EVALUATION OF THE EFFECT OF VARIOUS INTRACANAL MEDICAMENTS ON THE PUSH-OUT BOND STRENGTH OF A RESIN BASED ENDODONTIC SEALER TO THE ROOT CANAL DENTIN AFTER USING 95% ETHANOL AS A FINAL IRRIGANT - AN IN VITRO STUDY

Dissertation submitted to

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

In partial fulfilment for the Degree of

MASTER OF DENTAL SURGERY

BRANCH - IV

CONSERVATIVE DENTISTRY AND ENDODONTICS

2017-2020

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation titled "**EVALUATION OF THE EFFECT OF VARIOUS INTRACANAL MEDICAMENTS ON THE PUSH-OUT BOND STRENGTH OF A RESIN BASED ENDODONTIC SEALER TO THE ROOT CANAL DENTIN AFTER USING 95% ETHANOL AS A FINAL IRRIGANT - AN IN VITRO STUDY"** is a bonafide work done by **Dr.PUSHPALATHA.K,** Postgraduate student, during the course of the study for the degree of **MASTER OF DENTAL SURGERY** in the speciality of **BRANCH-IV DEPARTMENT OF CONSERVATIVE DENTISTRY AND ENDODONTICS,** Vivekanandha Dental College for Women, Tiruchengode, during the period of 2017-2020.

Date:

Place:

Signature of Guide

Dr. A.S. PRASAD, M.D.S.,
Reader ,
Department of Conservative Dentistry and Endodontics.

ENDORSEMENT BY THE HEAD OF THE DEPARTMENT AND HEAD OF THE INSTITUTION

This is to certify that **Dr.PUSHPALATHA.K,** Post Graduate student (2017-2020) in the **DEPARTMENT OF CONSERVATIVE DENTISTRY AND ENDODONTICS**, Vivekanandha Dental College for Women, has done this dissertation titled **"EVALUATION OF THE EFFECT OF VARIOUS INTRACANAL MEDICAMENTS ON THE PUSH-OUT BOND STRENGTH OF A RESIN BASED ENDODONTIC SEALER TO THE ROOT CANAL DENTIN AFTER USING 95% ETHANOL AS A FINAL IRRIGANT - AN IN VITRO STUDY"** under our guidance and supervision in partial fulfillment of the regulations laid down by the Tamilnadu Dr.M.G.R. Medical University, Chennai-600032 for M.D.S **(Branch-IV) DEPARTMENT OF CONSERVATIVE DENTISTRY AND ENDODONTICS**

Signature of H.O.D

Dr.Vaiyapuri Ravi, M.D.S.,
Professor and H.O.D,
Department of Conservative Dentistry and Endodontics.

Signature of the Principal

Dr. N. Balan, M.D.S.,
Principal,
Vivekanandha Dental College for Women,
Elayampalayam, Tiruchengode

DECLARATION

TITLE OF DISSERTATION	**EVALUATION OF THE EFFECT OF VARIOUS INTRACANAL MEDICAMENTS ON THE PUSH-OUT BOND STRENGTH OF A RESIN BASED ENDODONTIC SEALER TO THE ROOT CANAL DENTIN AFTER USING 95% ETHANOL AS A FINAL IRRIGANT - AN IN VITRO STUDY**
PLACE OF STUDY	**VIVEKANANDHA DENTAL COLLEGE FOR WOMEN, TIRUCHENGODE**
DURATION OF THE COURSE	**3 YEARS (2017-2020)**
GUIDE	**DR. A. S. PRASAD., M.D.S., (READER)**
HEAD OF THE DEPARTMENT	**Dr. VAIYAPURI RAVI, M.D.S., (PROFESSOR & HOD)**

I hereby declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission of the Principal, Vivekanandha Dental College for Women, Tiruchengode. In addition, I declare that no part of this work will be published either in print or electronic format without the permission of the Guide who has been actively involved in the dissertation. The author has the right to reserve publishing of work solely with prior permission of the Principal, Vivekanandha Dental College for Women, Tiruchengode.

Head of the Department	Guide	Signature of the Candidate
Dr.Vaiyapuri Ravi, M.D.S.,	**Dr. A. S.Prasad., M.D.S.,**	**Dr. Pushpalatha.K**

CERTIFICATE – II

This is to certify that this dissertation work titled **"EVALUATION OF THE EFFECT OF VARIOUS INTRACANAL MEDICAMENTS ON THE PUSH-OUT BOND STRENGTH OF A RESIN BASED ENDODONTIC SEALER TO THE ROOT CANAL DENTIN AFTER USING 95% ETHANOL AS A FINAL IRRIGANT - AN IN VITRO STUDY"**of the candidate **Dr.PUSHPALATHA.K,** with registration Number **241717553** for the award of **MASTER OF DENTAL SURGERY** in the branch of **CONSERVATIVE DENTISTRY AND ENDODONTICS**.

Guide & Supervisor sign with Seal.

ACKNOWLEDGEMENT

God's support through this career cannot be quantified. My sincere thanks and deep sense of gratitude to our respected Dean, **Dr.Capt.S. Gokulanathan,B.Sc., M.D.S.,** and **Dr.N.Balan M.D.S.,** Principal, Vivekanandha Dental College for Women, for permitting me to pursue this work.

With submissive ambition, I aspire to acknowledge my indebtedness and deep sense of gratitude to my respected Mentor, **Dr.Vaiyapuri Ravi, M.D.S.,** Professor and Head of the Department, Department of Conservative Dentistry and Endodontics, Vivekanandha Dental College for Women, for his inspiring guidance, invaluable counsel and encouragement throughout the course of work. His valuable guidance, kind supervision and his affectionate and compassionate counselling given to me throughout the course shaped me the present work as its shown.

I am greatly indebted to my guide **Dr.A.S.Prasad,M.D.S.,** Reader**,** (Guide), Department of Conservative Dentistry and Endodontics, Vivekanandha Dental College for Women, for his knowledge and experience in guiding me to understand the concept behind this research work. His valuable criticism, constructive suggestion and constant support that enable me to comprehend this dissertation and reach its successful culmination. I am grateful to him for sparing his valuable time in guiding me throughout this work. His profound knowledge and valuable suggestions had benefited me in every facet of my academic life.

I would like to extend my heartfelt gratitude to **Dr.Andamuthu Sivakumar , M.D.S** .,Professor , **Dr.Aji Markose, M.D.S**, Professor**,** for his invaluable guidance and support at every juncture throughout my postgraduate curriculum.

I take this opportunity to express my sincere heartfelt thanks to **Dr.J.S.Sivakumar, M.D.S.,** Reader, **Dr.Saravana Priyan Soundappan, M.D.S**., Reader**, Dr.M.Chittrarasu, M.D.S.,** Senior Lecturer for rendering me their valuable suggestions and generous support during this course of work.

I am extremely thankful to my **Parents (Dr.P.C Kannaian and Mrs.Sathyavathy kannaian),** Husband **Dr.J.Ravindra prasad** and my two sons **Master R.Kavin Prasath and Master R.Navin Prasath** for the help rendered during my dissertation work, without whom this academic session would just have been a dream. They were with me in all ups and down of my life and the pillars of my strength.

I am grateful to my juniors - **Dr.Annabelle Primola, Dr.Ragavi.S** and **Dr.Sasmitha.C,** my sub juniors **Dr.Arun karthika.P, Dr.Saranya Kumaravel** and **Dr.Saranya.R** and my batchmates **Dr.Anuradha.R.S** and **Dr.Brindha.L** for their continued support and encouragement throughout my postgraduate programme.

Urkund Analysis Result

Analysed Document: edited plagarisim 4 %.docx (D61834573)
Submitted: 1/4/2020 8:40:00 AM
Submitted By: drpushpalathaprasad@gmail.com
Significance: 5 %

Sources included in the report:

https://www.actascientific.com/ASDS/pdf/ASDS-03-0716.pdf
https://www.researchgate.net/publication/297752464_Evaluation_of_the_effect_of_calcium_hydroxide_and_propolis_intracanal_medicaments_on_the_push-out_bond_strength_of_a_resin-based_endodontic_sealer_to_the_root_canal_dentin_An_in_vitro_study
https://www.researchgate.net/publication/6739851_Removal_Efficiency_of_Calcium_Hydroxide_Intracanal_Medicament_With_Two_Calcium_Chelators_Volumetric_Analysis_Using_Spiral_CT_An_In_Vitro_Study
https://www.researchgate.net/publication/236275385_Effect_of_Different_Irrigation_Protocols_on_Resin_Sealer_Bond_Strength_to_Dentin
https://dergipark.org.tr/tr/download/article-file/284819
https://www.researchgate.net/publication/258636547_Effects_of_calcium_hydroxide_and_propolis_intracanal_medicaments_on_bond_strength_of_resin-based_endodontic_sealer_as_assessed_by_push-out_test
https://www.researchgate.net/publication/224977016_Effect_of_Different_Final_Irrigation_Solutions_on_Dentinal_Tubule_Penetration_Depth_and_Percentage_of_Root_Canal_Sealer
https://www.researchgate.net/publication/44662127_Efficacy_of_different_irrigants_in_the_removal_of_calcium_hydroxide_from_root_canals
https://www.researchgate.net/publication/224768378_The_Effect_of_Prior_Calcium_Hydroxide_Intracanal_Placement_on_the_Bond_Strength_of_Two_Calcium_Silicate-based_and_an_Epoxy_Resin-based_Endodontic_Sealer

Instances where selected sources appear:

45

LIST OF TABLES

S.NO	CONTENT	PAGE. NO
1.	**INTRODUCTION**	**1-4**
2.	**AIM AND OBJECTIVE**	**5**
3.	**REVIEW OF LITERARURE**	**6-14**
4	**MATERIALS AND METHODS**	**15-21**
5.	**IMAGES**	**22-31**
6.	**RESULTS**	**32-50**
7.	**DISCUSSION**	**51-58**
8.	**SUMMARY AND CONCLUSION**	**59-61**
9.	**BIBILIOGRAPHY**	**62-73**

INTRODUCTION

Endodontic therapy also known as endodontic treatment or root canal therapy, is a treatment sequence for treating the infected pulp which results in the elimination of infection and protection of the decontaminated tooth from future microbial invasion[1].Root canals and their associated pulp chamber are physical hollows present within a tooth that are naturally inhabited by nerves, blood vessels and, various cellular entities. Together, they constitute the dental pulp[2].

