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Effect Of Irrigants On The Fracture Resistance Of Endodontic Ally Treated Roots Of The Comparative Evaluation - An In Vitro Study

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Abstract

Background

Mechanical instrumentation produces a layer of debris on the root canal walls called the smear layer. To remove smear layer and to kill microorganisms, irrigating solutions are used. This process can causes changes in the microstructure of the dentin which affect the fracture resistance of teeth. Aim of this in vitro study to evaluate and compare the effect of final irritants such as 5.25% sodium hypochlorite followed by 17% ethylenediaminetetraacetic acid and Chloroquick on the fracture resistance of endodontic ally treated roots.

Material and Methods

After biomechanical preparation, teeth were randomly divided into three groups (n = 10) according to the type of final irritant used. Group I: normal saline (control); Group II: 5.25% sodium hypochlorite (NaOCl) +17% ethylenediaminetetraacetic acid (EDTA); Group III: Chloroquick solution. Final irrigation was performed using respected irritant for 5 min with syringe and needle. Thereafter, roots were obdurate with ProTaper Universal F3 Gutta percha and AH Plus sealer using a single cone technique. Fracture resistance of specimen was tested using Universal Testing Machine. Force necessary to fracture each root was recorded in Newtons (N). The peak load to fracture the sample was recorded. Results were evaluated statistically with one-way analysis of variance and *post hoc* Turkey test.

Results

Group I i.e. control showed the highest fracture resistance (753 ± 174.64) followed by Group III i.e. Chloroquick (714 ± 159.18). Least fracture resistance

was found with Group II i.e. 5.25% NaOCl+17% EDTA (689 ± 109.07).

Keywords

Chloroquick; Ethylenediaminetetraacetic acid; fracture resistance; smear layer.

Introduction

Successful endodontic therapy depends on the quality of instrumentation, irrigation, disinfection and three dimensional obscuration of the root canal system.[1,2] Biomechanical preparation is one of the most important factors for successful root canal treatment and determines the efficacy of all subsequent procedures. Mechanical instrumentation of the root canal either using hand or rotary instruments produce a layer of debris on the root canal wall called the smear layer.[3] This amorphous irregular layer contains both organic and inorganic components like vital or necrotic pulp tissue, odontoblastic process, microorganisms and dentin chips.[4,5]

Smear layer harbors bacteria which covers the prepared canal walls, occludes the orifices of the dentinal tubules and limits effective action of irritants and intracranial medicaments, so it is generally recommended that this smear layer should be removed.[6] Several methods have been recommended for removal of smear layer such as ultrasonic instruments, lasers and chelating agents.[6] The use of irritants during biomechanical preparation to clean all aspects of the root canal system, to remove smear layer, residual tissue and to kill microorganisms is central to successful endodontic treatment. Irrigation is complementary to instrumentation in facilitating the removal of pulp tissue and microorganisms.[7]

Sodium hypochlorite (NaOCl) with a concentration ranging between 1%-5.25% is the most widely used irritant in root canal treatment because of its antimicrobial activity and the capability to dissolve organic tissues but NaOCl alone does not effectively remove the smear layer.[8] Ethylenediaminetetraacetic acid (EDTA) is a potent chelating agent which removes inorganic portion of smear layer. Studies have shows that combination of 5.25% NaOCl and 17% EDTA is very effective in removal of smear layer.[9,10]

Etidronic acid or HEBP (1-hydroxyethylidene-1,1-bisphosphonate) has been suggested as a possible alternative to EDTA.[11] Recently, a new combination of 18% etidronic acid with 5% NaOCl has been commercially marketed as “Chloroquick” available in 2 vial system.

The final irrigation process can cause changes in the dentin microstructure and calcium to phosphorus ratio of the root dentin. Change in mineral content ratio of the root dentin may alter the original proportion of organic and inorganic components of the dentin. This can result in a reduction of modulus of elasticity and flexure strength which have a deleterious effect on the micro hardness and the fracture resistance of teeth.[12]

Hence, the aim of this in-vitro study was to evaluate and compare the ef effect of etidronic acid based irrigating solution with others irritants on the fracture resistance of endodontic ally treated roots.

Material and Methods

Sample selection

Thirty extracted human single-rooted mandibular premolar teeth for an orthodontic treatment purpose or periodontal purpose were used in this study. Teeth were stored in normal saline.

Teeth preparation

The crown of each tooth was sectioned perpendicular to the long axis of the root below the cement enamel junction using a diamond disc (Summadisk, Shofu Inc., Japan) under a water coolant so that the length of root was adjusted to 13 mm. Canals were negotiated with

stainless steel number 10 K file (Mani, Japan). Working length was established 1 mm short from the apical foramen.

Canal preparation technique

Each canal was prepared up to an apical preparation of #F3 in a crown down manner. During biomechanical preparation, the canals were irrigated with 2 ml of 3% NaOCl (Vishal dent care Pvt., Ltd., Gujarat, India) was used as an irritant after each instrument change in all experimental groups. This procedure was followed by irrigation with saline solution.

Final irrigation

The final irrigating solutions were delivered through 5 ml syringe (Becton Dickinson, India) and 27-gauge needle (Aman medical, Daman, India) within 1 mm of the working length for 5 min.

