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Research Article

Comparison of the Effect of Different Irrigating Solutions on Bond Strength of Obturating Materials: An *In vitro* Study

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Abstract

Background: Success in endodontic therapy depends on debridement of the root canal system through the use of instruments and effective irrigating solutions. The aim of instrumentation and irrigation is to prepare a debris-free canal for subsequent obturation.

Aim: Comparison of the effect of different irrigating solutions on bond strength of obturating materials: An *in vitro* study.

Materials and Methods: Healthy sound caries-free premolars are included. Forty teeth were divided into four groups, *Azadirachta indica*, *Curcuma longa*, methyl ethylene diaminotetraacetic acid, and sodium hypochlorite (NaOCl) as irrigating solution. Roots were vertically placed in the center of blocks of resin. Sectioning was carried out horizontally. Three root sections of 2 mm thickness at 3, 7, and 11 mm from the apex were obtained. Each piece was further subjected to a compressive load through a universal testing machine. The push-out bond strength was calculated. Using one-way ANOVA test followed by *post hoc,* comparison of bond strength among four study groups was evaluated.

Results: Mixture of tetracycline, acid, and detergent has highest push-out bond strength among all 4.54 mpa. MTAD has highest pushout bond strength among all which is 4.54 mpa. Significant p value is 0.005 in the middle region. NaOCl has highest mean value than others. Pairwise comparison is done in coronal region. No significant results were found.

Conclusion: Hence, we can easily replace NaOCl with herbal irrigating material. However, natural alternatives such as *A. indica* and *C. longa* may prove to be more inert irrigating solutions.

Key words: *Azadirachta indica*, Irrigation, Mixture of tetracycline, acid, and detergent, Sodium hypochlorite

INTRODUCTION

Preservation of primary teeth is crucial for the harmonious development of occlusion, maintenance of arch length, an optimum function of chewing speech, and preservation of a healthy oral environment. Endodontic treatment is necessary when pulp is got contaminated by bacteria and their toxins.[1] Root canal preparation is a rudimentary step in endodontic treatment.[2] Successful root canal therapy is relying on the removal of microorganisms from the pulp canals, tissue remnants, and dentinal debris of the root canal system during chemomechanical instrumentation and irrigating solutions. Three-dimensional obturation along with microorganism free canals leads to a path of success for a dentist.[3]

Chemical debridement is needed for primary teeth for complicated internal anatomy and zones are out of

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reach to debridement, such as accessory canals, dentinal tubules that might be not reachable by instrumentation. The choice of materials in the pulpal therapy of primary teeth should be taken into consideration. Therefore, it is necessary to noticeably reduce or, to an extent possible, the microorganisms and their by-products present to the root canals using effective and biocompatible irrigants, which also helps in dissolving organic debris.[4]

Dentin microhardness is diplomatic toward composition and surface changes in tooth structure and the multiple chemical irrigants that are used tend to decrease microhardness. These changes may have a profound effect on the tooth's strength.[5]

Berutti *et al*. stated that solutions used as irrigation agents could penetrate about 130 μm into the internal surfaces of root.[6] However, bacteria may be present in the root dentinal tubules up to 1000 μm depths.[7] In clinics, different irrigating solutions have been suggested for deciduous teeth, such as sodium hypochlorite (NaOCl), chlorhexidine gluconate, ethylenediaminetetraacetic acid (EDTA), hydrogen peroxide, mixture of tetracycline, acid, and detergent (MTAD), and others.[8]

Byström and Sundqvist, 1985, stated that NaOCl is used as an endodontic irrigant as it is the most potent, easily available, and inexpensive and universally accepted irrigant which has an effective antimicrobial and tissue-dissolving capabilities.[9] It has low viscosity allowing easy introduction into the canal anatomy, an acceptable shelf life.

In the root canal treatment of deciduous teeth, NaOCl can damage permanent tooth buds, tissues, and oral mucosa. The major disadvantages of NaOCl are its cytotoxic effect if injected into the surrounding tissue, a foul smell, taste, and its ability for causing corrosion. It is also known to produce an allergic reaction.[10,11]

Herbal products have been used since ancient times in folk medicine, involving both eastern and western medical traditions. MTAD, *Azadirachta indica*, and *Curcuma longa* also show effective antibacterial and irrigating properties. Hence, it is very important to study and evaluate the new irrigating materials to achieve long-term, successful endodontic treatment. Endodontic literature has scrutinized the effect of many endodontic irrigants on the bond strength of various types of root canal sealers. Sealers can be used in association with core filling material as gutta-percha (GP).