Root canal therapy involves removal of these structures, subsequent shaping, cleaning, with endodontic instruments, irrigating solutions, and then finally obturating (filling) the prepared canals using gutta-percha coated with the sealer having a high capability to bond to dentin to achieve a proper seal[3].

Bacteria remaining in the root canal system and, their proliferation might exert adverse effects on the outcome of endodontic treatment . Although root canal treatment procedures have made a lot of progress in recent years, no single technique can completely debride the root canal system free of microbes. Hence, researchers have recommended the use of intracanal medicaments to decrease bacterial counts in the root canals [4].

Various intracanal medicaments have been placed inside the root canal between treatment appointments in an attempt to destroy remaining microorganisms and prevent reinfection. Thus they may be utilized to kill bacteria, reduce inflammation (and thereby reduce pain), help eliminate apical exudate, control inflammatory root resorption, and prevent contamination between appointments[5]. Various intracanal medicaments are Calcium hydroxide, Calcium hydroxide in combination with iodoform , Triple antibiotic paste, Ledermix (steroid), phenols,

aldehydes, Bioactive glass, Iodine-potassium iodide, Chlorhexidine gel and a combination of Chlorhexidine mixed with calcium hydroxide.

Calcium hydroxide is widely used in the field of endodontics as an intracanal medicament due to its antibacterial and biological properties , has an organic tissue dissolution capability and anti-inflammatory effect and promotes denaturation of proinflammatory cytokine mediators[6].It has an initial bactericidal and later bacteriostatic effect, promotes healing and repair, high pH stimulates fibroblasts, stops internal resorption, neutralizes low pH of acids, is inexpensive and, easy to use[7].

Several workers have studied the combination of other substances with calcium hydroxide in order to improve some of its properties. Among these additional substances are vehicles that can speed up or slow down ionic dissociation, substances that aid the filling of the pulpal cavity through their consistency and it's enhance radiopacity [8]. One such composition of Calcium hydroxide with a trading name Metapex contains iodoform and silicone oil which is effective against Enterococcus faecalis[9]. The superior antimicrobial efficacy of Metapex may be due to the combination with iodoformand the viscous and oily vehicle, which may prolong the action of the medicament. In a study by Cwikla et al., Metapex exhibited a more potent antibacterial activity within the root canal compared to pure Calcium hydroxide[10].

Infections of the root canal system are considered to be polymicrobial consisting of both aerobic and anaerobic bacteria. Therefore, a single antibiotic therapy may not be sufficient to handle root canal's infection for its complexity. A combination of antibiotics is essential to address the diverse flora encountered. Triple antibiotic paste containing metronidazole, ciprofloxacin and minocycline has been

proposed as a root canal medicament due to its antimicrobial effects. However, crown discoloration has been associated with Triple antibiotic paste[11]. Therefore recent studies have suggested substituting minocycline with another antibiotic namedClindamycin which has been found to be effective against various endodontic pathogens. A modified triple antibiotic paste (MTAP) composed of metronidazole, ciprofloxacin, and clindamycin was successfully used as an intracanal medicament to disinfect necrotic immature teeth[12].

The remnants of intracanal medicaments within the root canal walls could compromise the outcome of endodontic treatment as it would interfere with the sealing ability of endodontic sealers. It should be removed before root filling because the residue on the canal walls negatively affects the quality of the root filling[13].

Various methods that have been advocated to remove the intracanal medicaments are ultrasonics, sonic, canal brush, and irrigating agents including NaOCl, EDTA, their combination, maleic acid, distilled water and passive ultrasonic irrigation agitated with EDTA.

Passive ultrasonic irrigation is one such method used to remove the intracanal medicaments and is based on the transmission of energy from an ultrasonic oscillating instrument to the irrigant inside the root canal [14].It has been shown that the irrigants combined with ultrasonic vibration, is directly associated with the amount of removal of organic and inorganic debris from the root canal walls [15].

It has been postulated that increased sealer penetration has the potential to decrease the apical leakage[16]. An ideal root canal sealer should have a low viscosity and good wetting properties to flow into the irregularities of the root canal wall and into the dentinal tubules[17].Surface wetting can be affected by altering the sealer and by altering the surface activity of the dentin[18].Studies using 95% Ethanolas final

rinse and its effect on the bond strength of sealers are very few and this study aims toevaluate the effect of 95% Ethanol as a final rinse after removal of various intracanal medicaments and to evaluate the bond strength of Resin based endodontic sealer to root dentin using push - out test.

AIM AND OBJECTIVES

AIM

The purpose of the present in vitro study is to evaluate the use of 95% Ethanol as final rinse to remove various intracanal medicaments and to evaluate the bond strength of Resin based endodontic sealer to root dentin using push - out test.

OBJECTIVES

1. The objective of the present study is to compare the removal of calcium hydroxide, metapex and triple antibiotic paste using 95% ethanol as final irrigant and to evaluate the bond strength of the resin based endodontic sealer by using Universal testing machine.

2. To assess the modes of bond failure between the interface of the sealer, canal wall and the obturating core using Stereomicroscope at 32X magnification.

REVIEW OF LITERATURE

Suresh Nandini et al in 2006 evaluated the removal efficiency of Calcium Hydroxide Intracanal Medicament with Two Calcium Chelators and concluded that the vehicle used to prepare calcium hydroxide paste is important for its retrieval. Oil based calcium hydroxide is more difficult to remove than powder form calcium hydroxide mixed with distilled water. Both 17% EDTA and 10% citric acid were found to remove the powder form of calcium hydroxide in distilled water efficiently, whereas 10% citric acid was found to perform better than EDTA in removing oil-based calcium hydroxide [19].

Stevens, et al in 2006 evaluated the smear layer removal did not affect the diffusion of intracanal medicaments. After the smear layer removal, the dentinal tubules were left open and demonstrated a capillary type action and explored the idea of using alcohol as an agent to increase wetting of the dentin surface before sealer application. He found a final rinse of 95% ethyl alcohol prior to obturation increased sealer penetration Final rinse with 95% ethyl alcohol may have a similar effect when used before application of CH intracanal medicaments [20].

C. Sathorn, P. Parashos & H. Messer in 2007 studied on Antibacterial efficacy of calcium hydroxide intracanal dressing: a systematic review and meta-analysis and concluded Calcium hydroxide has limited effectiveness in eliminating bacteria from human root canal when assessed by culture techniques [21].

Saif, et al.in 2008 found that 3mL of EDTA with a final rinse of 10mL NaOCl was more effective in promoting hydroxyl ion diffusion to the external root surface than 1mL and equally effective to 10 mL EDTA [22].

Saito, et al in 2008 demonstrated that 1mL for 1 min of EDTA provided adequate smear layer removal, but shorter time periods did not remove the entire smear layer[23].

Vinicius Humberto et al in 2008 evaluated the Adhesion of Epiphany and AH Plus Sealers to Human Root Dentin Treated with Different Solutions and resulted that AH Plus sealer presented greater adhesion to dentin than Epiphany, regardless of the treatment of root canal walls [24].

João Vicente Baroni et al in 2008 evaluated the Effect of Calcium Hydroxide Intracanal Dressing on the Bond Strength of a Resin-Based Endodontic Sealer and concluded that the use of Ca (OH)2 as an intracanal dressing material affected the adhesion of Epiphany™ to the root canal walls [25].

Ricardo Julio Cabrales Salgado et al in 2009 Compared different irrigants on calcium hydroxide medication removal and microscopic cleanliness evaluation and concluded that the recapitulation of master apical file in combination with irrigants improved the removal of calcium hydroxide medication better than an irrigant flush alone [26].

Hong-Guan Kuah et al in 2009 studied the effect of EDTA with and without Ultrasonics on Removal of the Smear Layer and concluded that a 1-minute application of combined use of EDTA and ultrasonics is efficient for smear layer and debris removal in the apical region of the root canal [27].

