

**Effect of Irrigants for Root Canal Treatment on
Bonding to Root Canal Dentin - *An Invitro Study***

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INTRODUCTION

The use of resin-based adhesive and restorative materials recently has become widely accepted for treatment of endodontically treated teeth. However, some solutions routinely used during endodontic treatment procedures may have an effect on bond strengths of resin based materials to root canal dentin.

Use of certain irrigants may not be compatible to the formation of an adequate bond between the Resin adhesive and the root canal dentin. Lack of formation of an adequate bond may lead to the failure of post endodontic restoration hence nullifying the effort of endodontic treatment.

Hence if the effect of irrigants on the resultant bond strengths between resin adhesives and root canal dentin are known the clinician can make an appropriate choice to select an irrigant, so as to avoid putting the post endodontic restoration in jeopardy.

'Eyes do not see what the mind does not know'

This study will hopefully be a step ahead in understanding the effect of irrigants for root canal treatment on bonding to root canal dentin. Bonding in recent context is an important step towards the complete success of endodontic treatment - that is a successful post endodontic restoration. And thus restoring endodontically treated teeth back into normal function.

REVIEW OF LITERATURE

In 1951³⁸ (as reported by Nakabayashi *et al.*,) **Dr. Oscar Hagggar**, a swiss Chemist developed an acidic glycerophosphoric acid dimethacrylate that permitted resin adhesion to dentin. It was observed that the bonded subsurface took up the haemotoxylin stain much more readily than the control groups.

In 1955³⁸ (as reported by Nakabayashi *et al.*,) **Buonocore** introduced the acid etch method to increase the adhesion of acrylic resin to the tooth surface. He used 85% orthophosphoric acid and produced a surface to which resin adhered.

In 1973,²⁸ **Henry Lee** and Colleagues, investigated the ability of acid etchants to penetrate dentin. Solutions containing 50% H₃PO₄ or 50% citric acid were applied in situations, which simulated clinical conditions. It only affected the treated surface (as observed after 5 minutes) as observed by calorimetric acid detection and SEM.

In 1979,³⁸ **Fusayame**, (as reported by Nakabayashi *et al.*,) introduced the concept of total etch technique of both enamel and dentin etching for non pressure adhesion of adhesive resin system.

In 1981,⁴⁶ **Pashley *et al.***, investigated the dentin permeability subsequent to smear layer removal. They derived the following conclusions.

- a) Use of dilute (6%) citric acid for very short time interval permits sequential removal of the smear layer on human dentin.
- b) Acid etching for as little as 5 seconds removes much of the smear layer and exposes the orifices of dentinal tubules.
- c) Dentin permeability increases rapidly during acid etching with

6% citric acid, reaching a maximum value only after 15 seconds of etching.

- d) production of smear layer on dentin during restorative procedures establishes a protective barrier. Removal of the smear layer by acid etching increase the permeability of dentin, which, under some condition must be regarded as a liability.

In 1984,²¹ **John Gwinnett** investigated the morphological consideration of the smear layer and observed that quantity and quality of such layering was influenced by the operating conditions. It was not firmly attached to or continuous over the substrate and was not conducive in the development and retention of the optimum bond strength with restoration materials. It was of necessity that this layer should be modified with compatible agents to aid in adhesion of restorative materials to tooth structures.

In 1984,⁹ **Bowen** and Colleagues, studied the removal and bonding considerations of smear layer. They observed that the intertubular collagen was seen to be denatured to a depth of upto 1 μ m with adhering debris being 0.1-1 μ m thickness. They also observed certain amount of microcracking of surface material (2-3 μ m deep).

In 1985,⁵ **Asmussen** and **Munkgaard** investigated the bonding to dentin promoted by aqueous mixtures of aldehydes and active monomers. They observed that on using adhesives based on HEMA and propionic aldehyde or HEMA and glutaraldehyde, higher tensile bond strengths were attained. The adhesive was seen to reduce the width of the polymerization contraction gaps between resin and dentin.

In 1985,³⁸ **Nakabayashi** stated that monomers which promote

adhesion not only to enamel but also to dentin have been formulated. They were seen to have a hydrophobic and hydrophilic groups. Chemical reaction between monomers and tooth substrate did not lead to adhesion. Cleaning of ground tooth to remove smeared layer with aqueous 10% citric acid and 3% ferric chloride prior to adhesion would promote the interpenetration of the monomers into the hard tissues, where methacrylates polymerize and shows good adhesion results.