The comparison of antibacterial efficacy has been evaluated, but there are very few studies that have evaluated their effect on dentin and obturating material. Hence, this study aims to compare the effect of the same. Hence, this study is needed to evaluate newer irrigating agents such as *C. longa*, *A. indica*, and methyl ethylene diaminotetraacetic acid (MTDA) with regard to their effect on dentin microhardness and bond between dentin and obturating material.

MATERIALS AND METHODS

The study was conducted on 40 extracted permanent teeth from the Department of Oral Maxillofacial Surgery, Bharati Vidyapeeth Dental College and Hospital, Deemed to be University, Pune, for dental treatment. Freshly extracted human permanent single-rooted premolars were taken for the study. Debris and soft-tissue remnants on the root surfaces were cleaned with a sharp scalpel and all teeth were stored in phosphate-buffered saline at until used. The selected teeth were stored in a jar filled with natural buffered thymol at room temperature.

Canal patency and working length were established by inserting K-file to the root canal terminus and subtracting 1 mm from this measurement. The root canals were instrumented. Each canal was enlarged to size #40 at the working length. Irrigation with 1 ml saline was performed between each file size. A total volume of 1 ml of each solution were inserted into the canal lumen in each root segment and left in place for 60 s exposure time.

Finally, the root canals were flushed with 5 ml distilled water after the completion of preparation.

The teeth were irrigated with material 1, material 2, and material 3, and material 4 as follows:
1. Group 1 – *A. indica*
2. Group 2 – *C. longa*
3. Group 3 – MTDA
4. Group 4 – NaOCl.

Preparation of Solutions

[Figure 1] *C. longa*: The rhizomes were washed with distilled water and dried. They were then cut into irregular large pieces and dried in an oven by tray drying process at a temperature of 45 ± 5°C for a period of about 9–10 days till they were completely moisture free. The irregular large-sized pieces were minced to form a rough powder. The maceration process of extraction is then performed on this coarse powder of the rhizomes. Two hundred and fifty grams g of coarsely ground powder of *C. longa* rhizomes were placed in two large glass chambers each. To one glass chamber, 1000 ml of sterile distilled water were added to prepare the aqueous extract. The glass chamber was locked with a glass lid to avert evaporation of the menstruum and this system was permitted to stand for 7 days with

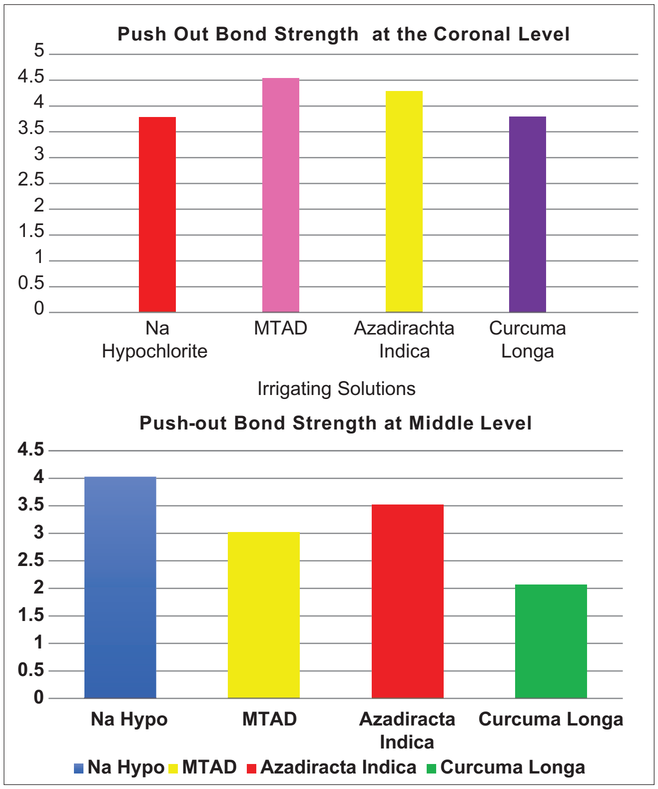


Figure 1: Materials used for this study

occasional stirring. The liquid, that is, the menstruum was then sieved and the solid residue, called marc, was bearing down on to retrieve as much occluded solution as possible. The strained and expressed liquid was mixed infrequently and purified using the filtration method [Figure 2]. The filtration was carried out in a beaker using a filter paper no 1. The menstruum obtained was stored in a refrigerator at 4°C in a beaker. China dishes were used for evaporation of the menstruum [Figure 3].