T. Ro¨ dig et al in 2010 evaluated the Efficacy of different irrigants in the removal of calcium hydroxide from root canals and resulted that Chelating agents such as citric acid and EDTA showed the best results [28].

R. P. A. Balvedi et al in 2010 compared two techniques for the removal of calcium hydroxide from root canals found neither syringe injection nor PUI methods were efficient in removing the inter-appointment root canal medicaments [29].

Lei-Meng Jiang et al in 2010 influenced the Oscillation Direction of an Ultrasonic File on the Cleaning Efficacy of Passive Ultrasonic Irrigation and concluded that Oscillation of the ultrasonically driven file toward the groove is more effective in removing dentin debris from the groove than oscillation perpendicular to the groove, which can be related to the fact that there is a high-velocity jet from the file tip in a single direction following the file oscillation and a relatively slow inflow in the perpendicular direction [30].

T. Tas¸demir et al in 2011 evaluated the efficacy of several techniques for the removal of calcium hydroxide medicament from root canals and resulted that canalbrush and ultrasonic agitation of NaOCl were significantly more effective than irrigant-only techniques [31].

Heward and Sedgley et al in 2011 evaluated the CH concentration of 41-46% and a Barium Sulphate concentration of 5-10%. The mixing vehicle is listed as Ringer solution >48 %, and the pH is reported to be 12.4. Both of these materials are convenient to apply, and have been previously demonstrated to affect pH change and have adequate antimicrobial properties and concluded the common use and favorable properties of these specific dressings makes their inclusion in this study clinically applicable [32].

Anne Wiseman et al in 2011 evaluated the efficacy of Sonic and Ultrasonic Activation for Removal of Calcium Hydroxide from Mesial Canals of Mandibular Molars and concluded that the combination of rotary instrumentation and passive

ultrasonic activation for 3 periods of 20 seconds each results in significantly lower amounts of Ca(OH)2 remnants in the canal compared with sonic irrigation [33].

Danielle Ferreira de Assis et al in 2011 evaluated the Interaction between Endodontic Sealers and Dentin Treated with Different Irrigant Solutions concluded that smear layer removal and final flush with CHX favor the wettability of AH Plus and Real Seal SE sealers [34].

NV Ballal et al in 2012 Compared the evaluation of different chelators in removal of calcium hydroxide preparations from root canals concluded that Concentrations of 7% maleic acid and 10% citric acid were found to be superior to 17% EDTA in the removal of (CH + iodoform + silicone oil). (CH + PG) preparation was completely removed by all the irrigants [35].

Rangasamy Vijayaraghavan et al in 2012 did a study on Triple antibiotic paste (TAP) containing metronidazole, ciprofloxacin, and minocycline has been reported to be a successful regimen in controlling the root canal pathogen and in managing non-vital young permanent tooth concluded that Triple antibiotic paste can be effectively used for sterilization of canals and healing of periapical pathology [36].

P. Neelakantan et al in 2013 studied continuous chelation irrigation improves the adhesion of epoxy resin-based root canal sealer to root dentine concluded that the continuous chelation irrigation protocol optimizes the bond strength of an epoxy resin sealer to dentine [37].

Mohan Thomas Nainan et al in 2013 Compared the efficacy of ethylene diamine tetra acetic acid and maleic acid in the removal of three calcium hydroxide intracanal dressing concluded that Calcium hydroxide, distilled water mixture and polyethylene glycol-based calcium hydroxide were efficiently removed by 17%

EDTA and 7% maleic acid. 7% maleic acid removed silicone oil-based calcium hydroxide preparation better than 17% EDTA [38].

Yakup ÜSTÜN et al in 2013 studied the effects of calcium hydroxide and propolis intracanal medicaments on bond strength of resin-based endodontic sealer as assessed by push-out test concluded that no significant differences in bond strength were observed at coronal and middle thirds, Propolis group showed significantly superior push-out bond strength than Ca(OH)2 and Control groups at apical third. Propolis is not a mainstream intracanal medicament material yet, but it had shown promising results when used with an epoxy resin-based sealer such as AH Plus [39].

Maira Prado et al in 2013 did a study on the Effect of Different Irrigation Protocols on Resin Sealer Bond Strength to Dentin concluded that the gutta-percha/AH Plus groups, the bond strength values were higher when NaOCl was associated with phosphoric acid or CHX with EDTA. In the Resilon/Real Seal SE groups, the protocol associating CHX with phosphoric acid showed better results. The gutta-percha/AH groups showed mainly cohesive failure patterns, whereas in the Resilon/Real Seal SE the failure patterns were mainly adhesive [40].

Nikhil Vineeta et al in 2014 studied the retrievabilty of calcium hydroxide intracanal medicament with Chitosan from root canals and gave a conclusion that combination of 0.2% Chitosan and ultrasonic agitation results in lower amount of Ca(OH)2 remnants than 17% EDTA irrespective of type of vehicle present in the mix[41].

Merve Akcay et al in 2014 evaluated the effect of Calcium Hydroxide and Double and Triple Antibiotic Pastes on the Bond Strength of Epoxy Resin–based Sealer to Root Canal Dentin concluded that double antibiotic paste and chlorhexidene did not affect the bond strength of the epoxy resin–based sealer. However, TAP

improved the bond strength of the epoxy resin– based sealer in the middle and apical thirds [42].

Julie A. Berkhof et al in 2018 evaluated the Triple Antibiotic Paste Removal by Different Irrigation Procedures and concluded that approximately 88%of the TAP was retained in the root canal system regardless of the irrigation technique used [43].

M. Z. Scelza et al in 2014 evaluated the Influence of a new push-out test method on the bond strength of three resin-based sealers use of different irrigating solutions did not affect resistance to the displacement of resin sealers. Real Seal sealer was less resistant than Ad Seal and AH Plus [44].

Flávia Angélica et al in 2014 evaluated the effect of calcium hydroxide dressing on push -out bond strength of endodontic sealers to root canal dentin and resulted that the bond strength values for MTA Fillapex and Sealapex were lower than those for AH Plus [45].

Blake T. Prather et al in 2014 evaluated the Effects of two combinations of triple antibiotic paste used in endodontic regeneration on root microhardness and chemical structure of radicular dentine and concluded that low concentration of TAP was suggested to be efficient against various endodontic pathogens [46].

Heuseyin Sinan Topc¸uo_glu et al in 2016 evaluated that the effect of different Final Irrigation Activation Techniques on the Bond Strength of an Epoxy Resin–based Endodontic Sealer and concluded that the bond strength of AH Plus sealer to root canal dentin may improve with ultrasonic activation in the coronal , middle and in the apical third [47].

Carina Michelon et al in 2015 studied the effectiveness of passive ultrasonic irrigation on calcium hydroxide removal with different solutions and concluded that

the association of 'master apical file' with the PUI using NaOCl and chelating solutions for removing Ca (OH)2 were equally effective in removing Ca (OH)2 [48].

Marcusvinci et al in 2015 did a study on passive 'ultrasonic irrigation in Calcium hydroxide'removal from root canals and concluded that the amount of Calcium hydroxide paste on the dentinal walls was not dependent on length of time of ultrasonic activation [49].

C. Bhuyan et al in 2015 compared the effectiveness of four different techniques in removing intracanal medicament from the root canals resulted that the Canal Brush and ultrasonic techniques were significantly better than the rotary instrument and irrigant groups [50].

Preeti Jain et al in 2015 evaluated calcium hydroxide medication removal using various irrigants and methods and said that passive ultrasonic irrigation proved more effective than syringe irrigation [51].

Busanello et al in 2015 evaluated the efficacy of different lengths of time of passive ultrasonic irrigation (PUI) in removing calcium hydroxide CH paste from root canal, using scanning electron microscopy and energy dispersive spectrometry SEM/EDS concluded that the amount of calcium hydroxide paste on dentinal walls was not dependent on the time duration of ultrasonic activation [52].

Derya Deniz Sungur et al in 2015 evaluated the Push-out bond strength and dentinal tubule penetration of different root canal sealers used with coated core materials concluded that the bond strength and sealer penetration of resin and glass ionomer-based sealers used with coated core was not superior to resin-based sealer used with conventional gutta-percha [53].

Elka n. radeva et al in 2016 evaluated the efficacy of different endodontic irrigation protocols in calcium hydroxide removal and concluded that there in not a universal technique for removal of intracanal medicaments [54].

Atul Jain et al in 2017 evaluated the removal of Intracanal Calcium Hydroxide with Different File System sand concluded that multiple rotary file system (HERO Shaper) is more effective in removal of Ca (OH)2 than the single file system (One Shape) [55].

Manjeet Kaur et al in 2017 compared the evaluation of Anti-Microbial effects of Triple Antibiotic Paste and Amox and its derivatives against *E. faecalis* and concluded that Triple antibiotic showed the maximum inhibition, Amoxicillin and Clavulanic acid combination along with Metronidazole gave the most reliable results[56].