In **1985**,⁵⁸ **Stanford** and Colleagues, investigated the effectiveness of dentin bonding agents and stated that tensile bond strength was seen to improve in two folds by using bonding agents requiring initial cleaning and etching of dentin.

In **1987**,³³ Meryon and associates investigated the smear removal agents invitro as well as invivo. They observed that in invivo EDTA was the most potent conditioner in removing the smear layer and opening up the orifices of the dentinal tubules, followed by acid conditioners. Invitro all acid conditioners caused increased smear layer removal and opening of the orifices of the dentinal tubules.

In **1988**,⁶ Asmussen and **Munksgaard** investigated the bonding of restorative resins to dentin. On the basis of their observations they divided dentin adhesives into calcium bonding and collagen bonding types. They observed that the two groups of bonding adhesives did not yield good tensile bond strength individually, but combination of certain calcium bonding and collagen bonding adhesives resulted in increased bond strength and smaller marginal gaps.

In **1993**,⁵⁷ **Tanaka J, Nakai H.**, in their study application of root

canal cleaning agents having dissolving abilities of collagen enhanced bonding of resin to dentin. Commercial root canal cleaning agents with the ability to dissolve collagen were used for the surface treatment to enhance the bonding of dental resins. These agents increased the bond strength of a dental bonding agent to dentin. The damage to the tooth surface was very small and was equal to or less than damage caused by EDTA. These results demonstrate the usefulness of commercial root canal cleaning agents for dentin surface treatment due to their ability to enhance the bonding of dental resin.

In 1994,¹¹ **Charlton D.G and Beatty M.W.** in their study "the effect of dentin surface moisture on bond strength to dentin bonding agents" compared the mean shear bond strengths of two dentin bonding agents to dry and to moist human dentin. This study indicated that for some current-generation dentin bonding agents, the presence of moisture on dentin surfaces does not compromise short-term bond strength.

In 1997,⁶² Vargas and Colleagues investigated the resin-dentin shear bond strength and interfacial ultra structure, with and without a hybrid layer, using 2 different adhesive systems. They observed that there was formation of hybrid layer in those specimen treated with both H_3PO_4 and NaOCl. There was no statistical difference in the shear bond strength values between all the groups. They concluded that the collagen layers may not be crucial to the mechanism of adhesion between resin and dentin. In fact this unsupported collagen layer may inhibit penetration of resin into the dentin substrate and undermine the long term durability of resin to dentin bond. Durable bonding may be facilitated by collagen layer removal, allowing more complete resin layer diffusion into the partially demineralized dentin.

In 1997,⁴⁷ **Pashley** and Colleagues reviewed the structure of dentin as it pertains to adhesive bonding and described the importance of resin impermeation into dentinal tubules and into spaces created between collagen fibrils by acid etching during resin bonding. They concluded that acid etching of dentin produced profound changes in the chemical composition and physical properties of the matrix which could influence the quality of resin dentin bonds, their strength and their durability.

In 1998,⁶⁵ **Jian Wu** *et al.*, evaluated the efficacy of 10% phosphoric acid conditioning for 'total etch wet-bonding' dentin bonding system on the calcium content in the dentin substrate. Efficacy of experimental contraction gap-free content in dentin was rapidly reduced by the 10% phosphoric acid conditioning. Complete marginal adaptation was seen in the experimental contraction gap free dentin bonding system. Since the primary requirement for dentin bonding is to maintain a high calcium content in the substrate its subsequent loss deteriorated the efficacy of the dentin adhesives. It was concluded that decalcification of the dentin wall by using dentin conditioners like 10% phosphoric acid should be avoided.

In 1999,⁴² **Nikaido T, Takano Y, et al.**, in their study "Bond strengths to endodontically-treated teeth", the purpose of which was to evaluate the bond strengths of three different types of resin bonding systems to teeth prepared for endodontic treatment. The root canals were chemically irrigated with saline (control), 5% sodium hypochlorite, 3% hydrogen peroxide, or combinations of both for 60s. Results showed statistically lower ($p < 0.05$) bond strengths in the chemical irrigation groups compared with the control groups.

