Dedication

To my adorable Mother who provided
me with every mean of love, Tenderness,
patience, and support throughout my life.
My thanks and appreciations are to my
Husband for his support
and understanding

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Thanks to **Allah** first and foremost. I feel always indebted to God, the most kind and the most merciful.

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INTRODUCTION

Dentin is a highly mineralized tissue penetrated by tubules. This unique tubular structure makes dentin permeable to many substances. These tubules are the main pathway for irrigants and intracanal medication diffusion which can modify its permeability to help in root canal therapy. A variety of irrigant solutions have been used in endodontics in order to flush out loose debris, to lubricate the dentinal walls, to dissolve organic matter in the canal, and to have antimicrobial effects.

The currently available evidence is strongly in favor of sodium hypochlorite (NaOCl) as the main endodontic irrigant during instrumentation, so it has been used in this study as a primary irrigant. Chlorhexidine (CHX) and MTAD had been used as final irrigants. CHX has a broad spectrum antimicrobial action. MTAD represents an innovative approach for the simultaneous removal of smear layer and disinfection of the root canal system.

Successful root canal treatment depends also on the complete sealing of the canal space to prevent ingress of bacteria from the oral environment and spread to the periapical tissue. Adhesion of the root canal filling to the dentinal walls is important to eliminate any space that may allow percolation of

fluids between the filling and the canal wall. Gutta-percha does not bond to root dentin and therefore must be used in association with sealer cement to provide a bond between the core material and the root canal wall. Epoxy resin-based sealer cements such as AH Plus sealer have been widely used because of their acceptable physical properties.

In this study, we assessed the effect of CHX and MTAD as final irrigants on the dentin permeability and shear bond strength of AH plus sealer and evaluated the correlation between both.

REVIEW OF LITERATURE

Dentin permeability **after various endodontic irrigtants**

Fogel and Pashley[1] studied the effects of endodontic instrumentation, irrigation and potassium oxalate application on the permeability of root dentin. The permeability of human radicular dentin was measured as a hydraulic conductance before and after treatment with K files and before and after subsequent treatment of the endodontic smear layer with NaOCl, 50% citric acid, or 3% monopotassiummonohydrogen oxalate. The use of endodontic files created smear layers which produced modest reductions in the permeability of inner and outer root dentin. Sodium hypochlorite or saline application did not affect the hydraulic conductance of such smear layers but increased many times after treatment with 50% citric acid for 2 min. Application of potassium oxalate to radicular dentin resulted in dramatic reductions in hydraulic conductance below that produced by creation of smear layers due to the production of a crystalline precipitate.

Tao et al.[2] evaluated the sequential effects of endodontic procedures on the permeability of human root dentin in vitro. Forty single-rooted teeth were used. Both the crown and the apical 2 mm of the root were removed. The hydraulic

conductance of the root before and after various endodontic procedures was measured using a fluid filtration method. Measurements were also made of dentin thickness, intracanal diameter changes, and changes in intracanal surface area. The results showed that instrumentation by K files alone or in combination with Gates Glidden drills did not alter radicular dentin permeability when the cementum remained intact. After removing the cementum, the creation of a smear layer and smear plugs on the canal surface tended to offset the expected increase in dentin permeability created by increasing the intracanal surface area and decreasing root dentin thickness. EDTA treatment inside the instrumented canal to remove the smear layer did not increase permeability significantly. The use of K files followed by Gates Glidden drills tended to remove more cervical dentin, increased the intracanal surface area, and increased the hydraulic conductance of root dentin more than the use of K files alone.

Guignes et al.[3] analyzed the variation of hydraulic conductance measured in situ after three endodontic preparations (manual K+H files, ultrasonic preparation, and manual with NaOCI and EDTA). Scanning electron microscopic analysis of the canal walls was made to permit correlations between variations of permeability and the amount of surface covered

with smear layer or organic debris. There was an inverse relationship between the variations in dentin permeability and the presence of smear layer. The significance of this correlation was variable according to the techniques used. The use of EDTA induced considerable increase in radicular permeability while, the use of ultrasonics produced a similar but weaker effect. For the conventional technique, the alternate use of K- and Hedstrom files produced a decrease in radicular permeability that was much more marked in the apical zones than in the cervical.