The irrigation procedure was accomplished using an irrigating syringe with a 27-gauge needle. All canals were dried with absorbent points. After mixing the AH plus sealer, a GP master cone was lightly layered with sealer and placed till the working length. A System B plugger size fine medium was used to condense the master cone to within 1 mm from the working length. The sectioned tooth was placed in 100% humidity for 48 h after coding to ensure the complete setting of the sealers. The tooth is sectioned horizontally using a microtome with constant fresh cooling water. Sectioning was implemented in a horizontal plane perpendicular to the long axis of the main canal. Three sections of 2 mm thickness were acquired at 3, 7, and 11 mm to represent apical, middle, and coronal third, respectively, from the root. The coronal surface of each section was coded and the exact thickness of each slice was measured with a Vernier caliper instrument. Each root section was then yielded to a compressive load through a

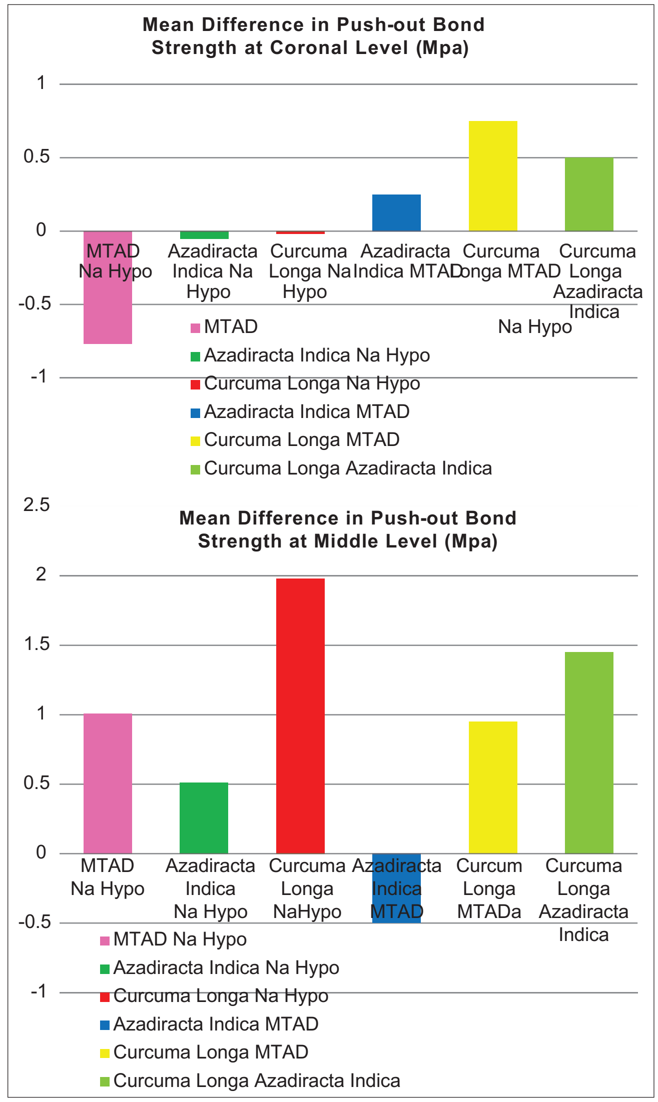


Figure 2: Filtration of curcuma lounga

Figure 3: Filtration of Azadirecta indica

universal testing machine. The plunger tip was positioned in such a way that it only contacted the filling material. The

Figure 4: Herbal extract

push-out force was applied in an apicocoronally direction until bond failure occurred, which was manifested by extrusion of the obturation material and a sudden drop along the load deflection. The maximum failure load was recorded in Newtons and it was used to calculate the push-out bond strength in megapascals.

