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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF EFFECT OF 0.2% CHITOSAN, COMBINATION OF 5.25% SODIUM HYPOCHLORITE (NaOCL) AND 17% ETHYLENE DIAMINE TETRAACETIC ACID (EDTA) AS FINAL IRRIGANTS ON PUSH-OUT BOND STRENGTH OF MTA FILLAPEX-AN IN VITRO STUDY

Dr. Aishwarya T.N¹, Dr. Neel V. Hiremath² and Dr. DhanyaKumar N.M³

1. Master of Dental Surgery (MDS) in Conservative Dentistry and Endodontics.
2. Professor, Department of Conservative Dentistry and Endodontics, College of Dental Sciences, Davangere, Karnataka, India.
3. Professor and Head, Department of Conservative Dentistry and Endodontics, College of Dental Sciences, Davangere, Karnataka, India.

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Abstract

Context: The push-out bond strength of a sealer depends on removal of smear layer and its adhesion to dentin. This can be achieved by using potential final irrigants.

Aim: To evaluate and compare effect of 0.2% chitosan and 5.25% Sodium Hypochlorite (NaOCL) followed by 17% ethylene diamine tetraacetic acid (EDTA) on the push-out bond strength of MTA Fillapex.

Methods and Material: 45 single rooted mandibular premolar teeth divided into three groups where final irrigation was done using
Group 1 - 0.2% Chitosan for 1 minute
Group 2 - 5.25% NaOCL followed by 17% EDTA for 1 minute
Control group – 0.9% saline.

Obturation was done using MTA Fillapex sealer and cold lateral compaction technique. Two horizontal sections of each sample were tested using universal testing machine for push-out bond strength.

Statistical analysis used: Data was assessed using one way ANOVA with Tukey's post-hoc analysis.

Results: The results showed that both in coronal and middle third, irrigation with 0.2% chitosan showed higher push-out bond strength. In intra-group comparison, coronal third showed highest pushout bond strength compared to middle third.

Conclusion: 0.2% chitosan can be used as an alternative to NaOCL and EDTA as it effectively removes the smear layer without causing erosion of intra-radicular dentin.

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Introduction:-

The success of endodontic treatment depends primarily on the eradication of micro-organisms from the root-canal system and prevention of their reinfection. The root canal system is shaped with the help of stainless steel and nickel-titanium instruments. This shaping process is accomplished in conjunction with constant irrigation to remove

Corresponding Author:- Dr. Aishwarya T.N

Address:- H no 19, Aishwarya Villas, Kadapa Road, Tadipatri - 515411, Andhra Pradesh, India.

the inflamed and necrotic tissue, microbes/biofilms and other debris from the root-canal space.^[1] The irrigation protocol thereby plays a key role in the disinfection of the root canal space.^[2]

The smear layer consists of inorganic and organic substances. Decalcifying chelating agents are most commonly used to remove smear layer. Endodontic chelators detach the biofilms that adhere to root canal walls.^[3]

EDTA is the most commonly used chelator. It acts on the inorganic portion of root canal dentin and is used in 17% concentration. It causes dentin erosion depending on the concentration and duration of application. Hence, the requirement of a biocompatible agent as a chelator becomes very important.^[3]

It is said that Ethylenediamine tetraacetic acid (EDTA) alone cannot remove the smear layer. Hence proteolytic component like Sodium hypochlorite (NaOCL) should be used alternately for removing organic component.^[3]

Chitosan is a natural polysaccharide derived from the deacetylation of chitin from crab and shrimp shells and has several advantages like biocompatibility, biodegradability and bioadhesion and atoxicity to human body. It also has good chelating capacity for different metal ions due to its acidic nature.^[3]

It is well-known that chemicals used for endodontic irrigation cause changes in the chemical composition of dentin. Any change in the Ca:P ratio will change the microhardness, permeability and solubility characteristics of dentin and negatively affects the sealing ability and adhesion of dental materials.^[5]

Bioceramic is the term used for the materials that can be classified as bioinert, bioactive or biodegradable which consists of alumina and zirconia, bioactive glass, glass ceramics, calcium silicates, hydroxyapatite and resorbable calcium phosphates and radiotherapy glasses.^[6]

Calcium-silicate sealer like MTA sealer, MTA Fillapex (Angelus SolucoesOdontologicas, Londrina, Brazil) includes salicylates and resin. It is composed of nano-particulated resin, bismuth trioxide and MTA. It is radioopaque and has lesser solubility.^[7]

Push-out test is the method used to measure the bond strength of endodontic sealers which helps to evaluate the bonding between sealer and dentin.^[8]

Materials And Methods:-

Forty-five recently extracted human permanent single rooted mandibular premolar teeth which did not have any previous endodontic treatment or no signs of root resorption or no caries were selected (FIG-1).



