THE EFFECT OF FOUR ENDODONTIC IRRIGANTS ON THE SHEAR BOND STRENGTH OF A SELF ETCH RESIN BASED SEALER TO DENTIN- AN INVITRO STUDY

Dissertation submitted to

THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY

In partial fulfillment for the degree of

MASTER OF DENTAL SURGERY

BRANCH IV : CONSERVATIVE DENTISTRY & ENDODONTICS

APRIL 2012

R A J A S D E N T A L C O L L E G E
RAJA NAGAR, KAVALKINARU - 627 105, TIRUNELVELI DISTRICT.

DCI Recognition No.DE-3 (44) - 93/2246, dated 09/11/1993
Affiliated to The Tamil Nadu Dr. M.G.R. Medical University, Chennai.

DEPARTMENT OF CONSERVATIVE DENTISTRY & ENDODONTICS

CERTIFICATE

This is to certify that this dissertation entitled "**The Effect Of Four Endodontic Irrigants On The Shear Bond Strength Of A Self Etch Resin Based Sealer To Dentin- An Invitro Study**" is a genuine work done by **Dr. Arun Mathew Thomas** under my guidance during his postgraduate study period between 2009-2012.

This dissertation is submitted to THE TAMILNADU Dr. M. G. R. MEDICAL UNIVERSITY, in partial fulfillment for the degree of **MASTER OF DENTAL SURGERY in CONSERVATIVE DENTISTRY & ENDODONTICS – BRANCH IV**. It has not been submitted (partial or full) for the award of any other degree or diploma.

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ACKNOWLEDGEMENT

I thank this opportunity to express my sincere and heartful gratitude to my postgraduate teacher and guide **Dr. R. Jonathan Emil Sam**, Professor and Head, Department of Conservative Dentistry and Endodontics, Rajas Dental College, for his inspiring guidance, constant encouragement, advice, unlimited help and kind support throughout the course of this study as well as during my entire course.

I owe my sincere thanks to co-guide **Dr. Arvind Kumar**, Reader, Dept of Conservative Dentistry and Endodontics, Rajas Dental College, for having reviewed my work and for his support, valuable guidance and supervision during the preparation of this dissertation.

I thank **Dr. Suresh Mohan Kumar. V**, Asst. Professor, **Dr. Bejoy John Thomas. J**, **Dr. KashiVishwanath. P, Dr. T. S. P. Ram Balaji, Dr. RenjithBabu, Dr.Anoop Samuel**, Senior Lecturers, Department of Conservative Dentistry and Endodontics, Rajas Dental College for their advice and suggestions throughout this study.

I express my deepest gratitude to all those who contributed directly or indirectly to bring the dissertation to this form.

It’s my extreme pleasure to thank Mr. Kurian Mathew Abraham for statistical interpretation of the data.

I whole heartedly wish to thank my parents and my wife for their patience, constant support and encouragement in every step of my dissertation.

Above all, I thank Almighty Lord for giving me strength and courage to undertake this project and complete.

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Introduction

In root canal therapy, Guttapercha combined with various sealers has been the most commonly used obturating system and they have served as a bench mark when evaluating newer materials.[1] It has been seen from previous studies and clinical data that canals obturated with Guttapercha and endodontic sealers were unable to prevent apical migration of bacteria when the canals were exposed. The main reason cited being the relatively weak adhesion of root canal sealers to dentin. This has led to a continuous quest for alternative sealers (or) techniques that bond simultaneously to the canal wall dentin, as well as to the root canal filling material like Guttapercha which has been the gold standard for root canal filling materials. Yet, there has been sporadic attempts made for the use of low viscosity resin composites and dentin bonding agents as sealers in combination with root filling materials. But the earlier claims on the potential advantages of bonding to root canals were modest. After the era of self priming, self etching and self adhesive resin luting technologies in restorative dentistry, functionally analogous low viscosity methacrylate resin based root canal sealers have since been available for use in endodontics with the claim that the root filling material adheres to the methacrylate resins. The most recently introduced self adhesive bondable root canal sealers are also associated with

the additional benefits of reduced application steps and overall improvements in their user friendliness.[40]

In addition to sealers, intracanal irrigants are an important adjunct in enhancing the effectiveness of cleaning and shaping. The traditional and most commonly used irrigant is Sodium hypochlorite in its various concentrations. Its excellent properties of tissue dissolution and antimicrobial activity make it the irrigating solution of choice for the treatment of teeth with pulpal necrosis even though it has several undesirable characteristics such as tissue toxicity , risk of emphysema when there is extrusion, allergic potential and disagreeable smell and taste.[26]

Another popular intracanal irrigant used is 2% solution of Chlorhexidine gluconate. Chlorhexidine gluconate is a bisguanide with amphiphatic and antiseptic properties. Chlorhexidine gluconate is antimicrobial and biocompatible. However the use of Chlorhexidine gluconate as an endodontic irrigant is generally restricted because it can discolor teeth and some patients have reported side effects such as loss of taste, burning sensation of the oral mucosa, subjective dryness of the oral cavity and discoloration of the tongue.[26] Moreover one of its significant disadvantage is that it lacks tissue dissolution ability.

The constant increase in antibacterial strains and the side effects caused by synthetic drugs and the spurt in popularity of herbal medicines has prompted several researches to look for herbal alternatives. The Polynesians have used the fruit juice extracted from the exotic Morinda citrifolia or Noni plant in folk remedies for more than 2000 years. Morinda citrifolia juice has a broad range of therapeutic effects including antibacterial, antiviral, antifungal, antitumor, antihelminitic, analgesic, hypotensive, anti-inflammatory and immune enhancing effects. Morinda citrifolia juice contains the antibacterial compounds L-asperuloside and alizarin. The extract of Morinda citrifolia also demonstrates some antimicrobial properties.In endodontic literature Murray et al evaluated Morinda citrifolia juice in conjunction with EDTA as a possible alternative to Sodium hypochlorite.[26]

Another commonly used Indian ayurvedic herbal formulation is Triphala which consists of the dried and powdered fruits of three medicinal plants namely Terminalia bellerica , Terminalia chebula and Emblica officinalis. The different compounds may be of help in enhancing the potency of active compounds resulting in an additive or synergistic positive effect. Another prominent feature is its ability to remove the smear layer.[27]

Ethylenediamine tetraacetic acid is a chelator preparation used during irrigation. It can reduce the extent of smear layer produced during endodontic procedures. The effectiveness of this preparation depends upon the length of application time.[32]

The shear test was seen to be more accurate for measuring the bond strength of endodontic sealers to dentin as well as to Guttapercha and has been proven to be effective as well as being reproducible. This test model though does not replicate the clinical environment, attempts to closely duplicate the clinical conditions have resulted in complicated experimental models that are difficult to reproduce and sometimes even to interpret.[16]

The aim of the present study is to evaluate the effect of four different irrigants: Sodium hypochlorite, Morinda citrifolia, Triphala and Chlorhexidine on the shear bond strength of a self etch sealer, RealSeal SE to dentin by using with and without EDTA as the final irrigant , using an Universal Testing Machine.

Review of Literature

1.Hand et al (1978)[30] evaluated the effect of dilution on necrotic tissue dissolution property of Sodium hypochlorite. Under the controlled conditions, necrotic pulp tissue specimens of rats were exposed to various concentration of Sodium hypochlorite i.e. 5.25% Sodium hypochlorite, 2.5% Sodium hypochlorite, 1% Sodium hypochlorite, 0.5% Sodium hypochlorite and the percentage of tissue weight change was determined . Statistical analysis indicated that 5.25% Sodium hypochlorite resulted in significant increase in the ability to dissolve necrotic tissue.

2.Indian herbal pharmacopoeia, Vol. II(1999)[12] reviewed Emblica officinalis (other names areamalaka ,amla). Its major chemical constituents are vitamin C, Tannins , Gallic acid, Ellagic acid , Phyllemblic acid and Emblicol and other alkaloids i.e. phyllantidine , phyllantine and minerals. It is effective in treatment of peptic ulcer and dyspepsia. The extract of amlaalso has antimicrobial property. It is an antioxidant with free radical scavenging properties, which may be due to the presence of high levels of super oxide dismutase. Its dosage is usually 3-6gms/day.

3.Johnson et al (2008)[14] stated that Morinda citrifolia can be used as an analgesic, antiarthritic, antipyretic, antitumor, antispasmodic, ascaricide, diuretic, emetic, fungicide, laxative and sedative. It is indicated for arthritis,

asthma, cold, cancer, constipation, dysentery, fever, gastritis, insomnia, gout, sapremia, pain, sore throat, stomach ache, high blood pressure, rheumatism, nervousness, wound, fungus and cramps. It's recommended dosage is 2 to 4 table spoons per day.

4.Grawehr et al(2003)[8] evaluated the interaction of Ethylenediamine tetraacetic acid with Sodium hypochlorite in aqueous solution. By using solutions consisting of 8.5% EDTA and 0.5% Sodium hypochlorite which were compared to a 1:1 mixture of 17% EDTA and 1% Sodium hypochlorite, for their calcium chelating, tissue dissolving and antimicrobial properties. The amount of available chlorine was determined using Iodine - thiosulphate titration method. Calcium chelation capacity was titrated with a pure calcium solution using a murexide indicator. Weight loss of procine palatal mucosal specimens incubated in the test solution was measured over time for its tissue dissolving property. Antimicrobial potential of pure solutions and combination were recorded using agar diffusion test. It was concluded that EDTA and Sodium hypochlorite should be used separately since EDTA caused Sodium hypochlorite to lose its tissue dissolving capacity.