Shibha Mehta et al in 2017 compared the evaluation of antimicrobial efficacy of triple antibiotic paste, calcium hydroxide, and a proton pump inhibitor against resistant root canal pathogens and concluded that proton pump inhibitor enhanced the antibacterial efficacy of CH against *E. faecalis* and *C.albicans* [57].

Carlos Henrique Ribeiro et al in 2017 evaluated that Calcium Hydroxide improves epoxy sealer adhesion on root dentin and resulted that intracanal medication based on calcium hydroxide improved the bond strength of AH Plus to dentin walls, regardless of the EDTA protocol [58].

Sahar Shakouie et al in 2017 compared the effects of different intra canal medicaments on the push out bond strength of endodontic sealers and concluded that bond strength values were significantly higher with AH26 compared to MTA Fillapex[59].

Sholeh Ghabraei et al in 2017 evaluated the effect of Intra-Canal Calcium Hydroxide Remnants on the Push- out Bond Strength of Two Endodontic Sealers and concluded that CH remnants had a negative effect on the push out bond strength of AH-26 and BC Sealer. Ultrasonic irrigation was more effective in removing CH [60].

Ardavan Parhizkar et al in 2018 did the latest findings and notions regarding 'triple antibiotic paste' (TAP) and its applications in dentistry, particularly endodontics and concluded that TAP seems to be a successful combination of drugs in root canal disinfection/sterilization and pulp regeneration and revascularization protocol [61].

Zahed Mohammadi et al in 2018 reviewed that Triple Antibiotic Paste as a Suitable Material Used in Regenerative Endodontics and concluded that TAP can be efficiently used for removal of bacteria from root canal [62].

Ramya Raghu et al in 2018 evaluated the retrievability of calcium hydroxide intracanal medicament with three calcium chelators, ethylenediamine tetraacetic acid, citric acid, and chitosan from root canals using cone beam computed tomography volumetric analysis and concluded that a combination of 0.2% Chitosan and ultrasonic agitation results in lower amount of $Ca(OH)_2$ remnants than 17% EDTA, 20% Citric acid irrespective of type of vehicle present in the mix [63].

Sowmiya Tamil et al in 2019 evaluated the Intracanal Calcium Hydroxide removal with Hand File, Rotary File, and Passive Ultrasonic Irrigation and concluded that PUI had the highest ability to remove Ca $(OH)_2$ from the root canal walls when compared to the use of HERO shaper followed by hand file system [64].

MATERIALS & METHODS

Sources of sample:

One hundred and eight single - rooted maxillary central incisors extracted for therapeutic reasons was collected from the Department of Oral and Maxillofacial Surgery, Vivekanandha Dental college for women, Thiruchengode for this study.

Materials used:

- Calcium hydroxide (Prevest Denpro).
- Calcium hydroxide + Iodoform (Metapex Meta biomed).
- Triple antibiotic paste.
- Distilled water (Wilkins)
- 17%EDTA (Prevest Denpro)
- 95% Ethanol (maxill).
- Cavit (3M ESPE).
- Lentulospiral (MANI) .
- 3ml syringe (Dispovan).
- Protaper Universal Rotary files (Dentsply).
- X-Ray films (Fujililm).
- F4 Guttapercha cones (Dentsply).
- AH Plus sealer (Dentsply).
- Passive ultrasonic irrigation tip

Armamentarium:

- Contra angle handpiece (NSK) Japan.
- Endomotor (Dentsply x-smart plus).
- X-Ray machine.
- Diamond disk (Mini drill).
- Incubator (DHP-9052 50L).
- Ultrasonic unit (Woodpecker UDS-P).
- Universal testing machine.
- Stereomicroscope.

Table 1 Composition of materials used in this study

S.NO	MATERIAL	MANUFACTURER	COMPOSITION
1.	Calcium hydroxide	Prevest Denpro	Powder:Calcium hydroxide
2.	Metapex	META BIOMED	Calcium hydroxide with Iodoform
3.	Triple Antibiotic paste		250mg of each antibiotic (metronidazole+clindamycin ciprofloxacin)
4.	AH Plus sealer	Dentsply	Paste A:Epoxy resin, Calcium Tungstate, Zirconium oxide, Silica, Iron oxide pigments Paste B:Amines, Calcium Tungstate, Zirconium oxide, Silica, Silicone oil

Method of collection of samples:

One hundred and eight single - rooted maxillary central incisors extracted for therapeutic reasons were collected from the Department of Oral and Maxillofacial Surgery, Vivekanandha Dental college for women, Thiruchengode for this study.

Infection Control Protocol followed to store the collected teeth:

Collection, storage, sterilization and handling of extracted teeth were followed according to the guidelines and recommendations given by **Occupational Safety and Health Administration (OSHA)Centre for Disease Control & Prevention (CDC):**

1. Handling of teeth was always done using gloves, mask and protective eyewear.
2. Teeth were cleaned of any visible blood and gross debris.
3. Distilled water was used in wide mouth plastic jars for initial collection.
4. Teeth were immersed in 10% formalin for 7 days, following which the liquid was discarded and the teeth were transferred into separate jars containing distilled water.
5. The initial collection jars, lids and the gloves employed were discarded into biohazard waste receptacles.
6. As and when the teeth were required, they were removed from the jars with cotton pliers and rinsed in tap water.

Inclusion criteria:

Single rooted maxillary central incisor with mature apices.

Exclusion criteria:

Roots with presence of cracks, caries, restorations, resorptions or open apices were excluded from the study.

Removal of external residual tissues:

The selected teeth were cleaned of soft tissues and debris with Ultrasonic scaler and were stored in 10% formalin.

Procedure:

One hundred and eight single - rooted maxillary central incisors with mature apices were selected for the present study. The crowns were cut off below the cementoenamel junction using diamond disk (Buehler, Lake Bluff, NY) under copious water spray to a standardized root length of 15 mm. Working length was established by Ingle's radiographic method. A 15 size K-file was inserted into the root canal until it could be seen at the apical foramen. The working length was determined by reducing 1mm short from this length. Further root canal preparation was done using ProTaper rotary instruments (Dentsply Maillefer) upto size F4 (size 40 .06 taper). At every instrument change, the canals were irrigated with 2 ml of 2.5% sodium hypochlorite solution and finally irrigated with distilled water. After chemo mechanical preparation, the specimens were dried using sterile absorbent paper points and the specimens were randomly divided into three groups accordingly to receive the following intracanal medicaments:

Table 2 Intracanal Medicament

GROUP	INTRACANAL MEDICAMENT USED
Group 1 (n=36/group)	Calcium hydroxide mixed with distilled water
Group 2 (n=36/group)	Calcium hydroxide+Iodoform
Group 3 (n=36/group)	Triple antibiotic paste

Calcium hydroxide was mixed with distilled water to achieve a creamy consistency (1:1.5, p/l ratio) and was placed into the root canal with the help of a lentulospiral.

Metapex was placed into the root canal with the use of special tips provided by the manufacturer. Triple antibiotic paste was prepared by mixing 250mgs of metronidazole, 250mgs of clindamycin and 250mgs of ciprofloxacin with distilled water and was placed into the root canal with the help of lentulospiral. The access cavity was then sealed with Cavit and the samples were incubated under 37 ^{0}C at 100% relative humidity for 2 weeks. After 2 weeks the samples were further sub divided as follows to remove intracanal medicaments.

Table 3 Intracanal Medicament removal

SUB GROUP	INTRACANAL MEDICAMENT REMOVAL
Sub group (1a, 2a & 3a)	Intracanal medicaments were removed using Distilled water.
Sub group (1b, 2b & 3b)	Intracanal medicaments were removed using distilled water and Passive Ultrasonic irrigation with 17%EDTA solution .
Sub group (1c, 2c & 3c)	Intracanal medicaments were removed using distilled water and Passive Ultrasonic irrigation with 17%EDTA solution . The root canal was then finally flooded with 95% Ethanol, by inserting a blunt tip syringe as close as to the working as possible.The solution was left in for 10 seconds , and was dried immediately thereafter with paper points.

Subsequent to the procedures, the root canals were dried using paper points. AH plus sealer was mixed according to manufacturer's instruction. The canal walls were coated with a single gutta percha cone of size F4 with AH Plus sealer and the canal was filled till the working length. After root filling, the access cavity was sealed with Cavit and the specimens were stored in 100% relative humidity at 37°C for 2 weeks. After two weeks, each specimen was sectioned perpendicular to the longitudinal axis of the root under water coolant spray with a low-speed diamond saw (Minitom, Struer, Denmark). Three slices, of 2 mm thickness, were obtained from each root along the apical, middle, and coronal regions.

Push-out bond strength test:

The push-out test was performed on each specimen with a universal testing machine at a crosshead speed of 1mm/min. The diameter of the plunger used was approximately (at least) 80% diameter of the canal. The maximum load applied to the filling material before failure was recorded in Newtons and then converted to megapascals (MPa) according to the following formula.

$$\text{Push-out bond strength (MPa)} = \frac{\text{Maximum load (N)}}{\text{Adhesion area of root filling (A) (mm}^2\text{)}}$$

The adhesion area of the root canal filling was calculated using the following equation:

$A = (2\pi r) \times h$, r = radius of the intraradicular space, h represents the thickness of the root section (mm), and π is the constant 3.14.