Berutti et al.[4] studied the penetration ability of different irrigants into dentinal tubules. Dentinal tubules of human root canal walls were infected with a known bacterial isolate. The teeth were divided into two groups and the root canals instrumentated. Different types of canal irrigant were used for each group. In group A 5% NaOCl was followed by a 10% EDTA rinse and neutralized with a final physiological solution rinse. In Group B 10% EDTA, a tensioactive agent (TRITON), and 5% NaOCl were used in sequence, with a final physiological solution rinse to neutralize the action of the agents used. Histological examination of group A specimens showed a residual area of infection extending from the canal lumen to a mean depth of 300/~m Histological examination of group B

specimens showed an infection-free area of tubules to a mean depth of 130 /~m. Below this was an infected area of variable extent. In some group B sections, no infection was found.

Buck et al.[5] compared the efficiency of three endodontic irrigants in killing bacteria established within human dentinal tubules. Root canals in extracted teeth were prepared and sterilized. Broth cultures of *Enterococcus faecalis* were allowed to grow within the canals to penetrate dentinal tubules. The infected canals were exposed individually to each of the irrigants for 1 min. Irrigants were 0.525% sodium hypochlorite, Tubulicid (0.2% EDTA), and 0.12% chlorhexidine (Peridex). Sterile water was the control. Viable bacteria were analyzed by drilling incrementally into dentin from the cementum toward the canal. Shavings were cultured at three depths, for each of three root levels: coronal, midroot, and apical. They found that NaOCl had the greatest number of zero colony counts, followed by Tubulicid and then Peridex. The control, sterile water, had the greatest number of positive plates at all root levels and all dentin depths.

Carrasco et al.[6] studied dentin permeability quantitatively after the use of different irrigants into the pulp chamber, with or without ultrasonic activation, before the application of an internal bleaching agent. Thirty maxillary

anterior teeth, treated endodontically, were randomly assigned to six groups, according to the irrigant used: group I, distilled water; group II, 17% EDTA; group III, 1% sodium hypochlorite; for groups IV, V, and VI, respectively, the same solutions were used, but were ultrasonicated. In groups I, II, and III, the irrigant that filled the pulp chamber was left undisturbed for 15 s and was then aspirated; in groups IV, V' and IV, the irrigants were placed into the pulp chamber, ultrasonic-activated for 15 s, and were then aspirated. This sequence was repeated three times for all groups. Afterwards, for all groups, the pulp chamber was dried, filled with a bleaching agent, and sealed with glass ionomer cement. After staining, roots were removed at the cemento-enamel junction (CEJ) and sectioned in a mesiodistal direction starting from the cervical plug level. The sections were thinned, observed under an optical microscope. Statistical analysis showed that, regardless of the irrigant, ultrasonication increased dentinal permeability.

Giardino et al.[7] compared the surface tension of four common endodontic irrigants: Moltendo EDTA 17%, Cetrexidin, Smear Clear, Sodium hypochlorite 5.25%, with the surface tension of MTAD and Tetraclean. Freshly produced MilliQ water was used as a reference. Briefly, a glow-discharge cleaned glass slide was immersed in 5 ml of the test liquid in a

carefully cleaned glass beaker. The force on the glass slide was continuously recorded by the instrument software as the beaker was raised and withdrawn at the constant speed of 40 micron/s, until at least 1 cm of the glass slide was immersed. The liquid surface tension was calculated through an equation. MilliQ water, sodium hypochlorite 5.25%, and EDTA 17% had the highest surface tension, whereas those of Cetrexedin and Tetraclean have shown the lowest surface tension value. Both new irrigants, MTAD and Tetraclean, are capable of removing the smear layer. Their low surface tension increases their contact with the dentinal walls, so permit deeper penetration.