5.Hulsmann et al (2003)[11] reviewed chelating agents in the root canal. Chelating agents were introduced in endodontics as an aid for the preparation of narrow and calcified root canals in the year 1975 by Nygaard-Ostby. A liquid solution of Ethylenediamine tetraacetic acid was thought to chemically soften the root canal dentin and dissolve the smear layer, as well as to increase the dentin permeability. Although the efficacy of EDTA preparations in softening root dentin has been debated, chelator preparations have regained in popularity. Almost all manufacturers of nickel- titanium instruments recommend their use as a lubricant during rotary root canal preparation, a final irrigation of root canal with 15-17% EDTA solution is recommended to dissolve the smear layer.

6.Yamashita et al(2003)[38]investigated the cleaning ability of irrigating solutions ; Saline, 2% Chlorhexidine, 2.5% Sodium hypochlorite, 2.5% Sodium hypochlorite + EDTA . A total number of thirty six extracted human teeth were divided into four experimental groups according to the irrigating solutions used. The cleaning of the apical, middle and coronal thirds of the roots was evaluated by using a Scanning Electron Microscope. The crowns were sectioned with a diamond disc at the CEJ to standardize the preparation. Mechanical preparation was performed manually with K-files using a step-back technique.The apical stop was created with a size 50 K file

and step back technique was performed up to a size 80 file. The results showed better cleaning in canals with those irrigated with 2.5% Sodium hypochlorite + EDTA followed by 2.5% Sodium hypochlorite whose cleaning was similar to that of 2% Chlorhexidine in the cervical third. Cleaning by Saline and 2% Chlorhexidine were worse than the other two groups and similar in all the apical, middle and coronal thirds. For all groups better cleaning was found in the cervical and middle thirds with the worst results seen in the apical third.

7.Little et al(2004)[13] investigated complementary and alternative medicine techniques (CAM), which is a group of diverse medical and health care systems, practice and products that are not considered to be part of conventional medicine. Biofeedback, acupuncture, herbal medication, massage, bioelectromagnetic therapy, meditation and music therapy are examples of CAM treatment. Some dentists have used some of these treatment methods and products in their practice. Complementary medicine includes herbal remedies, homeopathic medicines and essential oils. There has been an increase in the use of herbal medicines over the past 15-20 years. There is a public belief that these medicines are safe because they are sourced from natural sources. However, some of these products have associated adverse effects including toxicity and drug interactions. The

health history taken by the dentist should also include questions regarding the consumption of herbal and over the counter medications. The dentist needs to be informed regarding the herbal and over the counter products as they may impact the delivery of safe and effective dental treatment. In addition the use of CAM treatments in dentistry should be based on the evidence of effectiveness as well as safety.

8. Brett et al (2006)[6] evaluated the hepatotoxicity of Noni juice (Morinda citrifolia), Noni juice has been approved for use as a safe food within the European union, following a review of safety. Since approval, cases of acute hepatitis in Noni juice consumers have been published, where a causal link is suggested between liver dysfunction and ingestion of anthraquinones from the plant. Measurements of liver function in a clinical safety study of Tahitian Noni juice, as well as subacute and subchronic animal toxicity tests revealed no evidence of adverse liver effects at doses many times higher than those reported in the case studies. Additionally Morinda citrifolia anthraquinones occur in fruits in quantities too small to be of any toxicological significance.

9.Patel et al (2006)[25] compared the penetration depth into the dentinal tubules by RealSeal and Tubliseal using twenty single rooted extracted

premolars. Following the completion of root canal instrumentation with rotary Protaper files, the teeth were divided into 2 groups each using a stratified sample technique. In group 1, 10 teeth were filled with Gutta-percha and Tubliseal by using cold lateral condensation. In Group 2, 10 teeth were filled with Realseal. Both sealers were labelled with the help of Rhodamine B dye. The teeth were then sectioned parallel to the long axis resulting in 20 specimens per group. Confocal microscope was used to assess the penetration depth of sealers at 3 sites (coronal, middle, apical). The penetration depth of RealSeal in each one of the thirds of the root canal was found to be higher than that of Tubliseal.

10. A.K.Palu et al (2007)[2] investigated the mechanisms involved in the immunomodulatory effect of Morinda citrifolia, both invitro and invivo in mice. Invitro Tahitian Noni Juice (TNJ) and Noni fruit juice concentrates (NFJC) potently activate cannabinoid2 but inhibit cannabinoid1 receptors in a concentration dependant manner. In vivo oral administration of Tahitian Noni Juice for 16 days decreased the production of IL-4 but increased the production of INF-γ. These results suggest that Noni juice modulates the immune system via the activation of CB_2 receptors and the suppressing of IL-4 but increasing the production of IFN- γ cytokines. It may also exert

beneficial immunomodulation effects in conditions involving inadequate immune responses.

11.Pawlus et al (2007)[3] reviewed the ethnobotany, chemistry, biological activity and safety of the botanical dietary supplement of Morinda citrifolia, it has a long history as a medicinal plant and its use as a botanical dietary supplement has grown tremendously .It is used as a medicinal plant in Polynesia, Southeast Asia, Northeastern Australia and the Caribbean. It is morphologically diverse with both large and small fruits and its leaves exhibits a wide range in both size and shapeand they being variously described as elliptical, long, straplike, ovate or rounded. It can be used for the application of sores, cuts, inflammation stings from poisonous fish and even headaches. It is also used in the treatment of cancer. It can be also be used as a mouthwash for inflamed and sore gums, sore throats and mouth ulceration. Noni juice extracts demonstrates hypotensive activity and has shown to have ACE inhibitory activity.

12.Wachlarowicz et al (2007)[1] examined the effects of commonly employed endodontic irrigants on the shear bond strength of Epiphany to dentin. Smear layer was created on dentin discs obtained from human third molars. Five groups of 10 discs each were treated with (a) water (b) 2%

Chlorhexidine (c) 6% Sodium hypochlorite (d) 6% Sodium hypochlorite followed by EDTA and Water (e) 1.3% Sodium hypochlorite followed by MTAD. The treated surfaces were then air dried and treated with Epiphany primer. Hollow steel tubes of dimension 4.32 internal diameter and 3mm height were placed on the dentin surface and Epiphany sealer was applied to the dentin inside the tubes. Samples were tested for shear bond strength after 7 days storage by using the Universal Testing Machine at a cross head speed of 1mm/min. The shear bond strength of each specimen was recorded in Megapascals. The results showed that by using Water or Chlorhexidine as irrigants it resulted in a significantly lower bond strength values when compared with Sodium hypochlorite, Sodium hypochlorite / EDTA or Sodium hypochlorite /MTAD. Neither EDTA nor MTAD significantly improved Epiphany's dentin bond strength when compared with Sodium hypochlorite used alone.

13. Hammad et al (2008)[21] compared the polymerization shrinkage behavior of root canal sealers EndoRez, RealSeal, Guttaflow and TubliSeal using a bonded disk method. Sixty specimens were tested at both room temperature (37^{o}C) and body temperature (27^{o}C). Dual cured resin based sealers were tested as chemically cured and as dual cured. Samples of the sealers were then tested for 24 hours .It was found that EndoRez had the

highest shrinkage rate at both 37°C and 27°C temperature followed by RealSeal and TubliSeal. However Guttaflow exhibited expansion on polymerization. It was concluded that shrinkage associated with the setting might jeopardize seal of the root canal leading to root canal failure.

14.Khedmat et al (2008)[32] compared the efficacy of SmearClear, 17% EDTA, 10% Citric acid in smear layer removal. Forty eight extracted single rooted human teeth were randomly divided into 4 groups (n=12) and instrumented using Mtwo nickel-titanium rotary instruments. Each canal was subsequently irrigated with one of the following solutions: 5.25% Sodium hypochlorite (control), SmearClear, 17% EDTA and 10% Citric acid. All the specimens were subjected to irrigation with 5.25% Sodium hypochlorite. The teeth were then processed for Scanning Electron Microscopy and removal of smear layer was examined in the coronal, middle and apical third. The results showed that there was no significant difference in the efficacy of the three chelating agents at all levels of the root canals. The comparison of the three apical one thirds in each group showed no significant difference between the SmearClear and EDTA groups. However the efficacy of citric acid was significantly less in the apical third when compared with the coronal and middle third of the canals.

15. Murray et al (2008)[26] compared the invitro effectiveness of Morinda citrifolia juice (MCJ) with Sodium hypochlorite and Chlorhexidine gluconate to remove smear layer from the canal walls of endodontically instrumented teeth. Sixty extracted single rooted mature permanent human premolar teeth with single canal was inoculated with E.faecalis at 37°C in a CO_2 atmosphere for 30 days. During instrumentation, irrigation was provided by Morinda citrifolia, Sodium hypochlorite, Chlorhexidine gluconate, Morinda citrifolia / Chlorhexidine gluconate, followed by final rinse of 17% EDTA. The teeth were then processed for SEM and the removal of smear layer was examined. It was observed that the most effective removal was seen with Morinda citrifolia and Sodium hypochlorite after rinsing using 17% EDTA. Both Morinda citrifolia/ 17% EDTA and Sodium hypochlorite/ 17% EDTA treatments completely removed upto 80% of smear layer from some aspects of the root canal. Morinda citrifolia juice was more effective than Chlorhexidine for removing the smear layer. Morinda citrifolia juice appears to be a possible alternative to the use of Sodium hypochlorite as an intracanal irrigant.