In 1999,⁵¹ **Pioch T, Kobaslija S**, in their study "Interfacial

micromorphology and tensile bond strength of dentin bonding systems after NaOCl treatment". The objective of this study was to test the hypothesis that NaOCl treatment of acid - etched dentin would not lower the tensile bond strength of adhesive resins, but would eliminate the hybrid layer. After etching with phosphoric acid, 75 dentin samples were pretreated with 10% NaOCl. The other 75 samples were etched only with phosphoric acid and were kept as controls. Composite was bonded to the pretreated surfaces with a bonding resin. Results showed in NaOCl - treated samples, hybrid layers were not visible.

In 1999,⁵³ **Saleh A.A and Ettman W.M.** in their study "effect of endodontic irrigation solutions on microhardness of root canal dentin" evaluated the effect of several endodontic irrigation solutions on the microhardness of root canal dentin combination of 3% H₂O₂, 5% NaOCl; and 17% EDTA solutions were used in this study. They concluded that both H₂O₂ /NaOCl and EDTA irrigating solutions significantly reduced the microhardness of root canal dentin.

In 1999,⁴² **Nikaido et al.**, analysed the effect of chemical irrigation for endodontic purposes on dentin bonding. This study demonstrated that 5% NaOCl, 3% H₂O₂ and their combination adversely affected the bond strengths to dentin, and adhesive failures between the resin and dentin increased in the groups treated with oxidant compounds compared with the control group (Saline). It is possible that conformational changes in collagen and proteoglycans induced by oxidant radicals may influence the penetration or polymerization of resin-bonding materials.

In 2000,¹⁷ **Ferrari M, Mannocci F, et al.**, in their study "Bonding to root canal: structural characteristics of the substrate", showed that the

dentin surface area available for bonding increased after etching. The increase in dentin surface area might be responsible for the enhanced bond strength.

In 2000,³⁹ **Nakajima M, Kanemura N, et al.**, in their study "Comparative microtensile bond strength and SEM analysis of bonding to wet and dry dentin", compared bond strengths of resins to acid-etched wet vs. dry dentin. Moist dentin produced high bond strengths with all bonding systems and created thicker, acid/NaOCl-resistant hybrid layers.

In 2000,⁵⁸ **Tasman F, Cehreli A.C, Ogan C, Etikan I.** in their study "surface tension of root canal irrigants" evaluated the surface tension values of established and potential endodontic irrigants to which a surface active agent had not been added. The results showed that distilled water had the highest surface tension values, whereas those of NaOCl (2.5% and 5%) and 17% EDTA were relatively low. A low surface tension agent should penetrate tubules better.

In 2000,^{49a} **Perdigao J. et al.**, in their study "effect of a sodium hypochlorite gel on dentin bonding" determined the effect of a commercial 10% NaOCl gel on the dentin shear bond strengths and HL (Hybrid layer) ultra-morphology of two simplified dentin adhesives. Two total-etch adhesives systems namely Prime and Bond NT (Dentsply Caulk); and Single Bond (3M Dental Products Division). The increase in the NaOCl application time resulted in a progressive decrease in shear bond strengths for dentin adhesives.

In 2001,⁴¹ **Ngoh E.C., Pashley D.H. et al.**, in their study "Effects of eugenol on resin bond strengths to root canal dentin", compared the regional bond strengths with or without treatment using a eugenol -

containing endodontic sealer liquid. The specimens treated with the eugenol liquid had significantly lower bond strengths than those without eugenol ($p < 0.05$).

In 2001,²⁰ **Gaston B.A., West L.A., Pashley D.H. et al.**, in their study "Evaluation of regional bond strength of resin cement to endodontic surfaces", tested the feasibility of adapting a new microtensile testing technique to measure resin cement bond strength to the cervical, middle, and apical thirds of root canals. Post spaces were created in extracted human teeth and the roots were ground flat on one side to expose the canal and permit ideal placement of one of two resin cements (panavia 21 or C & B Metabond). After 48 hours of storage, serial 1-mm thick cross sections were cut to create 6-10 specimens per root. The first three specimens were from the cervical third, the next three were from the middle third, and the last three were from the apical third of the root. Each 1 x 1 x 8mm specimen was pulled to failure in a miniature testing machine. The results indicated that both resin cements produced high bond strengths (12 - 23 MPa). They concluded that this new method shows promise for evaluating resin bond strengths within root canals.

