials used in the study with their composition and manufacturers were listed in table-1.

40 freshly extracted lower first premolar human teeth from teeth bank Faculty of Dentistry Ain Shams University were selected and stored in an aqueous solution of 5% chloramine-T at 4°C before use. Access cavity was done using diamond stone with round end (Mani). Stainless steel k-file (#15 taper 0.02%) was introduced in the root canal until its tip is visible at the apical foramen. Working length was determined visually by subtracting 1mm from the length. Cleaning and shaping was done using Twisted File (TF) #25 taper 0.04% in a crown down manner until reaching the working length.

Teeth were then randomly divided into two equal groups (n=20). Group#1 was irrigated during the instrumentation with 2.5% sodium hypochlorite and final flushing with 25ml for 5 minutes. Group#2 was irrigated during the instrumentation with 17% EDTA gel (Meta) and final flushing with 17% EDTA solution for 1 minutes.

Canals were then dried and obturated using thermo-plasticized continuous wave technique in each group with the corresponding taper of the master cone (Meta Gutta percha). AH+ resin sealer was used. Teeth were stored in 100% humidity for 2 weeks for the sealer setting.

Each main group was randomly subdivided into 2 equal subgroups (10 teeth each) according to the applied core material. Universal adhesive (Single Bond Universal™, 3M ESPE) was formerly applied following the manufacturers' instructions prior to application of either of the tested core materials.

Regarding subgroup A test samples, cavities were filled with Multicore Flow (Ivoclar Vivadent, Schaan, Liechtenstein) core material that was injected into cavity by the aid of a specific gun ³⁰. While for subgroup B test samples, SonicFill (SF) (Kerr, Orange, CA, USA) capsules were loaded to a specific hand piece and applied according to the manufacturers' instructions ³¹.

Roots of the tested samples were coated with a single layer of low viscosity rubber impression material (Imprint II, 3M ESPE, St. Paul, MN) to mimic the natural periodontal ligament. The coated roots were then embedded into acrylic resin blocks attempting to conduct the fracture resistance test. The buccal cusps of all restored sample teeth were obliquely stressed (at 45° inclination) till fracture by the aid of a round end rod on a universal testing machine (LLOYD Universal Testing Machine, LR 5K, Ametek / Lloyd Instruments) running at a crosshead speed of 0.5 mm/min. The maximum load at failure were recorded for each specimen and the collected data were statistically analyzed using both ANOVA and Tukey's comparisons at $\alpha = 0.05$ to determine the significance of the differences detected between subgroups.

Table 1:-Materials used in the study, compositions and manufacture

Core material	Description	Chemical composition	Manufacturer
Multicore Flow	Low viscosity dual-cured resin composite core material	Barium glass, silicon dioxide (5-10%), oxide, chemicals (10-30%), MPS (10-30%), silicon dioxide, EBPDMA (1-5%), bisphenol A bis (2-hydroxy-3 methacryloxypropyl) ether (1-5%), and TEGDMA (1-5%) (Filler 83.5 wt%)	(Ivoclar Vivadent, Schaan, Liechtenstein)
SonicFill	High viscosity, sonically activated bulk fill resin composite material	Glass, oxide, chemicals, 3-trimethoxysilylpropyl methacrylate, Silicon dioxide, ethoxylated bisphenol-Adimethacrylate bis-phenol-Abis-(2-hydroxy-3-methacryloxypropyl) ether, triethyleneglycoldimethacrylate	(Kerr, Orange, CA, USA)
17% EDTA	Irrigating solution	Ethylene Diamine Tetraacetic acid	
2.5% NaOCl	Irrigating solution	Sodium Hypochlorite	

Results:-

Means $\pm$ standard deviations (SD) for the effect of irrigant and core material on the fracture resistance of teeth are presented in Table-2. Two-Way ANOVA showed that the NaOCl caused statistically significant decrease of fracture resistance than EDTA solution. While SonicFill on the other hand, neither the core nor the interaction of the independent variables (irrigant and core material) had a significant effect on the fracture strength of teeth.

Table-2:-Means $\pm$ Standard Deviations (SD) and coefficient of variation (CV %) for the effect of irrigant and core material on fracture strength of teeth.

Core material	Irrigant		p
	Subgroup A (NaOCl)	Subgroup B (EDTA)	
	Mean $\pm$ SD	Mean $\pm$ SD	
Group I (MCF)	337.598 $\pm$ 36.67 (10.86%)	440.08 $\pm$ 75.86 (17.23%)	0.0001
Group II (SF)	359.07 $\pm$ 59.62 (16.6%)	460.54 $\pm$ 93.85 (20.37%)	0.001
P	0.354	0.683	

P = Probability for the effect of irrigant and core material.

Discussion:-

Regain of periapical health is a goal of endodontic treatment and it is mainly obtained by the elimination of bacteria through different steps of root canal treatment ⁽²⁾.

Chemo-mechanical disinfection during root canal preparation is a mandatory step for bacterial elimination. A lot of studies proposed different technique sequences for irrigation using the main two players in the irrigation solutions, NaOCL, EDTA ⁽¹⁶⁻²⁷⁾.

In agreement of our studies, short term exposure of EDTA to dentin caused the least weakness and the highest fracture resistance. This effect was statistically different than NaOCL that cause more weakening effect on dentin. This could be explained by the ability of EDTA irrigating solution in removal of smear layer without erosive effect which consequently increases the sealing effect and the bond strength of resin to dentin ⁽²⁷⁻²⁹⁾.

Some articles even showed that EDTA may increase the fracture resistance of the original dentin but here we have no control.

In this study, the results for low viscosity build up material (MCF) was not statistically significant than high viscosity build up material (SF) in term of fracture resistance of the whole tooth structure.

The effect of irrigating solution is not only affecting the apical dentin, but it is also extending to the coronal dentin. The interaction between the two irrigating solutions and the two build up material is not statistically significant and the only effective factor in the strength of the tooth within the limitation of this study is the dentin treatment rather than the restorative material.

Conclusions:-

Within the limitation of this study, it has been concluded that the dentin is the main role player in the fracture resistance of the tooth regardless the restorative material.

EDTA has a lesser weakening effect on the mechanical properties of tooth structure than NaOCL

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