16.Ring et al (2008)[18] compared the effect of 10 different endodontic irrigants and the use of chelating treatment on dental pulp stem cell attached to the root canal surfaces. Thirty eight extracted human non-diseased single

canal teeth were cleaned and instrumented using Protaper and Profile rotary instruments respectively. The irrigation treatment investigated were 6% Sodium hypochlorite, 2% Chlorhexidine gluconate, Aquatine Endodontic cleanser and Morinda citrifolia juice. The irrigation treatments were used in conjunction with EDTA or MTAD. The instrumented teeth were then immediately placed in cell culture with confluent dental pulp stem cells for one week .The number of attached dental pulp stem cell appeared to be correlated with the cytotoxicity of the root canal irrigating solution. The presence or absence of smear layer had little influence on the dental pulp stem cell activity.

17.Babb et al (2009)[5] investigated the push out bond strength of EndoRez and 2 self adhesive resin based sealers (MetaSeal , RealSeal SE) when they were applied to radicular dentin, following the manufacturer's recommended use of EDTA as the active final rinse. Forty two human canine teeth were used in this study. A modified push out testing design was used to evaluate the dislodgement of core free sealers. It showed that the MetaSeal and RealSeal SE had higher push out bond strength. But the true self etching potential of RealSeal SE and MetaSeal were not exhibited when EDTA was used as the final irrigant. The ability of these self etching sealers to etch through thick canal wall smear layers to create micromechanical

retention and achieve gap free sealing of canal walls have important implications because debris and smear layer removal may be incomplete in the apical thirds of canal walls with many of the contemporary irrigation protocols.

18.Jainkittiwong et al (2009)[4] investigated the antifungal activity of Morinda citrifolia fruit juice extract on Candida albicans invitro at various concentrations (10,20,30,40,50,60 mg/mL) and at different contact times (15,30,45,60,75,90 minutes). The inhibitory effect of Morinda citrifolia extract on Candida albicans was determined by cultures and an applied broth dilution test. Using cultures, growth of Candida albicans was not detected with 50mg/mL of extract at 30 minute contact time or with 60mg/mL of extract at 15minute contact time. It was concluded that Morinda citrifolia fruit extract had an antifungal effect on Candida albicans and inhibitory effect varied with both the concentration and contact time.

19.Kim et al (2009)[41] evaluated the true self etching potential of RealSeal and RealSeal SE to etch through endodontic smear layers and demineralize the intact radicular dentin without the adjunctive use of EDTA. Fifteen single rooted human teeth were used in the study. Instrumentation was done by crown down technique using Profile nickel–titanium rotary

instruments. The groups were then divided into 3 groups (1) instrumented canal wall dentin that was irrigated with water as final rinse to preserve smear layer (2) fractured radicular dentin that was devoid of smear layer (3) instrumented canal wall dentin that was irrigated with EDTA as final rinse to remove the smear layer. The roots were then separated into 2 halves. For each root, one half of the fractured canal was filled with RealSeal and other half was filled with RealSeal SE according to the manufacturer's instruction. It showed that unlike RealSeal, RealSeal SE was unable to demineralize the fractured dentin and was unable to etch beyond the smear layer into the underlying intact dentin.

20.Lottanti et al (2009)[18] evaluated the effects of EDTA, Etidronic acid and Peracetic acid irrigation on human root dentin and quality of smear layer when used in conjunction with Sodium hypochlorite as root canal irrigant on the calcium eluted from canals, smear layer and root dentin demineralization was analyzed after instrumentation /irrigation by using Atomic Adsorption Spectroscopy. Smear layer covered areas were observed by Scanning Electron Microscope and root dentin demineralization after instrumentation were observed by using a back scatter mode by Scanning Electron Microscope. Fifty one single rooted human premolars were divided into four groups(n=12) and one positive group(n=3). The teeth were irrigated as

follows (1) 1% Sodium hypochlorite during instrumentation and deionized water after instrumentation (2) 1% Sodium hypochlorite and17% EDTA after instrumentation (3) 1:1 mixture of 2% Sodium hypochlorite and 18% Etidronic acid during and after instrumentation (4) 1% Sodium hypochlorite during, 2.25% Peracetic acid after instrumentation. The total irrigation time during instrumentation was 15 minutes, and the volume was 10mL. After instrumentation, 5ml of the final irrigant was administered 1mm from the working length over a period of 3minutes. Subsequently, the canal was rinsed with 5ml of deionized water. In the positive control the root canal wall demineralization was done using x-ray energy dispersive analysis, the canals were irrigated during instrumentation as described previously and subsequently 10 ml of 17% EDTA was administered over a period of 30 minutes. It was concluded that the decalcifying agents (EDTA, Etidronic acid and Peracetic acid) were able to remove the smear layer. However it was seen that all the three agents eroded the dentin wall.

21.Rahimi et al (2009)[20] compared the microshear bond strength of three resin based sealers (AHplus, EndoREZ, RealSeal) to root dentin and assessed whether sealer cements behave differently in thin and thick films. Maxillary premolars extracted for orthodontic reasons were sectioned buccolingually with a diamond wafering blade and the inner surface of each

root was ground until it was flat using a 1000 grid silicon carbide paper. A total of forty five root halves were randomly allocated for microshear bond testing with three resin sealers in thick and thin films. Microshear bond strength was calculated in Megapascals. Failure modes were examined under light and Scanning Electron Microscopy. Overall AHplus sealer had the highest microshear bond strength followed by RealSeal and EndoREZ to the root dentin .Bond strength for the thick sealer group was significantly higher than the thin sealer group.

22.Hu et al (2010)[37] investigated the hypothesis that irrigating solutions might influence the physiochemical properties of human root canal dentin including the wettability and roughness. The roots of twenty human permanent anterior teeth were selected and the roots of the teeth were sectioned longitudinally into dentin slices. They were divided into 4 groups and immersed in 17% EDTA for 10 minutes, 5.25% Sodium hypochlorite for 10 minutes, 3% Hydrogen peroxide for 10 minutes respectively. Distilled water was used as control. Wettability was evaluated by the contact angle measurement and surface roughness was evaluated by using atomic force microscopy. It was observed that the contact angle was less for 5.25% Sodium hypochlorite and was followed by 3% Hydrogen peroxide. Surface

roughness among irrigants was highest for 5.25% Sodium hypochlorite followed by 17% EDTA.

23.Kandaswamy et al (2010)[15] investigated the antimicrobial activity of 2% Chlorhexidine gel, Propolis, Morinda citrifolia juice, 2% Povidine iodione and Calcium hydroxide on E.faecalis infected root canal dentin at 2 different depths (200µm & 400 µm) and at 3 time intervals 1,3,5 days using 180 extracted human teeth. Dentin shavings were collected at 2 depths (200µm and 400µm) and the total number of colony forming units were determined. The number of colony forming units were statistically significant in all groups where Chlorhexidine produced better antimicrobial efficacy followed by 2% Povidone, Propolis, Morinda citrifolia juice and Calcium hydroxide . Propolis and Morinda citrifolia juice were effective against E.faecalis in dentin of extracted teeth.

24.Moon et al (2010)[42] evaluated the effect of different final irrigants on the sealer penetration into dentinal tubules of curved root canals. The mesiobuccal canals from forty five extracted maxillary and mandibular molars were instrumented using Profile rotary instruments with Sodium hypochlorite irrigation. The samples were then divided into 3 groups according to the final irrigant used, Group N (control) - 3.5% Sodium

hypochlorite,Group E-17% EDTA and Group EN-17% EDTA followed by 3.5% Sodium hypochlorite. All the teeth were obturated with Guttapercha and AHplus sealer and labeled with fluoroscent Rhodomine B isothiocyanatedye. Transverse sections at 2mm (apical) and 5mm (coronal) from root apex were examined by using confocal laser scanning microscope with 50X magnification. The apical sections in each group showed significantly lower percentage and maximum depth of sealer penetration than the coronal section. In apical levels, Group E and Group EN resulted in a higher percentage of sealer penetration than the control group but there was no significant difference in the maximum penetration depth between Group E and the control group. It was concluded that in curved canals final rinse with Sodium hypochlorite after the use of EDTA had no additional effect on the sealer penetration.

25.Nayak et al(2010)[33] reviewed Morinda citrifolia , it is a plant which is mentioned both in Polynesian and Indian literature of Rasayana, a branch of Ayurveda which deals with the ability of the herb to bestow upon the body an enhanced capacity of warding off infection and delaying the ageing process. Morinda citrifolia also known as Noni is an indigenous plant found in Tahitian and Hawaiian islands. This tree is also cultivated largely in India, Burma and China. Morinda citrifolia fruits have traditionally been used by

native Polynesians for the treatment of diabetes, high blood pressure, cancer, injury, arthritis, digestive distress, arteriosclerosis, pain relief and senility. In India, different plant parts have been reported to be used as cathartic for the treatment of infantile diarrhea, for wound healing and as a general tonic. It is only in the last decade or so that attention has been focused on the effects of this plant on the immune system.

26.Prabhakar et al (2010)[27] evaluated the antimicrobial efficacy of Triphala, Green tea polyphenols, MTAD, and 5% Sodium hypochlorite against E.faecalis biofilm formed on tooth substrate. Single rooted human mandibular premolars with fully formed apices were used in this study. The tooth specimens were sectioned below CEJ with a diamond disc to obtain a standardized tooth length of 8mm. After instrumentation canals were enlarged to an apical size corresponding to Protaper F3. All teeth were vertically sectioned and placed in tissue culture wells to expose the root canal surface to E.faecalis and to form a biofilm. The samples were then divided into 5 groups each containing 30 samples. At the end of 3rd and 6th week all the groups were treated for 10mintues with the test solution. The samples were then analyzed qualitatively and quantitatively. Results showed that Sodium hypochlorite showed maximum antibacterial activity against 3 week and 6 week E.faecalis biofilm. Triphala and MTAD showed complete

eradication against 3 week biofilm, whereas Triphala, Green tea polyphenols and MTAD showed reduced efficacy against 6 week biofilm.