Figure 1:- 45 Single Rooted Mandibular Premolar Teeth.

All the teeth were immersed in 5.25% NaOCL for disinfection for 30 minutes. After disinfection, teeth were kept in 0.9% normal saline at room temperature. All the anatomical crowns of teeth were removed till cemento-enamel junction (CEJ), perpendicular to the long axis of root with a diamond disc. Canals were negotiated with #10 and #15

K- files to ensure patency. The working length was determined subtracting 1mm from the measurement and all canals were instrumented using NeoEndo S rotary files of 0.04 and 0.06 taper.

After instrumentation, all the teeth were divided into 3 groups: (FIG – 2)

Control group (n=15): 5 ml normal saline for 1 minute as final irrigant.

Group 1 (n = 15): 5 ml of 0.2% Chitosan for 1 minute as final irrigant.

Group 2 (n=15): 5 ml of 5.25% NaOCL followed by 5 ml of 17%EDTA for 1 minute as final irrigant.

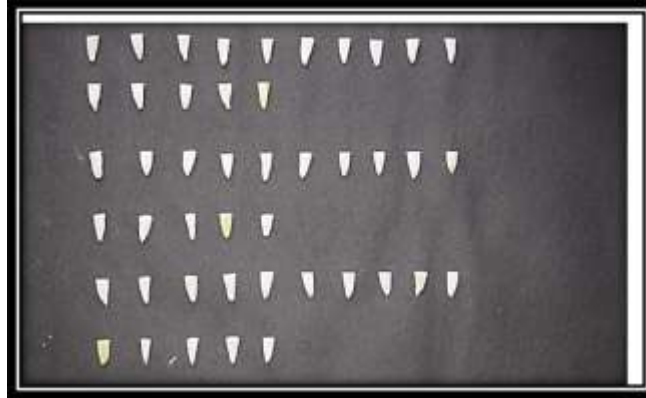


Figure 2:- Samples Divided Into 3 Groups According To Final Irrigation.

After irrigation, MTA Fillapex sealer was applied using a lentulospiral. Canals were obturated using gutta-percha cones by cold lateral compaction technique.

After obturation, the teeth were mounted in acrylic blocks and stored in 100% humidity at 37°C for 24h in an incubator. After incubation all teeth were sectioned at coronal and middle third of each 1 mm thickness resulting in 30 specimens in each group.

The samples were subjected to Universal Testing Machine (INSTRON) for push out bond strength test with indenter of diameter of 0.84 mm at a loading speed 0.5 mm/min (FIG -3). The amount of force applied to the material at the time of dislodgement was recorded in MPa for each specimen.



Figure 3:- Push-Out Bond Strength Using Universal Testing Machine.

Statistical Analysis:-

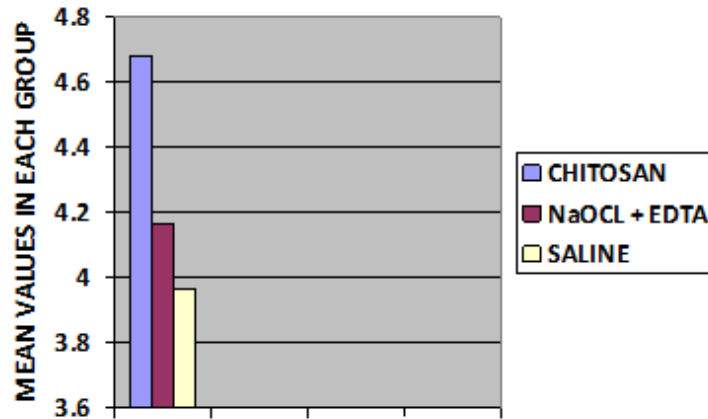
Statistical analysis was performed using SPSS software 21.0. Data was analysed using one-way analysis of variance (ANOVA) with post hoc analysis.