Pérez-Heredia et al.[8] compared ex vivo the decalcifying effect of 15% EDTA, 15% citric acid, 5% phosphoric acid and 2.5% sodium hypochlorite on root canal dentine. Two 2-mm-thick slices were cut from the coronal third of the root of 10 human incisors. Each slice was sectioned into two equal parts. Specimens were assigned to one of four groups (n ¼ 10) for immersion in 20 mL of either 15% EDTA, or 15% citric acid, 5% phosphoric acid or 2.5% NaOCl, for three time periods (5, 10 and 15 min). The concentration of Ca2+ extracted from the dentine was measured by atomic absorption spectrophometry. In the three time periods, 15% EDTA and 15% citric acid extracted the largest amount of calcium, with no significant differences

between them. The 2.5% NaOCl solution extracted insignificant amounts of calcium. They concluded that the solutions of 15% EDTA, 15% citric acid and 5% phosphoric acid decalcify root dentine, with most calcium extracted during the first 5 min of action. The efficacy of 15% citric acid and 15% EDTA solutions was significantly greater than that of 5% phosphoric acid solution at each time period; so they are more effective in smear layer removal during root canal preparation.

De-Deus et al.[9] studied the demineralizing ability of BioPure MTAD, 17% EDTA, and 5% citric acid on radicular dentin quantitatively and longitudinally. 3 mm thick disks were obtained at the root cervical third from 9 maxillary human molars, and a standardized smear layer was produced. Cosite images of the dentin surface were obtained after several cumulative demineralization times. Sixteen images were obtained in each dentin sample for each experimental time, at 1000× magnification. They concluded that the demineralization kinetics promoted by both 5% CA and BioPure MTAD was significantly faster than by 17% EDTA.

Ferreira et al.[10] studied the hypothesis that different conditions of contact with a dye solution would result in different levels of the impregnation by the marker agent in human radicular dentin. The root canals of 60 upper human

canines were immersed in methylene blue dye for 24 h under six different conditions: passive immersion; pre-agitation for 10 min using an endodontic ultrasound; pre-agitation for 10 min using a cleaning ultrasound; 25-mmHg vacuum for 10 min followed by passive immersion; 30-mmHg and 650-mmHg vacuum for 24 h. The roots were longitudinally sectioned and dye impregnation was assessed by a trained and calibrated examiner, using the Q 550 IW image analyser. The results revealed no significant difference among the different methods for dye impregnation. In the cervical third, impregnation with 30 mmHg was significantly more effective than with endodontic ultrasound or 25 mmHg. At the apical third, no differences were observed between any of the dye impregnation methods.

Bansal & Tewari [11] Compared the effect of sodium hypochlorite (NaOCl), chlorhexidine, povidone iodine and sodium ascorbate on dye penetration associated with various dentine adhesives used within the pulp chamber. One hundred and sixteen mandibular molar teeth were divided into eight groups of 12 teeth each according to the irrigation regimen and adhesive system. The roof of pulp chambers and roots were removed under water cooling. The pulp chambers in the experimental groups were irrigated with 5.25% NaOCl, 0.2% chlorhexidine, 5% povidone iodine or 5.25% NaOCl followed

by sodium ascorbate and restored with Surefil using either Prime & Bond NT or Xeno III with each irrigation regimen. Twenty teeth were used as negative control in which no irrigation was done. Ten teeth from each group were immersed in 2% methylene blue dye and assessed for dye penetration. Two samples in each group were observed under scanning electron microscopy for interfacial gap evaluation. No significant difference was found in dye leakage between control and groups with 5.25% NaOCl pretreatment with both adhesive systems. Chlorhexidine and povidone iodine pretreatment resulted in significantly less dye penetration with Xeno III as compared with Prime & Bond NT. Sodium ascorbate treatment following NaOCl application significantly reduced microleakage and improved the marginal adaptation with both adhesive systems.

Mozayeni et al.[12] studied the effectiveness of MTAD as the final irrigant to remove the smear layer, compared with that of 17% EDTA, both following root canal irrigation with 5.25% sodium hypochlorite (NaOCl). Fifty-five extracted maxillary and mandibular single-rooted human teeth were prepared by a crown-down technique using rotary 0.04 and 0.06 taper nickel titanium files. 5.25% sodium hypochlorite was used as the intracanal irrigant. The canals were then treated with 5 mL of