Stereomicroscopic examination:

After the test procedure, each specimen was visually examined under a stereomicroscope at 32X magnification to evaluate the failure type. The failure types have been categorized as follows into three different groups:

Adhesive failure (between the sealer and root dentin), cohesive failure (within the sealer or root dentin), and mixed (a combination of cohesive and adhesive).

FIG 1: PRE-OPERATIVE SAMPLES

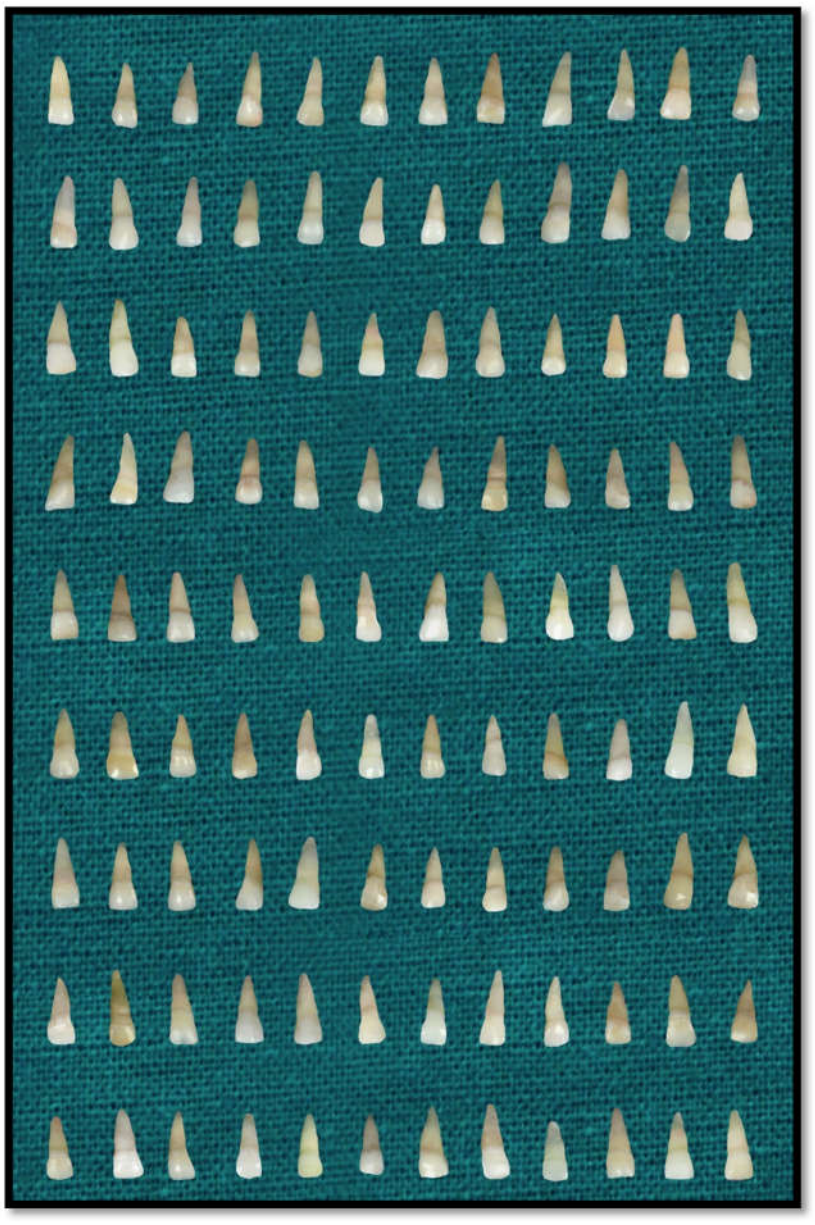
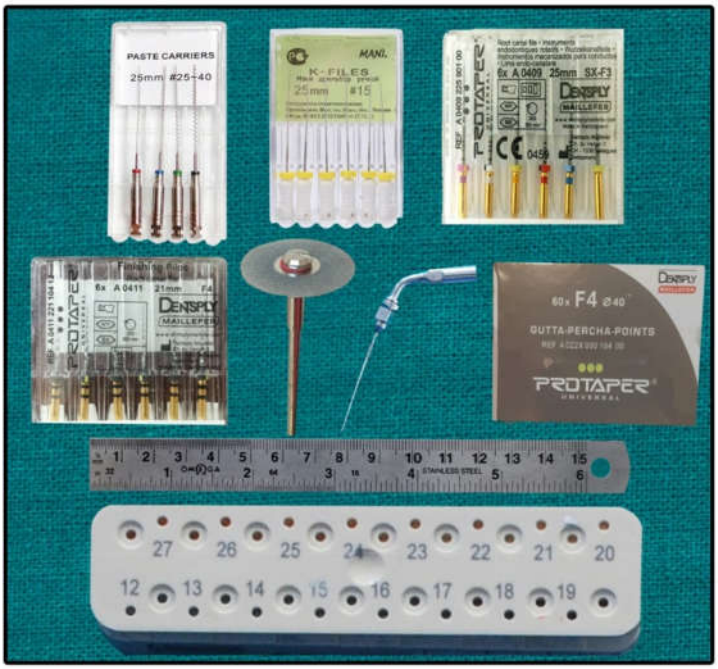
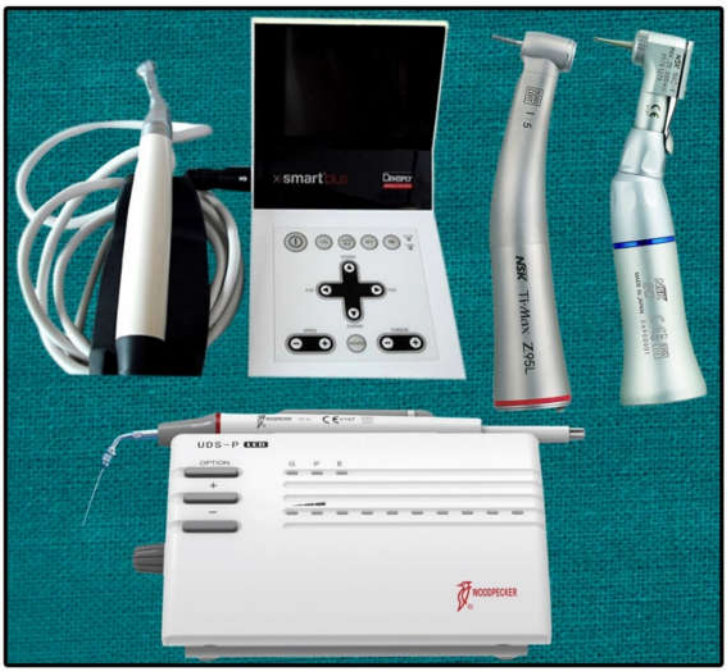
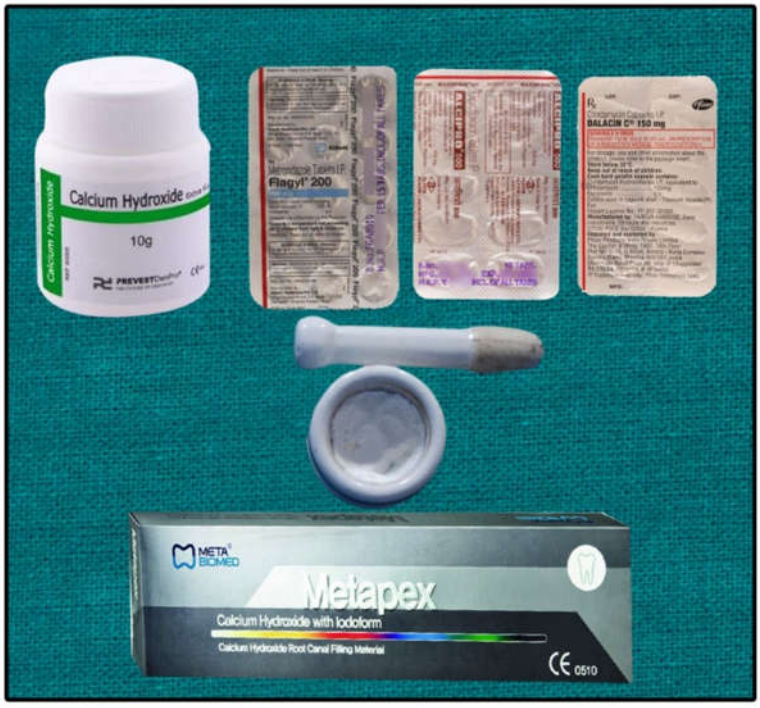


FIG 2: ARMAMENTARIUM






3M ESPE
Cavit™
Temporary Filling Material
28 g Paste
3M Deutschland GmbH, 41453 Neuss
DENTSPLY
60x F4 Ø40
GUTTA-PERCHA-POINTS
PROTAPER
UNIVERSAL
AH Plus™
AH Plus™


Calcium Hydroxide
10g
Flagyl 200
META BIOMED
Metapex
Calcium Hydroxide with Iodoform
Calcium Hydroxide Root Canal Filling Material
CE 0510