27. Stiegemeier et al (2010)[7] investigated the push out bond strength of Resilon / RealSeal, Resilon / RealSeal SE, Resilon / MetaSeal and Guttapercha/ KerrEWT. Forty single rooted human extracted teeth were used in this study. Access preparation was done and teeth were instrumented using 0.04 Profile Series 29 nickel titanium rotary files and irrigated using 5.25% Sodium hypochlorite,15% EDTA and Sterile water. The teeth were then filled with Resilon / RealSeal ,Resilon / RealSeal SE, Resilon/ MetaSeal and Guttapercha/ KerrEWT respectively. The roots were sectioned into 1mm thick slices. The bond strength was analysed using a Universal Testing Machine where the vertical load was applied at a rate of 1mm /min on the root canal filling. It was concluded that the Resilon/ MetaSeal and Gutta-percha/ KerrEWT have higher bond strength values than the Resilon / RealSeal, Resilon / RealSealSE. Resilon/ MetaSeal and Guttapercha/ KerrEWT bond strength did not differ significantly.

28.Stoll et al (2010)[28] evaluated the bond strength of different adhesive sealers (RealSeal, RealSeal SE, Hybrid root seal, AHplus) on Resilon and Guttapercha. Pellets of Guttapercha and Resilon were embedded into test

tubes. Small steel eyelets with core diameter of 2mm, 3mm in height and a wall thickness of 0.1mm were attached to the surface with a .5mm film of different root canal sealers and the shear bond strength was tested. Overall the bond strength to Resilon was higher than to Guttapercha.

29.Wu et al(2010)[35] investigated time dependent change of degree of conversion (DC) of RealSeal SE as well as the role of root canal moisture and root canal depth in the degree of conversion of RealSeal SE by using Micro-Raman Spectroscopy. Thirty extracted teeth with single roots were instrumented and divided randomly into 2 groups in terms of canal drying methods namely using Ethanol and Paper points. Excess distilled water was removed with paper points followed by 95% Ethanol. In the paper point group, root canal was blot dried with paper point until the last one appeared dry. It was concluded that a significant increase in the degree of conversion of RealSeal SE was observed in one week with a little change afterwards. Degree of conversion was same throughout the length of the root and root canals dried with the supplemental use of 95% Ethanol favored conversion of RealSeal SE.

30.Verma et al (2011)[24] reviewed Triphala as an important Rasayana in Ayurvedic medicine. Medicines of the Rasayana group are believed to

promote health, immunity, and longevity. According to Ayurveda, they strengthen all tissues of the body, prevent aging, promote intellect, and prevent disease. It consists of the dried fruits of three medicinal plants, Terminalia chebula, Terminalia belerica and Emblica officinalis, also known as the three myrobalans. Triphala means three (tri) and fruits (phala). Triphala is used in Ayurvedic medicine in the treatment of a variety of conditions and also forms part of many other Ayurvedic formulations. The combined effect of three plants in Triphala, claim to possess many pharmacological properties.

31.K M Nadkarnietal[23] reviewed Terminalia belerica and it's constituents are beleric myrobalans which consist of gallo-tannic acid, colouring matter, resins, and a greenish yellow oil. It acts as an astringent, tonic, expectorant and laxative. It is useful for treating cough, eye disease and scorpion stings.

Materials And Methods

One hundred and twenty freshly extracted human maxillary and mandibular molars (Fig.1) were collected and were stored in 0.9% Sodium chloride solution (Baxter PVT Limited India) containing 0.02% Sodium azide (Nice Chemicals PVT Limited India),(Fig.4D) at room temperature. This was done in order to prevent bacterial growth. Then a low speed diamond disk (Fig.6) with water coolant was used to slice off the occlusal 2mm of the samples (Fig2A), whereby a flat dentinal surface surrounded by a thin rim of enamel was obtained. This section of tooth, which included the roots, was embedded in a self cure acrylic resin. A uniform smear layer was created on the sectioned teeth using a 320 grit silicon carbide paper mounted on a Handimet grinder (Buehler, Limited, USA) under water irrigation (Fig.8) for a time period of 15 seconds. The dentin disks with the smear layer were then divided randomly into 2 Groups(n= 60).Each Group was further subdivided, (Fig.3) into 4 Subgroups. In Group I, the irrigants were used without EDTA as the final rinse and in Group II EDTA was used after using the irrigants as the final rinse.

Triphala (IMPCOPS Limited, Chennai, India) was made into solution by dissolving it in 10% Dimethyl sulfoxide(DMSO), (S. D. Fine Chem PVT Limited) Mumbai, India.

Group I

a) The dentin disks were soaked in 6% Sodium hypochlorite (Ecodent, Alfa surgical, India), (Fig.4A) for 10 minutes and then washed with distilled water for 1 minute (n= 15).

b) The dentin disks were soaked in 6% Morinda citrifolia (AmbePhyto Extract, India), (Fig.4E) for 10 minutes, and then washed with distilled water for 1minute(n= 15).

c) The dentin disks were soaked in Triphala, (60mg/ml, IMPCOPS Ltd, India, in 10% DMSO), (Fig.4f, 4g) for 10 minutes, and then washed with distilled water for 1minute (n= 15).

d) The dentin disks were soaked in 2% Chlorhexidine (Stedman Pharmaceuticals, India), (Fig.4B) for 10 minutes and then washed with distilled water for 1minute (n= 15).

Group II

a) The dentin disks were soaked in 5% Sodium hypochlorite (Ecodent, Alfa surgical, India) for 10 minutes and then washed with distilled water for 1 minute, after which the samples were washed with 17% Ethylenediamine

tetraacetic acid, (Fig.4C) (Dent Wash, Prime dental products, India) for 2-3 minutes then finally washed with distilled water for 1 minute (n= 15).

b) The dentin disks were soaked in Morinda citrifolia (AmbePhyto Extract, India) for 10 minutes, and then washed with distilled water for 1minute, after which the samples were washed with 17% Ethylenediamine tetraacetic acid for 2-3 minutes, and then finally washed with distilled water for 1minute (n= 15).

c) The dentin disks were soaked in Triphala (60mg/ml, IMPCOPS Ltd, India in 10% DMSO) for 10 minutes, and then washed with distilled water for 1minute, after which the samples were washed with 17% Ethylenediamine tetraacetic acid for 2-3 minutes, and then finally washed with distilled water for 1minute (n=15).

d) The dentin disks were soaked in 2% Chlorhexidine (Stedman Pharmaceuticals, India) for 10 minutes and then washed with distilled water for 1 minute, after which the samples were washed with 17% Ethylenediamine tetraacetic acid for 2-3 minutes then finally washed with distilled water for 1minute (n= 15).

Bonding procedure

The dentin discs were air dried using an air-water syringe. A brass tube of 4mm internal diameter and 3mm height was placed on the dentin surface. The brass tube was filled with RealSeal SE(Sybron Endo, USA), (Fig.4H) which was mixed according to the manufacturer's instructions. The sealer was light cured using a light curing unit (QHL-75Dentsply,India) for 40 seconds and then allowed to set for 45 minutes. The samples were immediately stored in distilled water at 37^{o}C, and maintained at 100% humidity for 7 days

Shear bond strength evaluation

The specimens were engaged perpendicularly at their bases on a Universal testing machine (INSTRON 3365). Each specimen was evaluated for its shear bond strength, at a cross head speed of 1mm/minute. The shear force required to separate the cylinder from dentin was recorded in Newtons (N) for each specimen, then divided by the contact surface area to determine the shear bond strength in Megapascals.

COMPOSITION

REALSEAL SE SEALER

Benzoyl peroxide

Tertiany amine

EBPADMA (Ethoxylated bisphenol A dimethacrylate)

BISGMA

HEMA (Hydroxy Ethyl Meth Acrylate)

Propiortory acidic

Silane treated barium glass

Calcium phosphate

Bismuth Oxychloride

Luting system

Source: Material Safety Data Sheet

SODIUM HYPOCHLORITE

Sodium hypochlorite

Sodium bicarbonate

Sodium chloride

Sodium

Water

Source: Material Safety Data Sheet

CHLORHEXIDINE

Chlorhexidine gluconate solution I P equivalent to Chlorhexidine gluconate

2.0% w/v

Source : According to manufacturer

EDTA

17% Ethylenediamine Tetraacetic acid

Source: According to manufacturer

TRIPHALA

Indian ayuevedic herbal formulation consisting of dried and powdered fruits of three medicinal plants

Terminalia belerica,

Terminalia chebula,

Embilica officinalis

Source: Review on wonderful and miraculous Triphala

Journal of Pharmacy and research 2011, Vol. 4: 690-694

MORINDA CITRIFOLIA

Polysaccharides

Lignans

Phytosterols

Carotinoids

Essential oils –hexoic and octoic acids

Fatty acid glycosides

Iridoids

Anthraquinones

Coumarins

Flavonoids

Paraffin

Esters of ethyl and methyl alcohol

Source: The noni fruit - A review of agricultural research, nutritional and therapeutic properties