MPa According to the Following Formula[10]

Push-out bond strength = Maximum load

Adhesion area of root canal filling (2 mm)

RESULTS

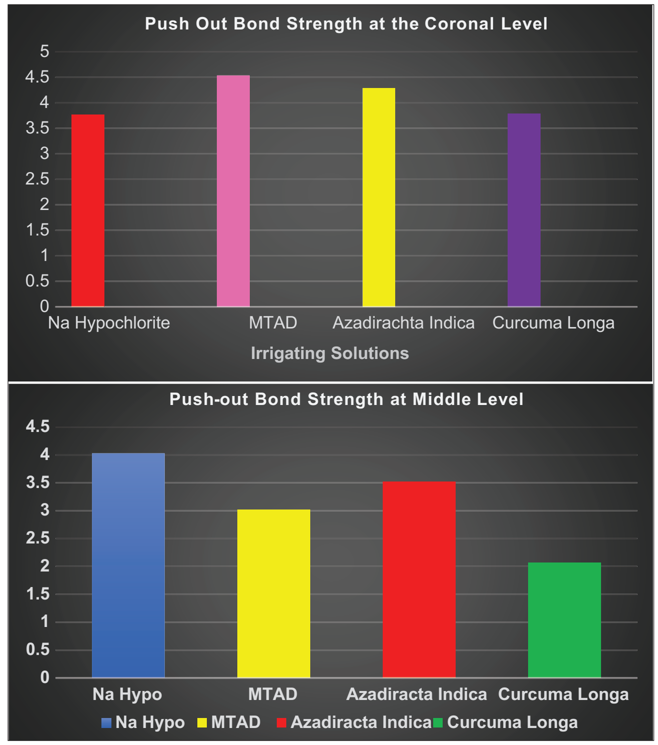
1. Machine specifications: Universal testing machine (computerized, software based)
2. Company: ACME Engineers, India. Model No. UNITEST-10
3. Accuracy of the machine: ±1%, crosshead speed: 1 mm/min
4. Area: Coronal: 8.16 mm^2, middle: 6.28 mm^2, apical: 5.02 mm^2

The mean values of bond strengths recorded for different groups for different areas are presented in Table 1 and Graph 1. MTAD yielded significantly the highest mean push-out bond strength at the coronal level (average 4.54 mpa) followed by *A. indica* and *C. longa*. On the other hand, the significantly lowest mean push-out bond was recorded for NaOCl (3.77 mpa) [Graph 2].

At the middle level, NaOCl shows the highest mean push-out bond strength. The apical sections of the specimen were not consideration as they were not fitting into the plunger. This is a drawback of this study.

Analyses of the push-out bond strength data indicated a statistically significant difference between the values of the differently treated groups and also within the groups. Using a one-way ANOVA test followed by a *post hoc,* comparison of bond strength among four study groups was evaluated. Pairwise comparison is done in the coronal region. No significant results are found. Significant p value seen in the middle area.

The pairwise difference was calculated which indicates a significant difference at $P \leq 0.05$. In between groups, Na hypo *C. longa* = mean diff is 1.98 and significant value is 0.004*. *A. indica* and *C. longa* mean value is 1.45 and significant diff is 0.027*. The maximum failure load was recorded in Newtons and it was used to calculate the push-out bond strength in megapascals [Figure 4].