In 2001,¹⁶ **Ferrari M, Vichi A, et al.**, in their study evaluated the influence of four adhesive procedures in resin tag, adhesive lateral branch and resin dentin inter diffusion zone formation when used to bond fiber posts. Results showed that microbrush might clinically be used for bonding fiber posts into the root canal. When a microbrush was used, the bonding mechanism created between root canal dentin and bonding system was uniform along canal walls and more predictable.

In 2001,¹⁵ **Ferrari M, Watson T.F.** in their study evaluate the bond

strength of two dentin-bonding systems to root canal dentin. The results showed that the bond strengths of the two bonding systems to dentin of the root canal were slightly lower than to those obtained with the latest adhesive systems, in the coronal dentin.

In 2001,⁴⁴ **Ogata M, Okuda M, Nakajima M, et al.**, in their study "Influence of the direction of tubules on bond strength to dentin". Showed that tensile bond strength of the group with tubules parallel to the bonded interface was higher than that of tubules cut perpendicularly.

In 2001,³⁵ **Mitizi D. Morris, Kwang-Won Lee, et al.**, in their study "effects of sodium hypochlorite and Rc-Prep on Bond strengths of resin cement to endodontic surfaces", showed that use of sodium hypochlorite (NaOCl) and RC-Prep may lower the bond strength of resin cements. The results demonstrated that both 5% NaOCl and RC-Prep produced significantly ($p < 0.05$) large reductions in resin-dentin bond strengths, and the reduction could be completely reversed by the application of either 10% ascorbic acid or 10% sodium ascorbate.

In 2001,²³ **Hatice Dogan, and Semra Calt**, in their study "effects of chelating agents and sodium hypochlorite on mineral content of root dentin", showed that the effects of combined and single use of EDTA, RC-Prep, and NaOCl on mineral content of root dentin were evaluated invitro using energy dispersion spectrometric microanalysis. Levels of calcium, phosphorus, and magnesium were measured in the root dentin after treatments. The results showed that (i) EDTA combined with NaOCl irrigation as final flush and NaOCl alone changed the calcium/phosphorus ratio of root dentin significantly ($p < 0.05$) and (ii) there was a significant increase in the magnesium level after the use of chelating agent combined

with NaOCl ($p < 0.05$). In conclusion they said the use of NaOCl irrigation as final flush altered the effectiveness of chelating agents on root dentin surface. The use of EDTA and RC-Prep alone did not change the mineral content of root dentin significantly.

In 2002,¹⁰ **Calt S, Serper A.** in their study "time - dependent effects of EDTA on dentin structures", evaluated the effects of EDTA on smear layer removal and on the structure of dentin, after 1 and 10 min of application. The results showed that 1 min EDTA irrigation is effective in removing the smear layer. However a 10 min application of EDTA caused excessive peritubular and intertubular dentinal erosion. They suggested that this procedure should not be prolonged more than 1 min during endodontic treatment.

In 2002,¹ **Alejandro Oyarzun, DDS, Ana M. Cordero, & Marta Whittle,** in their study "Immunohistochemical evaluation of the effects of sodium hypochlorite on Dentin Collagen and Glycosaminoglycans" tested that whether if 5% NaOCl produces structural and molecular alterations in the collagen and glycosaminoglycans of mineralized and demineralized dentin. The results of this study suggest that 5% NaOCl induces alterations in dentin collagen and glycosaminoglycans and show the protective role of hydroxyapatite on organic matrix stability. The results of this study suggested that the use of a 5% commercial solution of NaOCl produces an important alteration of demineralized-intertubular collagen and intratubular GAG. Moreover, the data demonstrate the protective role of minerals against the destructive effects of oxidant compounds on dentin extracellular matrix macromolecules.

In 2002,⁵⁴ **Simone Grandini, Piero Balleri, and Marco Ferrari,** in their

study "evaluation of Glyde file prep in combination with sodium hypochlorite as a root canal irrigant", confirm that irrigation with sodium hypochlorite alone is not able to totally remove the smear layer, because its action is mainly directed to the organic debris. To obtain the total removal of the smear layer, both organic and inorganic components, the combined use of sodium hypochlorite and EDTA is recommended.

In 2003,³ **Ari H, Yasar E, et al.**, in their study "Effect of NaOCl on bond strengths of resin cements to root canal dentin", showed that microleakage occurs due to the lack of sealing ability of root sealing materials or adhesive cements used to lute post-core materials. This may cause premature failure of endodontic treatment. The purpose of this study was to evaluate regional bond strengths of four adhesive systems to root canal dentin. Sixteen extracted human single rooted teeth were used. 5% NaOCl used as irrigant. Out of NaOCl treated and non-treated groups, C & B Metabond also had significantly higher bond strength compared with Variolink II and Panavia F groups when the canals were irrigated with NaOCl ($p < 0.05$).