Journal of food composition and analysis, 2006, Vol 19:645-654

FIGURE 1:120 HUMAN MOLARS

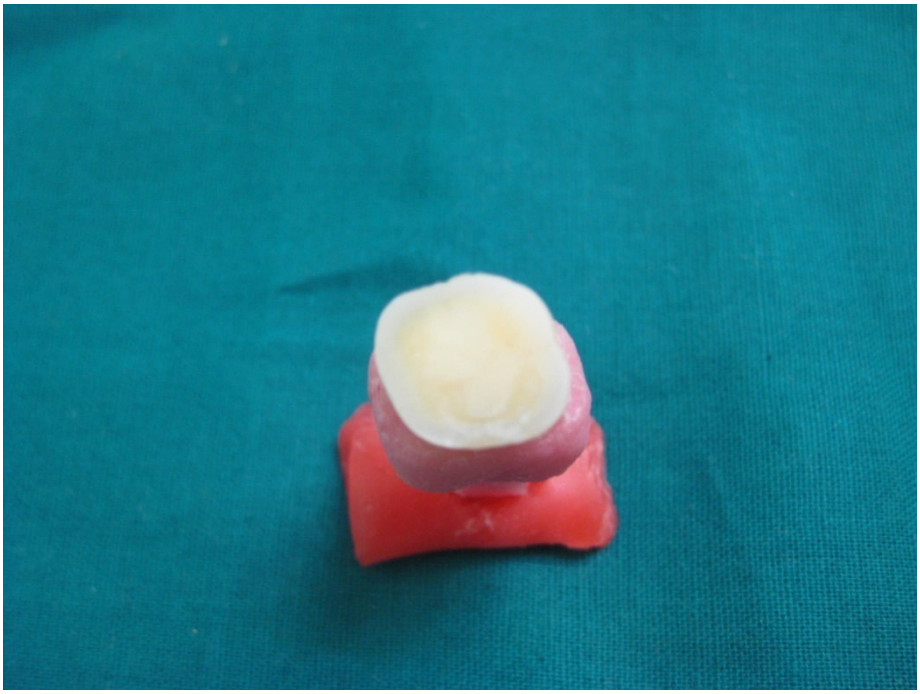


FIGURE 2A: HUMAN MOLARS AFTER 2MM OCCLUSAL REDUCTION

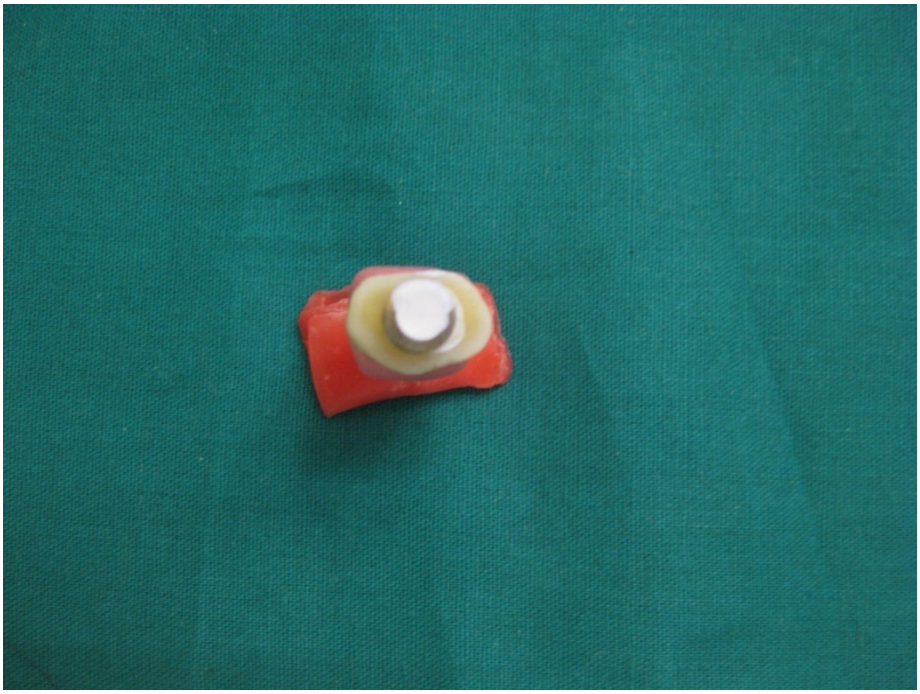


FIGURE 2B: BRASS TUBE FILLED WITH REALSEAL SE

FIGURE 3: SUBDIVISION OF SAMPLES

FIGURE 4A: 5% SODIUM HYPOCHLORITE

FIGURE 4B: 2% CHLORHEXIDINE

FIGURE 4C: 17% EDTA WASH

FIGURE 4D: 0.9% SODIUM CHLORIDE AND 0.2% SODIUM AZIDE

FIGURE 4E: 6% MORINDA CITRIFOLIA

FIGURE 4F: DIMETHYL SULPHOXIDE

FIGURE 4G: TRIPHALA

FIGURE 4H: REALSEAL SE SEALER AND BRASS TUBE

FIGURE 5: LIGHT CURING UNIT

FIGURE 6: 320 GRIT SANDPAPER, MANDREL, MICROMOTOR, DIAMOND DISC

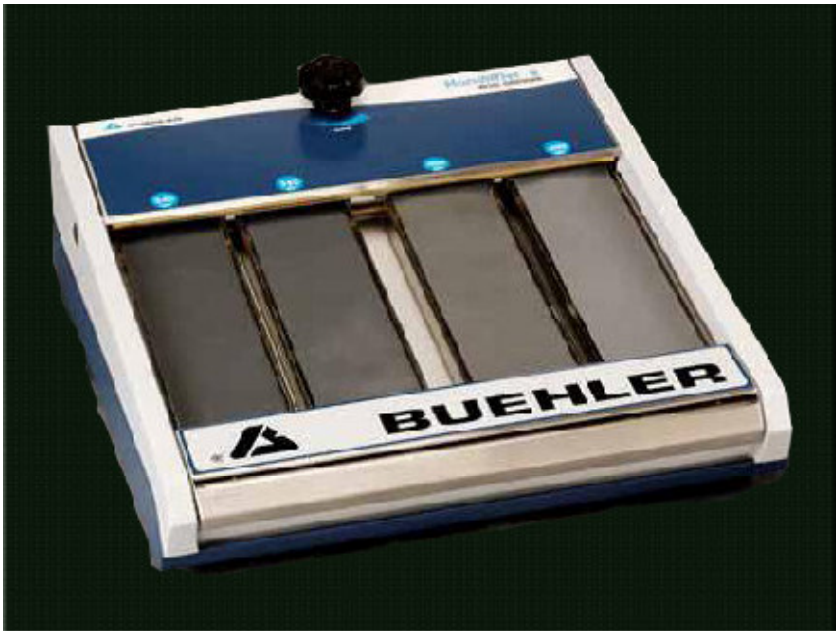


FIGURE 7: HANDIMET ROLL GRINDER

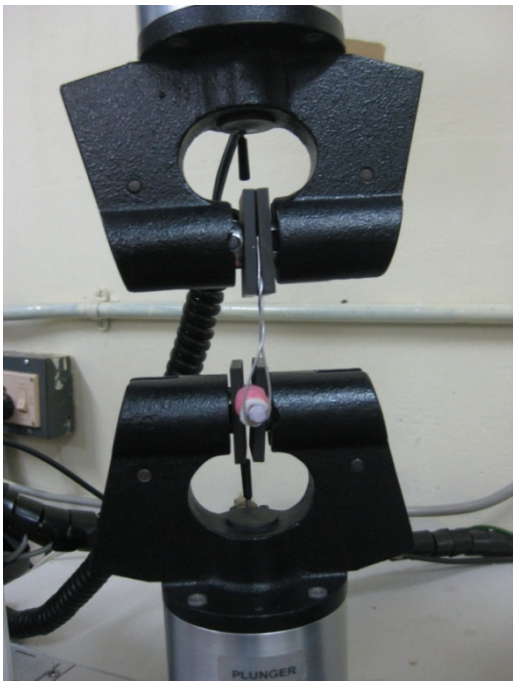


FIGURE 8: SHEAR BOND STRENGTH EVALUATION

Results

TABLE 1. MEAN SHEAR BOND STRENGTH (MPa)AMONG DIFFERENT IRRIGANTS OF GROUP I

Parameters	Mean	± SD	F value	P value
Sodium hypochlorite	2.14[bc]	0.96	5.118	< 0.01
Morinda citrifolia	1.63[b]	0.77		
Triphala	1.56[b]	1.26		
Chlorhexidine	0.86[a]	0.38		

a, b, c – Means with same superscript do not differ from each other (Duncan's Multiple Range Test)

TABLE 2. MEAN SHEAR BOND STRENGTH (MPa) AMONG DIFFERENT IRRIGANTS OF GROUP II

Parameters	Mean	± SD	F value	P value
Sodium hypochlorite and EDTA	3.52[d]	0.09	64.239	< 0.001
Morinda citrifolia and EDTA	3.25[c]	0.43		
Triphala and EDTA	2.95[b]	0.12		
Chlorhexidine and EDTA	2.10[a]	0.39		

a, b, c – Means with same superscript do not differ from each other (Duncan's Multiple Range Test)

TABLE 3. COMPARISON OF MEAN SHEAR BOND STRENGTH (MPa) BETWEEN TWO GROUPS

Parameters	Mean	± SD	Paired 't' value	P value
Sodium hypochlorite	2.14	0.96	- 5.244	< 0.001
Sodium hypochlorite and EDTA	3.52	0.09		
Morinda citrifolia	1.63	0.77	- 6.518	< 0.001
Morinda citrifolia and EDTA	3.25	0.43		
Triphala	1.56	1.26	- 4.325	< 0.01
Triphala and EDTA	2.95	0.12		
Chlorhexidine	0.86	0.38	- 9.393	< 0.001
Chlorhexidine and EDTA	2.10	0.39		