Results:-

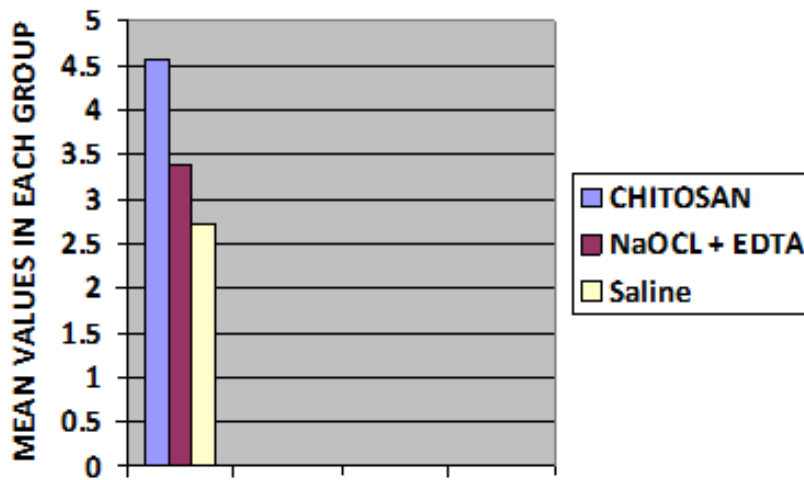
Group 1- (Samples treated with 0.2% chitosan) has shown the highest increase in push out bond strength while control group (Samples treated with saline) demonstrated the lowest push out bond strength. All the groups showed statistically significant difference (GRAPH – 1, 2).

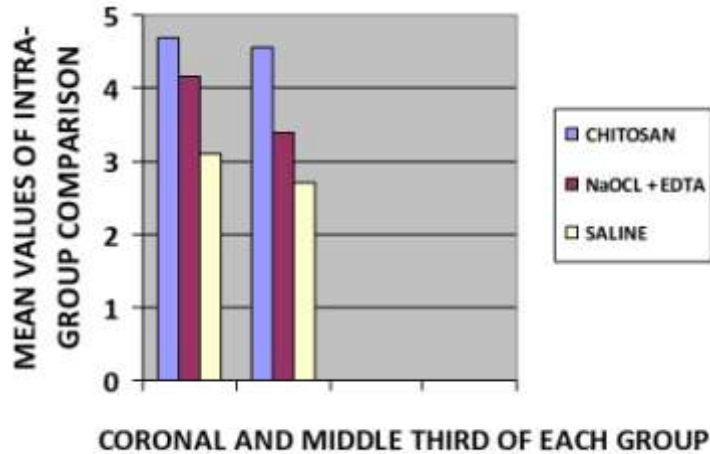
In all groups coronal third had greater push-out bond strength compared to middle third (GRAPH–3).

Graph 1:- Representing mean values in Coronal Third.



Graph 2:- Representing mean values in middle third.





Graph 3:- Representing intra-group comparison between coronal and middle third.

Discussion:-

Successful root canal treatment is dependent on the cleaning of the root canal system, the eradication of microbial organisms and filling the canal space with an inert root filling material to prevent the entering of microorganisms from the oral cavity and its spread to the periapical tissue.^[9]

During mechanical preparation, smear layer is produced which consists of superficial layer covering dentinal wall and a smear plug that occludes the dentinal tubules. Removing the smear layer allows for more cleaning and disinfecting of root canal walls and better adhesion of root canal sealers. Presence of smear layer seals the dentinal tubules and reduces the ability of bacteria from penetrating into the dentinal tubules.^[11]

Oksan et al., conducted a study on penetration of root canal sealers into dentinal tubules using SEM in which he stated that smear layer decreases the ability of sealer to penetrate the dentinal tubules.^[11]

The ability to clean an endodontic space and remove smear layer depends on chemomechanical preparation. There are many concepts on how to remove a smear layer, such as the use of different chelating agents, the volume and concentration of the solution used, ideal time required to eliminate smear layer without destructing the dentin matrix.^[12]