In 2003,⁸ **Bouillaguet S, et al.**, Studied the microtensile bond strength between adhesive cements and root canal dentin. They showed that stresses from polymerization shrinkage and problems with adequate access to the root canal complicate the formation of high-strength bonds when cementing endodontic posts with resin cements.

In 2003, **Menezes Ac., Zanet C.G., et al.**, in their study "Smear layer removal capacity of disinfectant solutions used with and without EDTA for the irrigation of canals: a SEM study". The purpose of this study was to carry out a scanning electron microscopic (SEM) analysis of the cleaning

qualities and smear layer removal from root canal walls, instrumented and irrigated with 2.5% NaOCl, 2.0% chlorhexidine and saline solutions. Fifty extracted teeth were used in this study. During root canal preparation, irrigations were made with the different solutions being evaluated: group 1: 2.5% NaOCl (10 Roots); Group 2, 2.5% NaOCl and 17% EDTA for 2 minutes (10 roots); Group 3 : 2.0% chlorhexidine (10 roots); Group 4: 2.0% chlorhexidine and 17% EDTA for 2 minutes (10 roots); Group 5: saline solution (5 roots); Group 6: saline solution and 17% EDTA for 2 minutes (5 roots). When EDTA was not used, a significantly higher quantity of smear layer on the apical third was observed only in the NaOCl groups. The use of 17% EDTA was significant for debris removal except for the chlorhexidine groups. The following conclusion could be drawn: the use of 17% EDTA was necessary to enhance cleanness of the root canals.

In 2003,⁶⁶ **Yamashita J.C, Tanomaru Filho M, et al.**, in their study "Scanning electron microscopic study of the cleaning ability of chlorhexidine as a root-canal irrigant" stated that the apical third of the root canals was not cleaned as well as the middle and coronal thirds. Cleaning by chlorhexidine and saline was inferior compared to the cleaning by sodium hypochlorite with and without EDTA.

In 2003,¹⁸ **Foxton R.M, Nakajima M, et al.**, in their study "bonding of photo and dual-cure adhesives to root canal dentin", adhesive resin (Clearfil Liner Bond 2V Bond A) was applied to two of the groups and light cured for 20 seconds. A dual-cure adhesive resin (Clearfil Liner Bond 2V Bond A+B, Kuraray Medical Co, Japan) was applied to the remaining three groups, one of which was light cured. Light exposure of both the adhesive resin and resin composite resulted in significantly higher micro

tensile bond strength than chemical-cure alone ($p < 0.05$). Light exposure also significantly increased Knoop hardness at both the coronal and apical regions ($p < 0.05$). When the bonding resin and dual-cure resin composite were chemically-cured, failure occurred cohesively within the resin. Photo-initiated polymerization of the adhesive resin and dual-cure resin composite was necessary to achieve good bonding to root canal dentin, which was not dependent upon region.

In 2003,²² **Hale Ari, Erdem Yasar, and Sema Belli**, in their study "effects of NaOCl on Bond Strengths of Resin Cements to root canal dentin" evaluated regional bond strengths of four adhesive systems to root canal dentin. The root canals were instrumented and irrigated with or without 5% NaOCl. The root canal dentin walls were then bonded with C & B Metabond, Panavia F, Variolink II, or Rely - X. Microtensile bond strengths to root canal dentin were then measured using an instron machine. In this study, 5% NaOCl reduced the bond strengths to dentin of all resin cements by 18% except for Rely-X. In addition, sodium hypochlorite breaks down to sodium chloride and Oxygen. Oxygen from such chemicals causes strong inhibition of the interfacial polymerization of resin bonding materials. The generation of oxygen bubbles at the resin-dentin interface may also interfere with resin infiltration into the tubules intertubular dentin. In conclusion, the results of this study indicated that a self-adhesive cement (C&B Metabond) showed higher bond values compared with dual-cure resin cements (Panavia F, Olink II, Rely-S).