TABLE 4. ANALYSIS OF VARIANCE (ONE WAY ANOVA) COMPARING MEAN SHEAR BOND STRENGTH (MPa) AMONG ALL IRRIGANTS TOGETHER

Parameters	Mean	± SD	F value	P value
Sodium hypochlorite	2.14^{c}	0.96	28.235	< 0.001
Morinda citrifolia	1.63^{bc}	0.77		
Triphala	1.56^{b}	1.26		
Chlorhexidine	0.86^{a}	0.38		
Sodium hypochlorite and EDTA	3.52^{e}	0.09		
Morinda citrifolia and EDTA	3.25^{de}	0.43		
Triphala and EDTA	2.95^{d}	0.12		
Chlorhexidine and EDTA	2.10^{c}	0.39		

a, b, c – Means with same superscript do not differ from each other (Duncan's Multiple Range Test)

Fig.3. Comparison of mean shear bond strength (MPa) between two groups, without and with EDTA

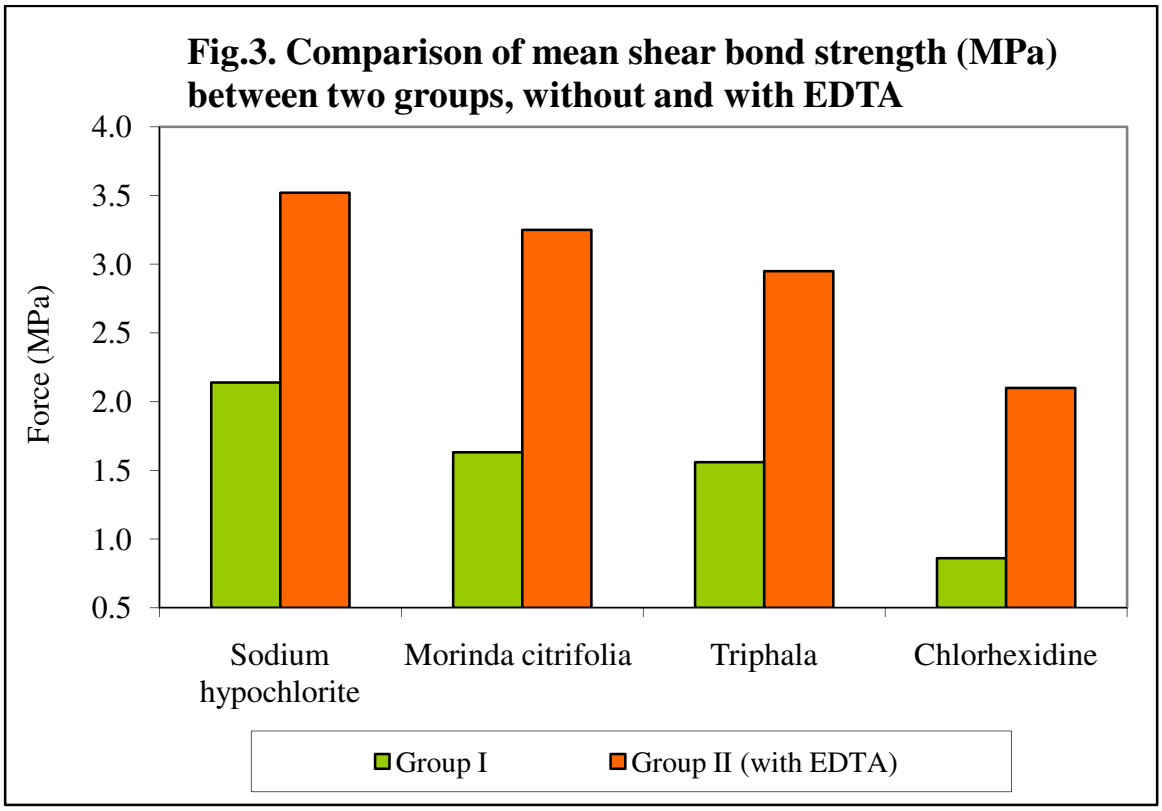
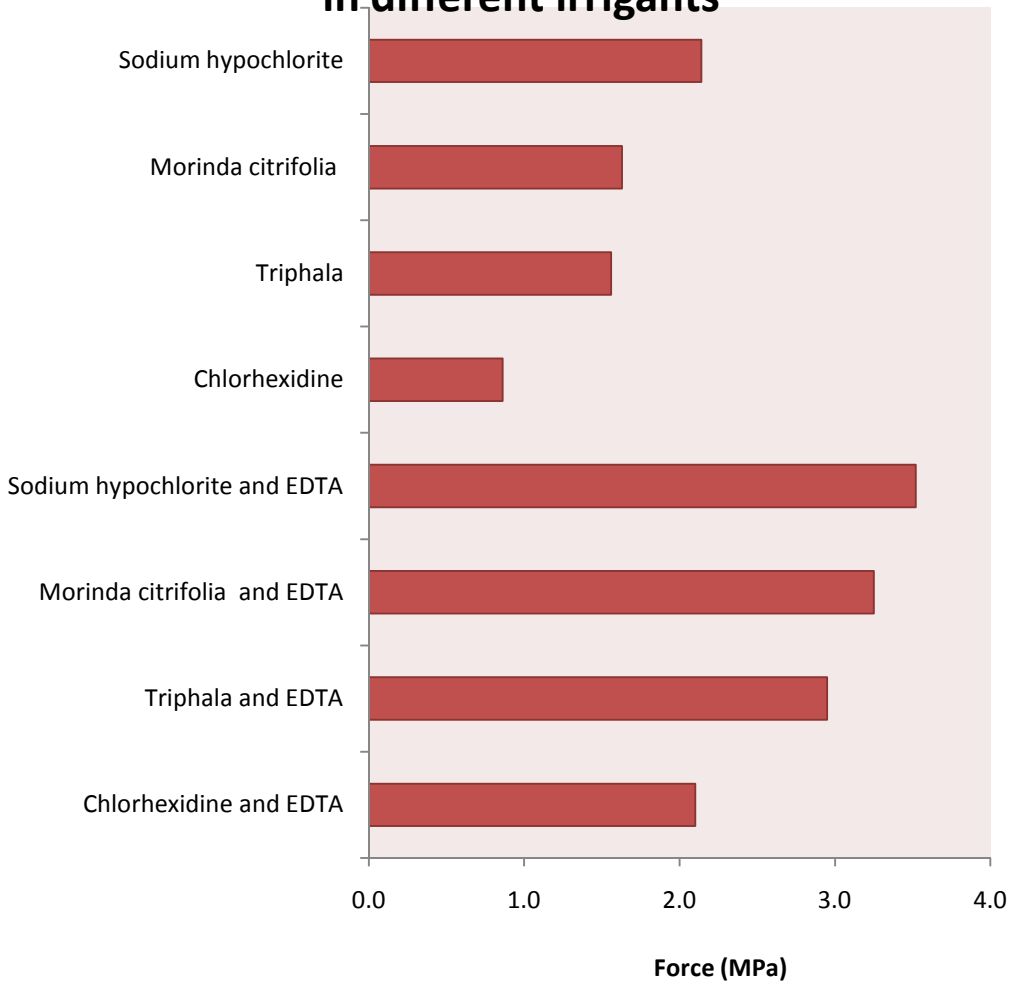


Fig.10. Mean shear bond strength (MPa) in different irrigants



Statistical Analysis

Data were analyzed using computer software, Statistical Package for Social Sciences (SPSS) version 10. Data are expressed in its mean and standard deviation. Analysis of variance (One Way ANOVA) was performed as a parametric test to compare different subgroups within each group as well as to compare all the subgroups in both the groups together. Duncan's Multiple Range (DMR) test was employed as a post hoc tool to elucidate individual subgroup comparisons along with ANOVA. Student's paired 't' test was used to compare the mean values between the two groups within each of the subgroup. For all statistical evaluations, a two-tailed probability of value, < 0.05 was considered as significant.

In group I, Sodium hypochlorite subgroup showed maximum values (2.14 MPa) and Chlorhexidine registered the minimum values (0.86 MPa) for the shear bond strength among the tested irrigants (Table 1). Morinda citrifolia and Triphala registered the second and third values with respect to their shear bond strength. Analysis of variance (One Way ANOVA) showed significant ($P<0.01$) difference between the tested subgroups. Post hoc analysis for ANOVA elucidated the individual group comparisons among the tested irrigants. Chlorhexidine showed the least bond strength values

which was significantly lower when compared to all other irrigants. Morinda citrifolia and Triphala did not show any significant difference between them. Where as Sodium hypochlorite registered statistically significant difference from all the other groups even though values were similar to that of Morinda citrifolia and Triphala.

In Group II, Sodium hypochlorite subgroup showed maximum (3.52MPa) and Chlorhexidine registered the minimum (2.10 MPa) shear bond strength values among the tested irrigants (Table 2). Morinda citrifolia and Triphala registered the second and third maximum values with respect to its shear bond strength. Analysis of variance (One Way ANOVA) showed significant ($P<0.01$) difference between subgroups. Post hoc analysis for ANOVA revealed that all the subgroups tested differed significantly among themselves.

Discussion

Guttapercha has been the traditional endodontic obturating material used in combination with a sealer containing either Zinc oxide or Eugenol, Calcium hydroxide or Epoxy resin. However in recent years, Obturating materials and sealers have been developed based on dentin adhesion technologies borrowed from restorative dentistry, in order to seal the root canal system more efficiently and effectively.[7] The main goal of obturation is to seal the canal space to prevent microbial egress into the periradicular tissues[1]. After the advancement of self priming, self etching and self adhesive resin luting technologies in restorative dentistry, functionally analogous low viscosity methacrylate resin based root canal sealers have since been made available for use in the field of endodontics. This is, especially after the commercialization of a root filling material that claims to adhere to methacrylate resins. This genre of bondable root canal sealers have been aggressively promoted with the highly desirable property of creating "monoblocks" within the root canal space. The monoblock concept refers to the scenario wherein the root canal space becomes filled with a gap free solid mass that consists of different materials and interfaces with the advantages of simultaneously improving the seal as well as the fracture resistance of the filled root canals.[17] The most recently introduced self

adhesive type of bondable root canal sealer based on methacrylate resin, is the Real Seal SE.