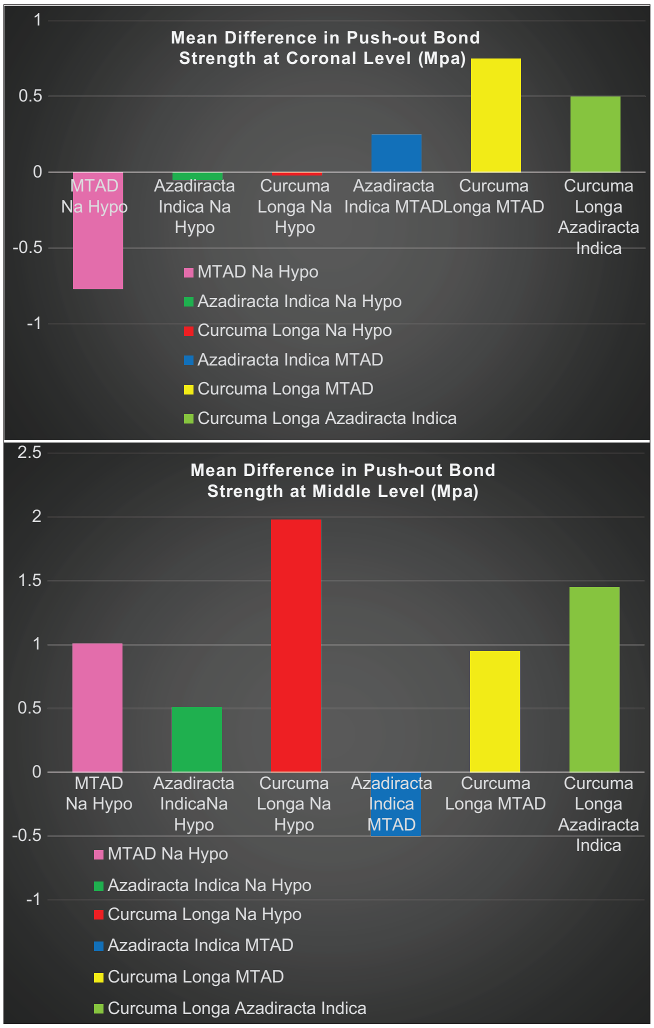
Graph 1: (a) Push out bond strength at coronal level, (b) Push out bond strength at middle level

Table 1: The mean values of bond strengths recorded for different groups

Average	Sodium hypo	MTAD	*A. indica*	*C. longa*
Coronal (mpa)	3.77	4.54	4.29	3.79
Middle (mpa)	4.02	3.02	3.52	2.07
Apical (mpa)	–	–	3.38	3.38

DISCUSSION

The main purposes of root canal filling are to avert leakage from the oral cavity and the periradicular tissue into the root canal system.[12] Dentin surface treatment with distinct



Graph 2: (a) Mean diff in push out bond strength (b) Mean diff in push out bond strength at middle level

irrigation solutions gives rise to a shift in the chemical and structural architecture of the human dentine, which may change permeability and solubility characteristics. These properties influence the bonding of materials to the dentin surface. Solubility characteristics affect the adhesion of filling materials to dentin surfaces. The clinical longevity of endodontically treated teeth depends on the effective adhesion of the obturating material to the dentin.[13,14] Lateral condensation was used currently as it is widely accepted as an obturation technique and resulted in higher bond strengths of the materials to root canal dentin.[15]

An ideal root canal sealer should adhere tightly to both dentin and core filling materials.[16] In the present study, it was found that the irrigation regimens influence the bond strength of the tested specimen. Therefore, suitable dentin substrate like AH Plus Sealers is required to provide the adhesion of hydrophobic materials.[17,18] Fisher *et al.* used sealers for evaluating their bond strength to the smear-free root dentin and found that AH Plus resin sealer had significantly higher bond strength compared with the other sealers available.[19]

The effective removal of the smear layer may enhance the adhesion of the AH Plus sealer with increased penetration of AH Plus sealer into dentinal tubules. It has been stated that good adaptation, penetration, and adhesion properties have a positive effect on sealing because of the increased surface contact between the sealer and dentin.[20] Bond strength testing is the most used method for determining the effectiveness of binding capacity between endodontic materials and tooth components.[21] As fracture occurs parallel to the dentine bonding interface, the push-out test is preferred to measure the bond strength, making it a true shear test for parallel sided samples. Push-out test permits root canal sealers to be evaluated even when bond strengths are low at different levels of root canal walls so we used to push-out bond strength for this study.[22]

Therefore, different irrigation regimens were used in the current study to examine their effect on the push-out bond strength of the AH Plus sealer with root canal obturation. Saleh *et al.* verbalized that the penetration of the endodontic sealers into the dentinal tubules when the smear layer was abstracted was not associated with higher bond strength.[16]

In the present study, the bond strength decreased from the coronal to the apical direction. Our result when compared with results from many studies juxtaposed that the binding ability of root canal sealers generally less in the coronal to the apical direction.[23] The shortness of approach to the end region of irrigation solutions and they result in incomplete extrapitation of the smear layer, due to that decrease the penetration of the sealer into the dentinal tubules and may affect the adhesion in the apical region.[24] The present results demonstrated that the push-out bond strengths for the coronal and middle root dentin were higher than that of the apical root dentin. This is probably because of insufficient volume or penetration of the irrigation into the apical portion of the canal. This was supported by Torabinejad *et al.* who show that MTAD is an effective solution for the removal of the smear layer and does not significantly change the structure of the dentinal tubules when canals are irrigated.[25] Moreover, Whitaker *et al.*[26,27] concluded that the structure of dentin in the apical region of human teeth, where the number of dentinal tubules was considered fewer than that in the cervical and middle dentine. The low number of dentinal tubules, the irregular structure of secondary dentin, and the presence of cementum like tissue apically on the root canal wall resulted in reduced penetration of adhesives into the apical root dentin collated to coronal.