Chitosan is obtained by the deacetylation of chitin found in crab and shrimp shells and has become ecologically interesting for various applications because of its abundance in nature and low production costs.^[12]

It is a natural polysaccharide which is biocompatible, biodegradable and atoxic to human cells. Adsorption, ionic exchange, and chelation are proposed mechanisms for the chelating effect of chitosan¹⁵. It is a potential chelating agent like EDTA and NaOCl. Due to its high chelating capacity and low cost, it was preferred as an irrigant for the present study.^[12]

Darrag et al., has conducted a study on effectiveness of different final irrigation solutions on smear layer removal in intraradicular dentin in which he mentioned that a lower concentration of 0.2% chitosan is advantageous in removing smear layer without decalcifying effect of 17% EDTA.^[13]

Silva et al., conducted a study on chitosan and its ability to remove smear layer after root canal instrumentation in which he stated that moderate decalcifying effect of chitosan removed the smear layer with less erosion of intraradicular dentin.^[14]

Erosion can be avoided by using chelators at low concentrations chelators, i.e., 0.2% chitosan.^[20]

In this present study 0.2% chitosan was used as chelating agent in group -1 and the result showed it has highly significant push-out bond strength when compared to other two groups.

Ethylenediaminetetraacetic acid (EDTA) is the most extensively used chelator and acts on the inorganic portion of root canal dentin. It reacts with calcium ions of dentin resulting in calcium chelation. These agents interact with calcium ions which are present in the dentin wall and form calcium chelates.^[4]

Sodium hypochlorite (NaOCl) is a halogenated compound which is commonly used to irrigate the root canal during endodontic treatments which has antibacterial action, proteolytic and dissolution capacity and debridement properties.^[15]

McComb et al., conducted a study on endodontic chemomechanical instrumentation in which he mentioned that application of EDTA results in better opening of the dentinal tubules with less smear debris. 17% EDTA can decalcify dentin up to a depth of 20–30 μm .^[16]

Rahul.E.R et al., conducted a study on effect of different final irrigation protocols on push-out bond strength of an epoxy resin root canal sealer to the tooth dentin in which he stated that irrigation with combination of 5.25% NaOCl and 17% EDTA can expose the dentinal tubules further that allows better sealer penetration into the dentinal tubules.^[17]

In this present study, final irrigation with 5.25% NaOCl and 17% EDTA (group – 2) showed less significance on push-out bond strength when compared to final irrigation with 0.2% chitosan.

MTA-Fillapex is a two-paste MTA-based salicylate resin root canal sealer. It consists of resins, bismuth oxide, silica nanoparticles and dyes. It also has high sealing ability, bactericidal effect and biocompatibility, radioopacity, low solubility and low setting expansion.^[21]

Agarwal A et al., conducted a study on push-out bond strength of BioRoot RCS in which he stated that while using bioceramic sealers for obturation, final rinsing of root canals using chelating agents affects the dentinal walls and change proportion of calcium and phosphate, as calcium silicate sealers react with the calcium of the dentin for the biomineralization process further affecting their adhesion.^[18]

In this study 0.2% chitosan, 5.25% NaOCl and 17% EDTA were used to note the push-out bond strength of MTA Fillapex.

In this study all the samples were sectioned into coronal and middle third as the advantage of the sectioning is to standardize the size.

Naser SH et al., conducted a study on push-out bond strength of different obturating materials in which he mentioned that middle and apical dentin contain less dentinal tubules than coronal dentin and undergoes infiltration by itself compared to the sclerotic middle and apical dentin.^[19]

In this present in-vitro study, results showed that Group-1 (0.2% Chitosan) showed highly significant push-out bond strength when compared to other groups both in coronal and middle third. This might be due to NaOCl and EDTA would cause erosion of intra-radicular dentin, it would further weaken the teeth leading to decrease in push-out bond strength.

In Intra-group comparison between coronal and middle third, coronal third showed the highest push-out bond strength than middle third in all study groups.

Conclusion:-

1. 0.2% chitosan showed higher push-out bond strength when used as final irrigant in coronal and middle third.
2. In intra-group comparison, coronal third showed higher push-out bond strength.
3. 0.2% chitosan is a natural agent that effectively removes the smear layer without causing erosion of intra-radicular dentin.

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