Sealers are used to attain an impervious seal between the core material and the root canal walls. They can be grouped according to their basic components as Zinc oxide eugenol, Calcium hydroxide, Resins, Glass ionomer, Iodoformor Silicone based. Ideally these materials should seal both the root canals laterally as well as apically and should have good adaptation to the root canal dentin. Even when used along with a sealer, Guttapercha was not capable of preventing microleakage.This has been confirmed by numerous authors that there was a high leakage rate between Guttapercha and the sealer used.[25]

Interest in adhesive endodontics has led to the introduction of four generations of methacrylate resin based root canal sealers.[40]The first generation Hydron appeared when scientific research behind dentin bonding was in its infancy stage of development. However this sealer came to a disastrous end because of the discrepancies between the manufacturer's claims and the clinical findings relating to its physical and clinical properties. Soon it became apparent that the sealer was not biocompatible as it caused a severe inflammatory reaction.[40]

EndoREZ, the second generation is non etching and hydrophilic in nature and does not require the adjunctive use of a dentin adhesive. It is designed to flow into accessory canals and dentinal tubules to facilitate the resin tag formation for retention, after smear layer removal with Sodium hypochlorite and EDTA.[40]

The third generation methacrylate resin based sealer incorporates self etching primers. The use of self etching primer reintroduced the concept of incorporating the smear layer created by hand/rotary instruments in between the sealer and the dentin interface. An acidic primer is applied to the dentin surface which penetrates through the smear layer and demineralizes the superficial dentin. The acidic primer is then air dried to remove the volatile carrier and dual cured. A moderately filled flowable resin composite sealer is then applied and polymerized. Provided, that these materials are sufficiently aggressive enough to etch through the thick smear layer. The technique sensitivity of bonding to root canals may be reduced when the smear layer is inadvertently retained in the apical third of the instrumented canal walls.[40]

The fourth generation of methacrylate resin based sealer (RealSeal SE) is functionally analogous to a similar class of recently introduced self

adhesive resin luting composites in that, they further eliminated the separate etching and bonding step in monomers. Acidic resin monomers that are originally present in dentin adhesive primers is incorporated into the resin based sealer / composite to render them self adhesive to the dentin substrate. The combination of an etchant, a primer and a sealer into an all in one self etching, self adhesive sealer is advantageous as it reduces the application time as well as the errors that might occur during each bonding step. The inclusion of an acidic resin monomer 4-methacryloyloxyethyl trimellitateanhydride(4-META) makes the sealer self etching , hydrophilic and also promotes the monomer diffusion into the underlying intact dentin to produce a hybrid layer after polymerization. The sealer bonds to the thermoplastic root filling material as well as to the radicular dentin via the creation of hybrid layers in both substrates.[40]

The ideal requirements of an endodontic irrigant according to Grossman are[9],that they should possess the following properties. The irrigant should

1. Have antimicrobial activity

2. Mechanically flush out the debris from the root canal

3. Be non toxic and biocompatible in nature

4. Dissolve necrotic and vital pulp tissue

5. Serve as a lubricant

6. Remove the smear layer

7. Have low surface tension

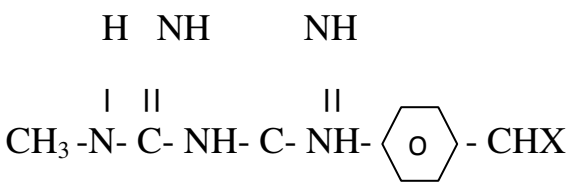
Out of all the current irrigants in use in the field endodontics, Sodium hypochlorite is the one that possess most of the desirable properties according to Grossman's ideal requirements and serves as a benchmark with which other irrigants are compared.

Sodium hypochlorite is both an oxidizing and hydrolyzing agent. It is a clear straw colored liquid with a pH of 10.83 to 10.98. It has bactericidal and proteolytic properties. As an endodontic irrigant it is relatively cheap, bactericidal, virucidal, it dissolves proteins, has low viscosity and has a reasonable shelf life. Some of the key features of Sodium hypochlorite is that it has a wide range of activity against both G+ve and G-ve bacteria. It is one of the strongest antifungal agents among root canal irrigants. It can also destroys bacterial biofilm effectively.[43]

Though, it is not without disadvantages, principally due to its toxicity. Sodium hypochlorite is extremely corrosive to metals, hypertonic and has

unpleasant taste. When Sodium hypochlorite reaches beyond the apical foramen it will lead to tissue necrosis and the patient will show signs of hematoma and ecchymosis.[43]

Chlorhexidine is a bisguanide that consists of two symmetric 4 chlorophenyl rings and two bisguanide groups connected by a central hexamethylene chain.



It has a pH of 5.5 to 7.[44]It has a positively charged hydrophobic and lipophilic molecule that interacts with phospholipids and lipopolysaccharides present in the cell membrane of bacteria and invades the cell membrane through a type of active or passive transport mechanism. Its efficacy is because of the interaction of the positive charge of the molecule and the negatively charged phosphate groups present on the microbial cell walls thereby altering the cells osmotic equilibrium. This increases the permeability of the cell wall which allows the Chlorhexidine molecule to penetrate into the bacteria.[44] Its key features are that it has a wide range activity against both G+ve and G-ve bacteria and is an effective antifungal agent especially against Candida albicans, it is less effective on microbial

biofilm than Sodium hypochlorite.[44]It has the important property of antibacterial substantivity in dentin lasting up to 48-72 hours. However Rosenthal demonstrated that the antimicrobial activity of 2% Chlorhexidine was maintained for up to 12 weeks after a 10 minute application.[22]The positively charged ions released by Chlorhexidine can also adsorb into the dentin and prevent microbial colonization on the dentin surface. The biocompatibility of Chlorhexidine is acceptable.[44]Its disadvantage is that it discolors the teeth. The effectiveness of Chlorhexidine to clean root canals is found to be inferior to that of Sodium hypochlorite.[26]

In the present scenario there is an increased awareness for safe, alternate, antimicrobial and biocompatible irrigants which can also provide the beneficial effects of traditional forms of medicine like Ayurveda, Siddha and Homeopathy without the potential hazards associated with irrigants like Sodium hypochlorite and Hydrogen peroxide. Hence the use of herbal alternatives like Triphala, Morinda citrifolia, Green tea, Aloe vera gel, Propolis, Neem tree extract and Tea tree oil started gaining in popularity.

Herbal and natural products of folk medicine have been used for centuries in every culture throughout the world. Scientists and medical professionals have shown increased interest in this field as they recognize

the true health benefits of these folk remedies. “Let food be your medicine and let medicine be your food” was quoted by the father of medicine (Hippocrates). Folk medicine in different cultures has a long history of ancestors creating primitive medicine during their struggle against natural calamities and disease.[36]

Polynesians have used the fruit juice extracted from the exotic Morinda citrifolia (or) Noni plant in folk remedies for more than 2000 years. Morinda citrifolia has a broad range of therapeutic effects including antibacterial, antiviral, antifungal, antitumor, antihelminthic, analgesic, hypotensive, anti-inflammatory and immune enhancing effects. It has been traditionally used for the treatment of diabetes, high blood pressure, cancer, injury, arthritis, digestive distress, artherosclerosis, pain relief and sensitivity.

Morinda citirfolia contains antibacterial components such as L-asperuloside and alizarin. Acetone extracts from Morinda citirfolia also demonstrated some amount of antimicrobial activity. It is also used for treating spongy gums, throat complaints and dysentery. It is also useful in alleviating symptoms of cold and flu such as fever, headache, ill-defined pain, congestion, cough, general malaise and sore throat.[3]

Triphala is a tridoshic formula of fruits namely Terminalia belerica, Terminalia chebula and Embilica officinalis. Clinical studies have proved its efficacy as an antioxidant, immunomodulator, rejuvenator, antiaging, anticancerous, antimutagenic, antimicrobial and blood purifier. It balances the level of cholesterol and removes the excess fat from the body. Triphala promotes longevity as well as memory.[24]Triphala is a good chelating agent and contains fruits that are rich in citric acid that may aid in the removal of the smear layer.

Antibacterial inertness of 10%Dimethyl sulfoxide was confirmed with the disc diffusion method.[27]10% Dimethyl sulfoxide is used in our study as a solvent for Triphala, since it is clean, safe and brings out the pure properties of all the components of the herbs being dissolved.

One of the fundamental principles in endodontic therapy is the efficient removal of diseased pulp from the tooth and replacing it with a suitable material. Thus cleaning and shaping of root canals dictates the success and failure of treatment to a large extent. The common obstacles one faces during this crucial part of treatment are in the form of calcified canals, pulp stones, dentinal obstructions and sclerosed canals. Chelating agents are one of the materials employed to overcome these problems. The most

commonly employed chelating agent is Ethylenediamine tetraacetic acid which was introduced by Nygard and Ostby in the year 1957.