This result is juxtaposed with results from several studies. It shows that the adhesion of root sealers is generally better in the coronal and middle regions.[23]

Torabinejad *et al*. introduced MTAD as a MTAD. They concluded that MTAD has shown that it is clinically effective and biocompatible with sustained antibacterial activity.[25]

The necrotic tissue-dissolving property of NaOCl is distinctive. Its activity increases with the concentration, temperature, and duration of application.[23] Many mishaps, such as the spattering of NaOCl into the patient's or dentist's eye, staining of the patient's clothes, extrusion of NaOCl beyond the apical foramen, unintentional injection of irrigants instead of anesthesia, or allergic reaction to the irrigation solution, can occur during root canal treatment. NaOCl is used in concentrations ranging from 0.5% to 5.25%; it is a vigorous antimicrobial agent and productively dissolves the remaining part of pulpal tissue and organic components of dentine. Farag *et al*. revealed that MTAD is a final irrigation solution when used with either NaOCl or CHX as irrigation solutions throughout instrumentation enhanced the bonding of obturation material to root canal dentin compared to EDTA solution. The current finding divulges that utilizing NaOCl throughout instrumentation and as a final rinse had significantly lower bond strength than compared groups. Hence, we can say why MTAD is better in the middle region than in NaOCl.[28]

Nikaido *et al*. commented that the use of NaOCl for irrigation was found to reduce the bond strength between the adhesive system and the dentinal wall. NaOCl is thought to remove debris from the dentin surface, thereby reducing the formation of the hybrid layer, which is required to achieve a dentin-adhesive link.[29]

NaOCl increased the wettability of root canal dentin so it might be the reason why MTAD shows the highest bond strength than NaOCl.[30] Sundaram *et al*. exclaimed that 5.25% NaOCl is more effective as irrigant when compared with neem leaf extract and honey.[31]

Deus *et al*. (2008) found no significant difference between EDTA and MTAD after the evaluation of bond strength but low bond strength in the NaOCl group. This may be claimed to the better cleaning efficacy of MTAD solution on the canal walls. Its active ingredient of 4.25% citric acid and the detergent Polysorbate 80, which decreased the surface tension, might allow MTAD to penetrate into dentinal tubules and enhance its effect on smear layer removal.[32] Wu *et al*. revealed that the effect of MTAD on smear layer removal was superior to EDTA.[33] It was also supported by Torabinejad *et al*.[35] and Adigüzel *et al*.[34] proved that the superlative results and excellent efficacy were associated with MTAD.

Herbal extracts such as *A. indica*, *C. longa*, *A. vulgaris*, and honey are well known for antimicrobial, anti-fungal, anti-inflammatory, antioxidant, antipyretic, and analgesic properties also they are less expensive hypoallergenic easily available, better tolerated and renewable in nature. The extract from neem bark, leaves, fruits, and flowers contains flavonoids, flavonoglycosides, dihydrochalcones, and tannins.[36,37] Although herbal irrigants have excellent biocompatibility and comparable antimicrobial properties as NaOCl, its ability to remove the smear layer is still lacking.[38]

CONCLUSION

In the recent past, there has been a shift from the recently used synthetic chemical substances to the natural herbal ingredients. Hence, we can easily replace NaOCl with herbal irrigating material. However, natural alternatives such as *A. indica* and *C. longa* might be more inert irrigating solutions. We can consider MTAD as a potent irrigating solution.

It could be inferred that within the limitations of this study:
1. MTAD has the highest push-out bond amongst all in the apical area
2. Middle sections showed higher bond strength values than the coronal and apical sections.

The present observations suggest that canal irrigation with various chemical solutions leads to structural changes as evidenced by the reduction of dentine microhardness.

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