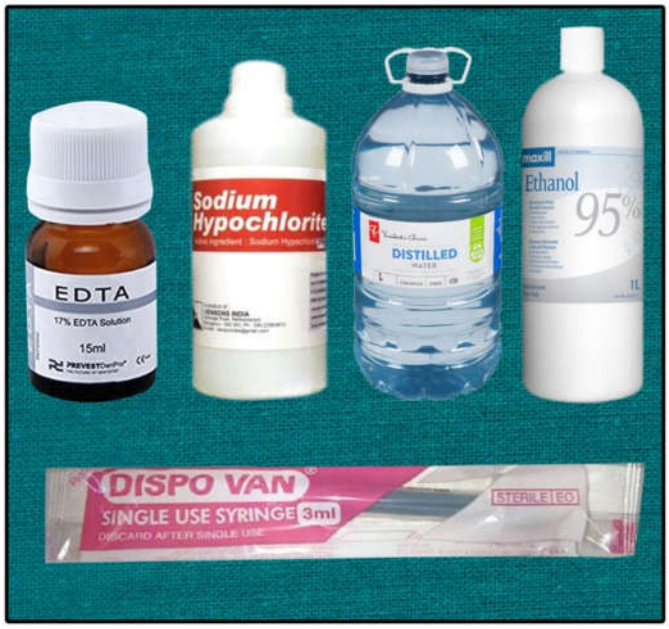


FIG: 3 DECORONATED SAMPLES

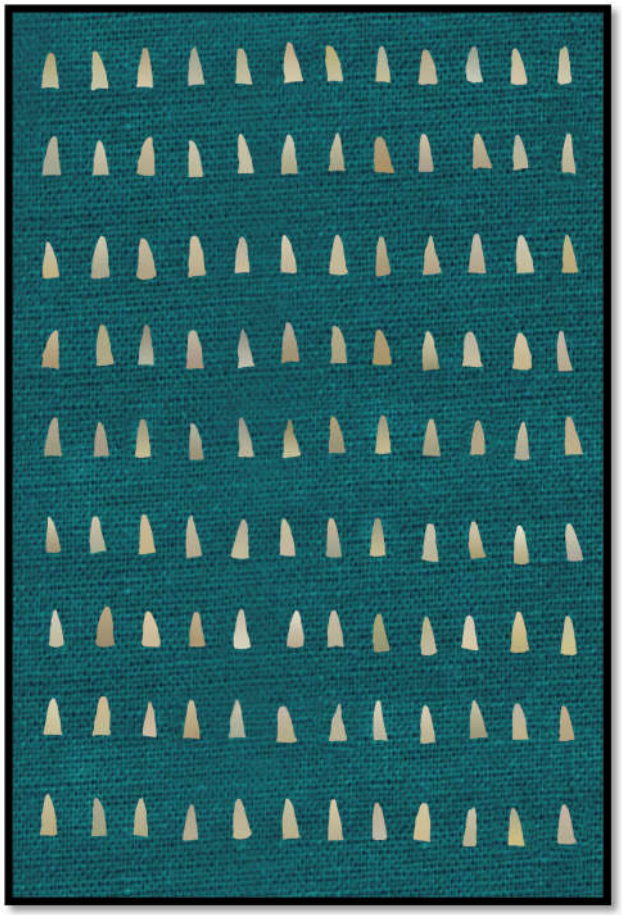


FIG: 4 WORKING LENGTH DETERMINATION

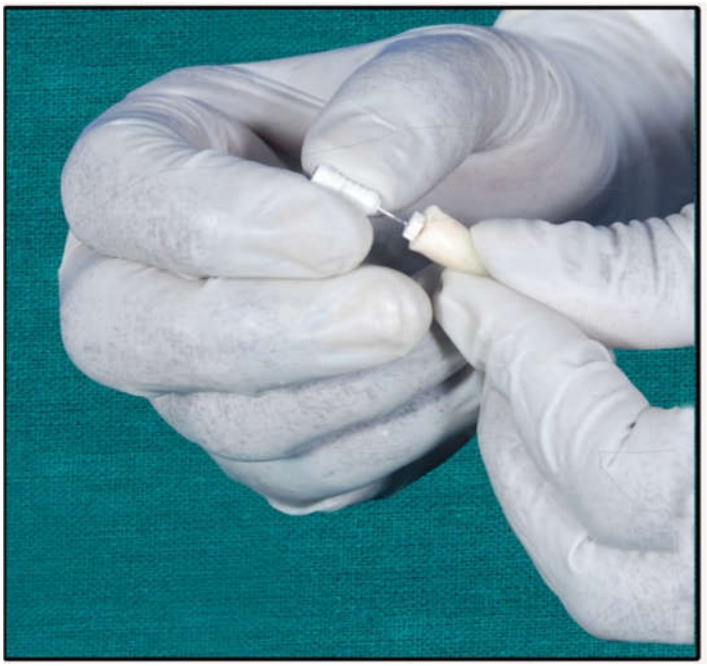


FIG: 5 CLEANING AND SHAPING

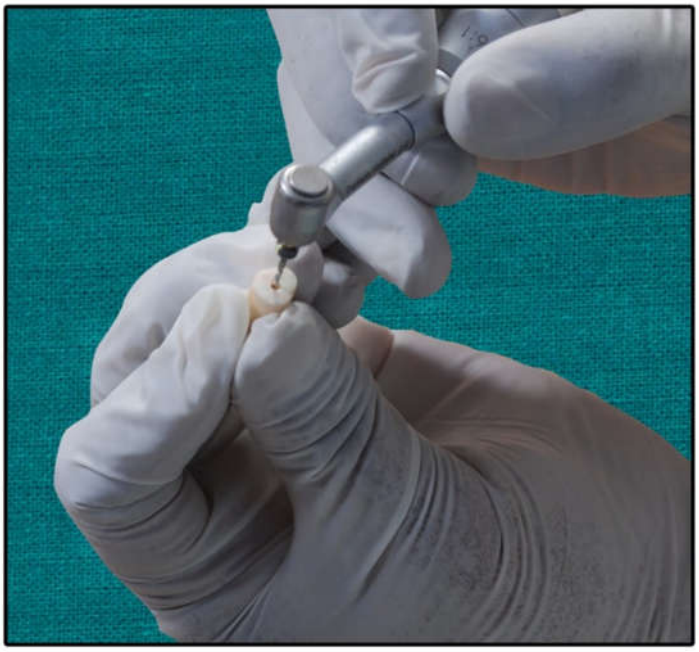


FIG 6: CALCIUM HYDROXIDE INTRACANAL MEDICAMENT PLACEMENT

GROUP 1

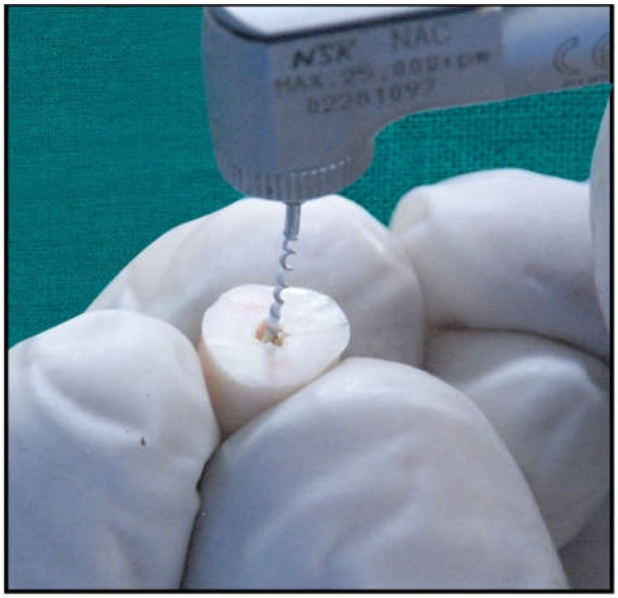


FIG 7: METAPEX INTRACANAL MEDICAMENT PLACEMENT
GROUP 2

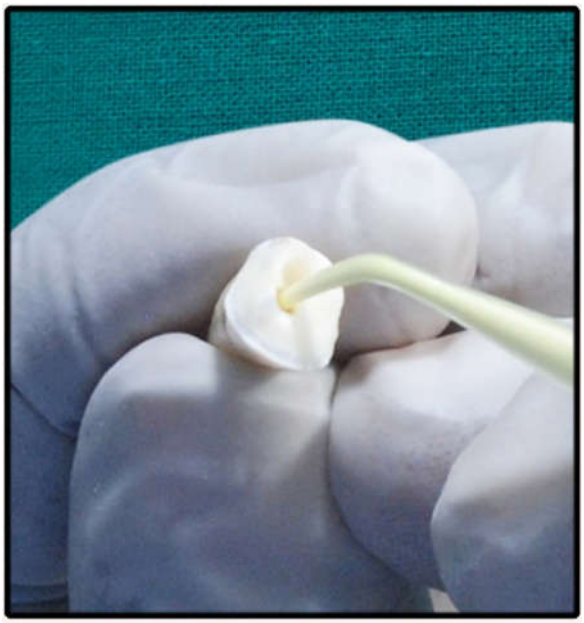


FIG 8: TRIPLE ANTIBIOTIC PASTE INTTRACANAL MEDICAMENT PLACEMENT

GROUP 3

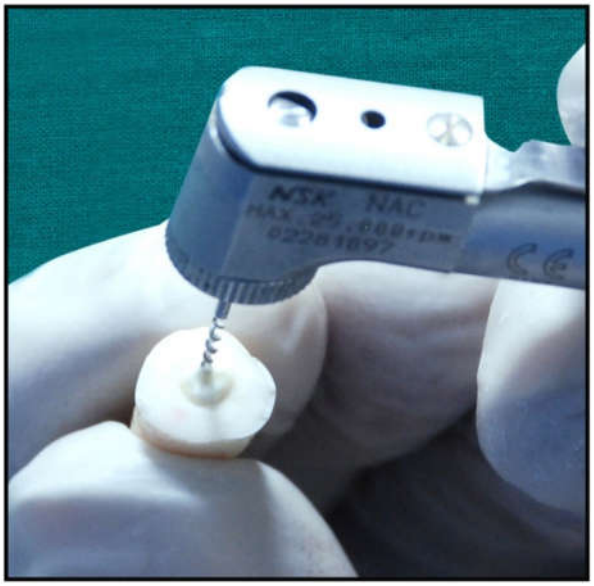


FIG 9: INCUBATOR

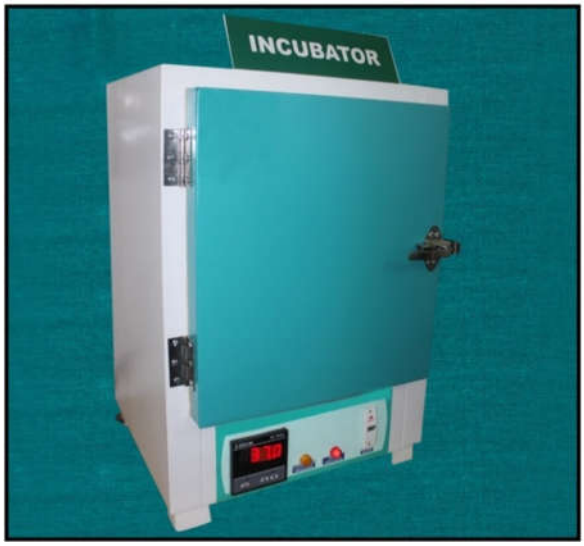


FIG 10:

INTRACANAL MEDICAMENTS REMOVED WITH

DISTILLED WATER

SUB GROUP (1a, 2a & 3a)

FIG 11:

INTRACANAL MEDICAMENTS REMOVED WITH

PASSIVE ULTRASONIC IRRIGATION USING 17%EDTA SOLUTION

SUB GROUP (1b, 2b &3b)

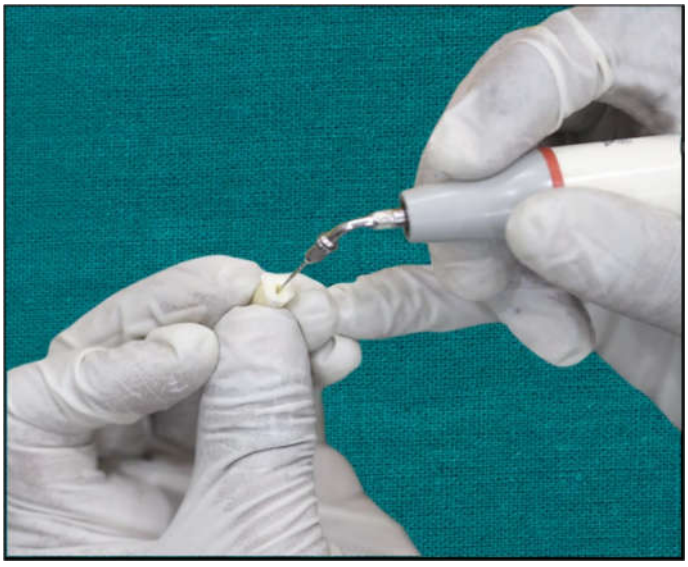


FIG 12:

ROOTCANAL FINALLY RINSED WITH

95% ETHANOL

SUB GROUP (1c, 2c & 3c)

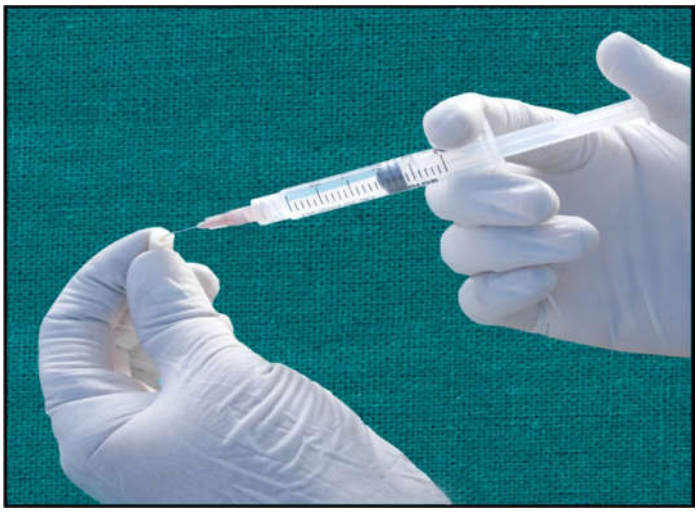


FIG 13:

OBTURATION

F4 GUTTAPERCHA COATED WITH AH PLUS SEALER

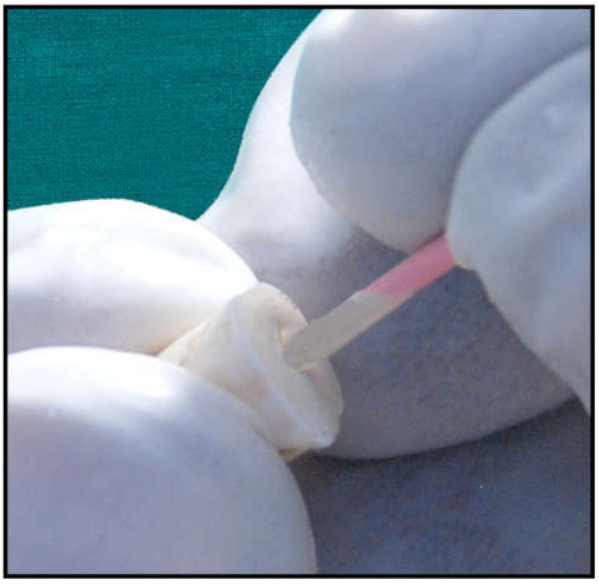


FIG 14:

UNIVERSAL TESTING MACHINE

LOADING FRAME

FIG 15:

STEREOMICROSCOPE

RESULTS

108 samples were used in this study. They were divided into three groups and each group was divided into three subgroups to evaluate the push-out bond strength following the removal of calcium hydroxide, metapex and triple antibiotic paste intracanal medicaments using distilled water, passive ultrasonic irrigation and 95% ethanol as final rinse respectively.