The disodium salt of EDTA at 17% concentration is widely preferred for root canal treatment. It can reduce the extent of smear layer produced during endodontic preparation. The effectiveness of this preparation depends on the length of application and it clearly decreases from the canal orifice towards the apex. It is also used as a lubricant for instruments. Studies have shown that the paste type chelating agents whilst having lubricant effect do not remove the smear layer as effectively when compared to the liquid form of EDTA[33]. So EDTA wash is used in our study after the use of different irrigants. Moon et al have demonstrated that EDTA application increases the percentage and depth of sealer penetration, as smear layer is removed and deeper sealer penetration is achieved.[42]

Leakage studies are much more common than adhesion studies in evaluating the fluid impervious apical seal of various endodontic sealers. However, it has been seen that in teeth, leakage study methods may provide varying results. In addition, leakage studies do not reveal which of the two interfaces are leaking at is, the dentin sealer or Guttapercha sealer interface. They also do not furnish any insight into the mechanism of how the

combination of two different materials can contribute to an efficient apical seal.[16] Adhesion tests measure the tensile bond strength, where the bond is broken by a force perpendicular to the interface between the material and the surface. Hence the shear test was seen to be more accurate for measuring the bond strength of endodontic sealers to dentin as well as to Guttapercha and has been proven to be effective as well as being reproducible. This test model though does not replicate the clinical environment. Attempts to closely duplicate these clinical conditions have resulted in complicated experimental models that are difficult to reproduce and sometimes even to interpret them.[16]

Several researchers have studied the composition and structure of radicular dentin and have found minor differences from the coronal dentin. In the apical one-third of the root there are fewer dentinal tubules and hence consequently less resin tag formation during bonding procedures. This is potentially a positive feature if adhesive materials can be applied effectively because more amount of intertubular dentin is available for hybridization, but resin tags only make a minor contribution to bond strength. In some apical areas the dentin is irregular and devoid of any dentinal tubules. After bonding procedures the hybrid layer was found to be thinner in apical areas according to some authors whereas no difference was found by others.[29]The

Results also varied depending upon the different products used .These differences appear to be of little significance because the thickness of the hybrid layer has no influence on the adhesive capacity. Root dentin is not uniform and the surface of canal walls that has been prepared during the cleaning and shaping procedures may differ widely. This is true not only between specimens, but also inbetween sites in the same root, according to the level or the direction of wall either proximal or faciolingual. Therefore coronal rather than root dentin was used for better reproducibility and hence occlusal 2mm reduction was done to obtain the coronal dentin.

Previous studies revealed that RealSeal SE showed time dependent increase in the degree of conversion after the mixing procedure.[35] According to the manufacturers, RealSeal SE will self cure in the root canal within 45 minutes but studies revealed that the degree of conversion was only up to 60% and it achieved a stable degree of conversion only after 1 week. So the samples were stored in 100% humidity for 7 days before the evaluation of shear bond strength. [35]

After the results were tabulated, statistical analysis was done using Student's 'T' test and Duncan's Multiple Range Test. Student's 'T' test was used to compare more than 2 groups, but its accuracy is less when there is

more than two groups . Hence we also used the Duncan's multiple range test as it is used to compare between groups when there is more than 2 groups and its accuracy is more when there are more than two groups.

In Group I and Group II, Sodium hypochlorite Subgroup showed the highest shear bond strength values when compared between both the other Subgroups. This is in concurrence to the previous studies where Wachlarowicz et al determined the shear bond strength of a resin based sealer to dentin using Sodium hypochlorite as an irrigant, where Sodium hypochlorite showed the highest values when compared with the rest of the irrigants used in the study.[1] This difference could be seen as a result of the absence of smear layer. Sodium hypochlorite irrigation alone is capable of removing only the organic portion of smear layer.[1]It is not effective in removing the entire smear layer. Using EDTA after Sodium hypochlorite resulted in the complete removal of smear layer and it results in higher bond strength.[1]The dissolving properties of Sodium hypochlorite on the collagen components of dentin increases the surface roughness. This surface roughness could be of clinical benefit for the micromechanical bonding of the adhesive material.[37]

When the Subgroup Morinda citrifolia is compared with both Subgroups Triphala and Chlorhexidine in Group I and Group II, dentin surface irrigated with Morinda citrifolia has higher shear bond strength values with the sealer RealSeal SE. This could be because of the ability of Morinda citrifolia in removing the smear layer which is in concurrence with the previous studies.[26]Murray et al also evaluated Morinda citrifolia in conjunction with EDTA as a possible alternative to sodium hypochlorite.The smear layer removing ability of Morinda citrifolia could be due to the acidic nature (pH 4.16)as it is rich in Ascorbic acid, Caproic acid, Caprylic acid, Ursolic acid, Aspartic acid and Glutamic acid.[31, 39]

When Subgroup Triphala is compared with Subgroup Chlorhexidine in both the Group I and Group II, it is seen that dentin surface irrigated with Triphala has a higher shear bond strength value with the sealer RealSeal SE. Triphala an Indian Ayurvedic herbal formulation consists of the dried and powdered fruits of three medicinal plants namely Terminalia bellerica Terminalia chebula and Emblica officinalis. Moreover Triphala is a very good chelating agent.[27]Triphala in particular contains fruits that are rich in Citric acid and that may aid in the removal of the smear layer.[27]It has also been proved in previous studies that Triphala is also rich in Gallic acid and

tannic acid[24] and this might have also resulted in the smear layer removal and resulted in high shear bond strength values for the Subgroup Triphala.

Subgroup Chlorhexidine in both Groups I and II showed the least shear bond strength values when compared among the other Subgroups. Chlorhexidine is used as one of the predominant irrigants during cleaning and shaping of the root canal. It is mainly used because of its antibacterial substantivity in dentin. The positively charged ions released by Chlorhexidine can adsorb into dentin and prevent microbial colonization on the dentin surface for sometime beyond the actual period of application.[44]But its only disadvantage is that it does not have the ability to remove the smear layer. Wachalarowicz et al concluded that using Water and Chlorhexidine as an irrigant resulted in significantly lower bond strength values[1], which might be the reason as to why RealSeal SE has the least shear bond strength values with dentin after irrigation with Chlorhexidine.

When Subgroups of Group I (without EDTA) and Group II (with EDTA) were compared, Subgroups of Group II had higher shear bond strength values, as it was proved by White et al[38]that the ability of the sealer to penetrate into the dentinal tubules and thereby adaptation of the root canal filling to the root canal walls is much more improved after the removal of

the smear layer[11] and this was due to the ability of 17% EDTA which had led to a better bonding of the sealer to the dentin.

However further invivo studies are necessary to evaluate how the role of oral environment will affect the shear bond strength of the resin based sealer RealSeal SE to dentin, using different irrigants.

Summary

The present in vitro study was undertaken to evaluate the effect of four different irrigants namely Sodium hypochlorite, Chlorhexidine, Triphala and Morinda citrifolia on the shear bond strength of a self etch sealer, RealSeal SE to dentin by using with and without EDTA as the final irrigant using an Universal Testing Machine.

The study was done using one hundred and twenty extracted maxillary and mandibular human molars. A low speed diamond disk saw with Water coolant was used to slice off the occlusal 2mm of the samples whereby a flat dentinal surface surrounded by a thin rim of enamel was obtained. This section of tooth, which included the roots, were embedded in a self cure acrylic resin. A smear layer was created on the sectioned teeth using a 320 grit silicon carbide paper on a Handimet grinder (Buehler, Ltd) under Water irrigation for a time period of 15 seconds. The dentin disks with the smear layer were then randomly divided into 2 groups namely Group I-without EDTA and Group II-with EDTA. Each of the Group was further divided into four Subgroups namely Sodium hypochlorite, Morinda citrifolia, Triphala and Chlorhexidine respectively.

The dentin discs were air dried using a air-water syringe. A brass tube of 4mm internal diameter and 3mm height was placed onto the dentin

surface. The brass tube was filled with RealSeal SE, (Fig.4H) which was mixed according to the manufacturer's instructions. The sealer was then light cured using a light curing unit (QHL-75,Dentsply) for 40 seconds and allowed to set for forty five minutes. The samples were immediately stored in distilled water at 37^{o}C and maintained at 100% humidity for 7 days.

The specimens were then engaged perpendicularly at their bases on a Universal Testing Machine (INSTRON 3365). Each specimen was evaluated for its shear bond strength values, at a cross head speed of 1mm/minute. The shear force required to separate the cylinder from dentin was recorded in Newtons (N) for each specimen, then divided by contact surface area to determine the shear bond strength in Megapascals.

The results were then statistically analyzed using a paired One way ANOVA, Students 'T' test and Duncan's Multiple Range Test. The results revealed that Subgroup Sodium hypochlorite had the highest shear bond strength in Group I (without EDTA) and Group II (with EDTA) followed in order by Subgroups Morinda citrifolia, Triphala and Chlorhexidine in both groups. When both Group I and Group II were compared, the GroupII (with EDTA), all the Subgroups showed highest bond strength to dentin with resin sealer (RealSeal SE).

Conclusion

CONCLUSION

Within the limitations of the study it can be concluded that

1. Sodium hypochlorite Subgroup in both the Group I (without EDTA) and Group II (with EDTA) showed the maximum shear bond strength values.

2. Chlorhexidine Subgroup in both the Group I (without EDTA) and Group II (with EDTA) showed the minimum shear bond strength values.

3.Triphala and Morinda citrifolia Subgroups showed shear bond strength values more than Chlorhexidine but less than Sodium hypochlorite in both the groups.

4. Triphala and Morinda citrifolia could be used as herbal alternative irrigants during the cleaning and shaping of the root canals. It is seen that they are as effective but are less toxic and more biocompatible than the traditionally used irrigants.

5. Further studies with more parameters are necessary to validate these results and to determine the suitability of this material for invivo use.

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