In 2004,^{13a} **Erdemir A, Eldeniz A.U, et al.**, in their study "Effect of solvents on bonding to root canal dentin" evaluated the effect of two gutta-percha solvents (chloroform versus halothane) on microtensile bond

strength to root canal dentin. The results revealed that water-treated roots had significantly higher resin-dentin bond strengths compared with chloroform or halothane treatment groups (control: 23.9 MPa; chloroform: 18.3 MPa; halothane: 17 MPa; $p < 0.05$). Gutta-percha solvents have an adverse effect on bond strengths of adhesive cements to root canal dentin.

In 2004,³¹ **Lopes G.C., Cardoso Pde C**, in their study "Microtensile bond strength to root canal vs pulp chamber dentin: effect of bonding strategies". Aimed to compare the microtensile bond strength between root canal and pulp chamber dentin with two bonding strategies (self-etching primer and total-etch technique). They concluded bonding to pulp chamber dentin seems to be more predictable than to root canal dentin. In the former region, the total - etch technique may result in a higher bond strength.

In 2004,⁴ **Ari H, Erdemir, et al.**, in their study "Evaluation of the effect of endodontic irrigation solutions on the Microhardness and the Roughness of root canal dentin", evaluated the effect of 0.2% chlorhexidine gluconate on the microhardness and roughness of root canal dentin compared with widely used irrigation solutions. The results indicated that all the irrigation solutions except chlorhexidine significantly decreased microhardness of root canal dentin ($p < 0.05$) ; 3% H₂O₂ and 0.2% chlorhexidine gluconate had no effect on roughness of the root canal dentin ($p > 0.05$). Chlorhexidine gluconate seems to be an appropriate endodontic irrigation solutions because of its harmless effect on the microhardness and roughness of root canal dentin.

In 2004,³² **Mannocci F, Pilecki P, et al.**, in their study "Density of dentinal tubules affects the tensile strength of root dentin", the results suggested that high values of tensile strength of the dentin are associated

with low densities of dentinal tubules and that apical areas of root dentin are more resistant to tension than coronal ones.

In 2004,⁴⁵ **Ozturk, Bora, Ozer, Fusun**, in their study "Effect of NaOCl on Bond strengths of Bonding Agents to Pulp Chamber Lateral Walls" evaluated the effects of 5% Na OCl on bond strengths of four bonding systems - Clearfil SE Bond, Prompt L-Pop, Prime & Bond NT, and Scotchbond Multi Purpose Plus - to Pulp chamber mesial walls. Forty mandibular third molar teeth were used in the study. The pulp chambers of the first 20 teeth were restored with bonding agents and composite resins after 5% NaOCl irrigation, and the remaining teeth were restored without 5% NaOCl treatment. NaOCl application decreased the bond strength values of the bonding agents.

In 2004,¹⁴ **Erdemir Ali, Ari Hale, Gungunes, Hakan Physics, Belli, Sema**, in their study "Effect of Medications for Root Canal Treatment on bonding to Root canal Dentin". The results indicated that NaOCl, H₂O₂, or a combination of NaOCl and H₂O₂ treatment decreased bond strength to root canal dentin significantly ($p < 0.5$). The teeth treated with chlorhexidine solution showed the highest bond strength values ($P < 0.05$).Formocresol and Ca(OH)₂ did not effect bond strength to root canal dentin.

SUMMARY

30 extracted human maxillary central incisors were chosen for this study. the teeth were instrumented upto size 70 and irrigated with various irrigants and categorized into 6 groups of 5 teeth each.

Group I - The teeth were irrigated with distilled water for 60 seconds.

- Group II - The teeth were irrigated with EDTA for 60 seconds.
- Group III - The teeth were irrigated with 3% NaOCl for 60 seconds.
- Group IV - The teeth were irrigated with H₂O₂ for 60 seconds.
- Group V - The teeth were irrigated with H₂O₂ and NaOCl for 60 seconds.
- Group VI - The teeth were irrigated with 0.2% Chlorhexidine for 60 seconds.

The samples were glued to the metal heads of long screws using cyanoacrylate cement and each specimen was stressed in tension (on universal testing machine - instron 4301) until failure. The load at failure for each sample were recorded in MPa. Results were tabulated and analyzed using one way test of variance (ANOVA) and student - Newman - Keuls test.

CONCLUSION

- . Maximum tensile bond strength was observed in canals treated with 0.2% chlorhexidine gluconate.
- . Least bond strengths were seen in groups treated with H₂O₂, NaOCl and combination of NaOCl & H₂O₂.
- . EDTA did not show significantly higher bond strength than control group.

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