Table 4 Push-out bond strength values in Group 1 (Mpa)

SI.No.	Group 1a			Group 1b			Group 1c		
	C	M	A	C	M	A	C	M	A
1	5.89	5.14	3.48	4.85	6.11	7.49	5.25	7.11	8.47
2	5.54	5.69	3.12	3.30	4.67	7.33	4.7	6.25	7.85
3	7.35	5.24	3.27	4.25	6.13	7.18	4.46	6.35	9.28
4	5.48	5.18	4.13	3.94	6.18	6.47	4.01	7.51	8.47
5	5.51	5.31	4.08	4.25	5.19	6.17	5.23	5.17	7.82
6	6.12	4.74	3.62	4.32	4.91	6.85	4.75	5.47	7.89
7	5.75	5.26	3.87	4.29	5.02	6.65	4.77	5.78	7.65
8	5.82	4.47	2.51	3.50	4.73	7.63	4.22	5.15	8.28
9	6.57	5.37	2.53	6.23	5.24	5.52	5.18	7.11	8.23
10	5.81	5.16	4.18	4.15	6.14	6.18	3.69	6.27	8.21
11	6.27	4.93	5.37	3.15	5.64	7.43	4.72	7.13	8.48
12	5.63	6.12	3.24	3.52	6.45	8.13	5.75	6.47	8.93

Table 4 shows the push-out bond strength values for group 1 in coronal, middle and apical third regions in MPa. In group 1a where calcium hydroxide was removed using distilled water, the pushout bond strength values were higher in the coronal third and least in the apical third. In group 1b where calcium hydroxide was removed using passive ultrasonic irrigation and final rinse with distilled water, the push-out bond strength was the highest in the apical third followed by the middle third and then the coronal third. In group 1c calcium hydroxide was removed with passive ultrasonic irrigation and then rinsed with distal water and were finally rinsed with 95% ethanol, the push-out bond

strength was the highest in the apical third region followed by the middle third and then the coronal third region.