All specimen teeth were randomly divided into three groups according to the type of final irritant used.

- Group I control (n=10): 10 samples were irrigated with 5 ml of 0.9% normal saline solution (Merck Biosciences Ltd., Goa, India) for 5 min.
- Group II (n=10): 10 samples were irrigated with 2.5 ml of 5.25% NaOCl (Vishal Dent care Pvt. Ltd., Gujarat, India) followed by 2.5 ml of 17% EDTA (Prime Dental Products Pvt. Ltd., Maharashtra, India) for 5 min.
- Group III (n=10): 10 samples were irrigated with 5 ml of freshly prepared Chloroquick solution which is available in 2-vial system (Neelkanth Dental and Surgical Factory, Jodhpur, India) for 5 min.

Obturation

The specimens were dried with #F3 paper points (Sure-endo, Gyeonggi-do, Korea) and obdurate with ProTaper #F3 Gutta percha (Sure-endo, Gyeonggi-do, Korea) and AH Plus (Dentsply DeTrey, Konstanz, Germany) root canal sealer using a single cone technique. Excess coronal Gutta percha was removed with a hot ball burnisher 1 mm below canal opening and sealed with e-Temp (DiaDent). Specimens were stored in an incubator at 37°C and 100% humidity for 7 days to allow the sealer to set completely.

Fracture resistance testing

Specimens from all groups were prepared for test assembly. The apical 5 mm of roots were embedded along the long axis in self-curing acrylic blocks with 8 mm of each root exposed. Fracture resistance of the specimen was tested using a Universal Testing Machine. (Fig. 1) A custom made stainless steel loading indenter with a round tip (r = 2 mm) was used to deliver force directed along the long axis of the tooth. The load increased at the rate of 1 mm/min until fracture occurred. The fracture was evidenced by an audible crack and/or a sudden drop in load as seen on the graph. The peak load necessary to fracture each root was recorded in Newton (N).

The data were then analyzed statistically using one-way ANOVA and the inter group comparison of means was conducted using a *post hoc* Tukey's multiple comparison test. Significance was established at $p<0.05$ level.

Results

The mean fracture resistance and standard deviation values for all groups were listed in Table 1. Highest mean fracture resistance was recorded in the unprepared roots group, i.e., Group I (753 N). Among the tested groups the lowest mean fracture resistance was recorded in Group II (689 N) and more fracture resistance is shown by Group III (714 N). Statistically significant results were obtained. The difference in mean fracture resistance between the groups (I-II and II-III) was found to be statistically significant ($p< 0.05$) showed in Table 2.

Discussion

Complete removal of this smear layer causes penetration of medicaments and root canal filling materials into the dentinal tubules.[13] The main process that helps to remove this smear layer and other dentinal debris is irrigation. Combination of irrigants are recommended to remove organic and inorganic material from canal.[14] Current concepts of chemomechanical preparation suggest that chelating agents should be applied on instrumented root canal surfaces to remove the inorganic components of the smear layer.[1,2]

Biomechanical preparation was performed with ProTaper Universal rotary files in a crown down manner as this technique allows for adequate cleaning and penetration of irrigant to the apical third of the root canal. Single cone technique of obturation was used in the study as it excluded both the wedging forces of the spreaders during lateral compaction and the excessive dentin removal required to facilitate the plugger's insertion during vertical compaction.[15] To control volume and flow, all the samples were irrigated using needle and syringe technique.[10]

A custom made stainless steel fixture with circular tip of radius 2 mm was used to apply a compressive force in a vertical direction at the rate of 1 mm/min. Studies have reported that applying the force vertically to the long axis of the tooth transmits the force uniformly.[12] Therefore, in the present study, a single load to fracture was applied vertically to evaluate the fracture resistance of endodontically treated roots.

In this study, results showed that the Group I containing normal saline i.e. control group had the highest fracture resistance compared with other experimental groups. Saline was used as control (Group I) as it does not alter the Ca/P ratio of the root dentin.[16] Hence it showed significantly higher fracture resistance.

it results in excessive erosion of peritubular and intertubular dentine that decreases microhardness of root dentine and it also interacts with NaOCl decreasing its antimicrobial effect through reducing the free available chlorine.[11] Hence Group II showed significantly least fracture resistance. According to Deus G *et al*. 17% EDTA is stronger in smear layer dissolution, but it has erosive effects on dentin.[17] Cruz-Filho *et al* also reported that EDTA solutions at varying concentrations significantly reduce the dentin hardness compared with distilled water.[16]

Among all other study groups, the Group III containing Chloroquick showed the higher fracture resistance strength than Group II. 18% etidronic acid used in combination with 5% NaOCl without interfering its antimicrobial action.[18] It is also weak chelating agent and have minimum effect on Ca/P ratio. Therefore large intertubular dentin surface area is available for hybridization and it is less erosive than EDTA.[19] Hence Group III (Chloroquick) showed significantly higher fracture resistance than Group II. Dineshkumar MK *et al*. found that HEDP treated root dentin showed the highest microhardness and increased bond strength of resin based sealer to root canal dentin than EDTA.[20]

Conclusion

Within limitations of this study, it can be concluded that Chloroquick can be used as an alternative to combination of 5.25% NaOCl+17% EDTA with less impact on the mineral content and fracture resistance of root dentin.

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