Student ‘t’ test was used to compare different sub groups and it was found that the push-out bond strengths were the highest in subgroup 1c, followed by subgroup 1b and subgroup 1a.

Table- 5 Student ‘t’ test between Group 1a & Group 1b

Independent Samples 't' Test of Group 1a & 1b									
Location		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
CORONAL	Equal variances assumed	0.52	0.48	22	0.017**	0.405	0.15668	0.72994	0.08006
	Equal variances not assumed			21.075	0.017**	0.405	0.15668	0.73076	0.07924
MIDDLE	Equal variances assumed	4.45	0.05	22	0.044**	0.3833	0.19637	0.79058	0.02391
	Equal variances not assumed			18.324	0.046**	0.3833	0.19637	0.79537	0.0287
APICAL	Equal variances assumed	0.05	0.83	22	0.028**	0.3025	0.27378	0.87029	0.26529
	Equal variances not assumed			21.971	0.029**	0.3025	0.27378	0.87033	0.26533

Table- 6 Student 't' test between Group 1a & Group 1c

Independent Samples 't' Test of Group 1a & 1c									
Locat-ion		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	df	Sig.	Mean Difference	Std. Error Differenc e	95% Confidence Interval of the Difference	
								Lower	Upper
Coronal	Equal variances assumed	0.55	0.47	22	0.001**	1.2525	0.19065	1.64789	0.85711
	Equal variances not assumed			21.286	0.001**	1.2525	0.19065	1.64866	0.85634
Middle	Equal variances assumed	0.63	0.44	22	0.001**	1.1908	0.17922	1.56251	0.81916
	Equal variances not assumed			19.755	0.001**	1.1908	0.17922	1.56497	0.81669
Apical	Equal variances assumed	0.2	0.66	22	0.001**	1.0508	0.26842	1.6075	0.49417
	Equal variances not assumed			220.001**	0.001**	1.0508	0.26842	1.6075	0.49417

Table- 7 Student 't' test between Group 1b & Group 1c

Independent Samples Test of Group 1b & 1c									
Location		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
CORONAL	Equal variances assumed	2.14	0.16	22	0.001**	0.8475	0.17666	1.21386	0.48114
	Equal variances not assumed			19.248	0.001**	0.8475	0.17666	1.21692	0.47808
MIDDLE	Equal variances assumed	0.93	0.35	22	0.001**	0.8075	0.22224	1.26839	0.34661
	Equal variances not assumed			21.632	0.001**	0.8075	0.22224	1.26885	0.34615
APICAL	Equal variances assumed	0.05	0.84	22	0.012**	0.7483	0.27341	1.31534	0.18132
	Equal variances not assumed			21.967	0.012**	0.7483	0.27341	1.31539	0.18127

Graph-1

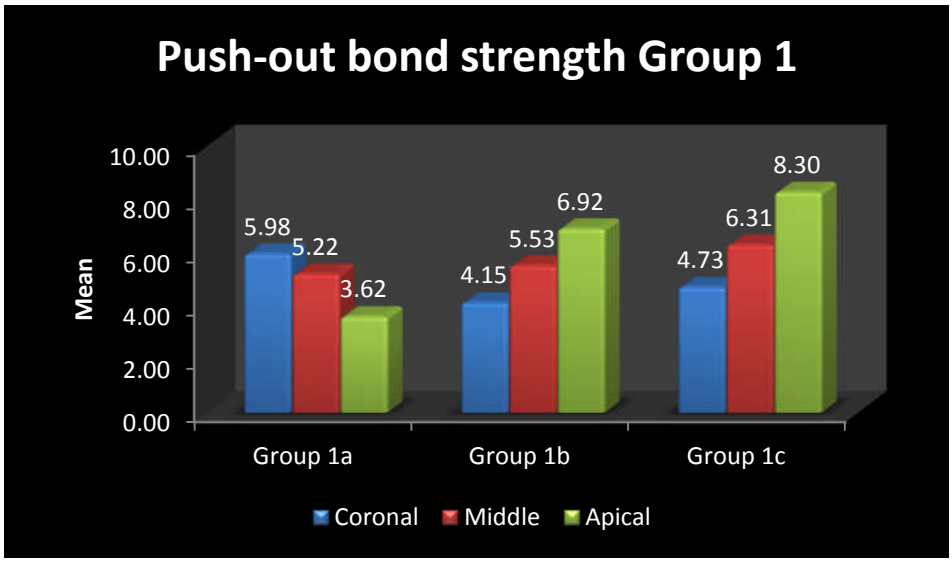


Table- 8 One-way Analysis of Variance (ANOVA) for push-out bond strength test for Group 1

Group 1		N	Mean	SD	SE	ANOVA	p
CORONAL	Group 1a	12	5.978	0.54	0.16	18.47	0.001**
	Group 1b	12	4.146	0.82	0.24		
	Group 1c	12	4.728	0.58	0.17		
	Total	36	4.951	0.85	0.14		
MIDDLE	Group 1a	12	5.218	0.42	0.12	26.61	0.001**
	Group 1b	12	5.534	0.65	0.19		
	Group 1c	12	6.314	0.8	0.23		
	Total	36	5.689	0.78	0.13		
APICAL	Group 1a	12	3.617	0.79	0.23	45.42	0.001**
	Group 1b	12	6.919	0.75	0.22		
	Group 1c	12	8.297	0.48	0.14		
	Total	36	6.278	1.13	0.19		

Graph 1 shows the mean push- out bond strength values of subgroup 1a,1b and 1c and it is observed that the push-out bond strength values were significantly higher in the apical third region in **subgroup 1c** (Calcium hydroxide intracanal medicament removed with distilled water, passive ultrasonic irrigation with 17%EDTA and final rinse with 95% Ethanol) followed by subgroup 1b(Calcium hydroxide intracanal medicament removed with distilled water and passive ultrasonic irrigation with 17%EDTA) and least in subgroup 1a (Calcium hydroxide intracanal medicament removed with distilled water).

Table 8 shows the mean push-out bond strength values of subgroup 1a,1b and 1c in the coronal, middle and the apical third regions. It was observed that the push-out bond strength values were significantly higher in the apical third region in subgroup 1c (Calcium hydroxide intracanal medicament removed with distilled water, passive ultrasonic irrigation with 17%EDTA and final rinse with 95% Ethanol) followed by subgroup 1b(Calcium hydroxide intracanal medicament removed with distilled water and passive ultrasonic irrigation with 17%EDTA) and least in subgroup 1a (Calcium hydroxide intracanal medicament removed with distilled water).

Table 9 Push out bond strength values in Group 2 (Mpa)

SI.No.	Group 2a			Group 2b			Group 2c		
	C	M	A	C	M	A	C	M	A
1	3.59	2.75	2.68	2.78	3.35	4.17	3.28	3.62	5.35
2	4.12	2.79	1.47	2.25	2.64	4.65	3.32	4.47	4.58
3	3.21	2.31	1.65	1.79	3.34	3.20	3.52	3.72	4.57
4	3.32	2.63	2.51	2.51	3.47	3.64	3.2	3.37	4.13
5	3.89	2.37	1.80	2.11	2.33	4.16	3.44	3.12	5.15
6	4.04	1.63	1.30	2.35	1.69	4.15	2.2	3.32	4.73
7	5.41	2.73	1.75	2.11	3.29	5.50	3.64	3.76	5.26
8	3.31	2.22	1.48	1.74	2.72	3.81	2.78	3.48	4.22
9	3.79	1.95	2.13	2.31	2.57	4.28	2.51	2.51	5.17
10	2.77	2.31	1.87	2.25	2.26	3.50	2.67	3.91	3.72
11	3.45	2.53	1.91	2.73	2.43	2.89	3.94	4.19	4.13
12	3.52	2.73	2.23	2.71	3.46	4.10	3.31	3.77	6.02

Table 9 shows the push-out bond strength values for group 2 in coronal, middle and apical thirds. In group 2a where metapex was removed using distilled water, push-out bond strengths was higher in the coronal third followed by the middle and the apical third. In group 2b metapex was removed using passive ultrasonic irrigation, push-out bond strength was highest in the apical third region followed by the middle third region and then the coronal third region. In group 2c metapex was removed using passive ultrasonic irrigation, followed by rinsing with distilled water and then the samples were finally rinsed with 95% ethanol. In this group pushout bond strengths were higher in the apical region followed by the middle third region and the least in the coronal region.

Student ‘t’ test was used to compare different sub groups and it was found that the push-out bond strengths were the highest in subgroup 2c, followed by subgroup 2b and subgroup 2a.

Table- 10 Student ‘t’ test between Group 2a & Group 2b

Independent Samples 't' Test of Group 2a & 2b									
Location		F	Sig.	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
CORONAL	Equal variances assumed	0.853	0.366	22	0.001**	-1.1108	0.28292	-1.69758	-0.52408
	Equal variances not assumed			20.186	0.001**	-1.1108	0.28292	-1.70066	-0.52101
MIDDLE	Equal variances assumed	5.006	0.036	22	0	-1.0967	0.26124	-1.63844	-0.55489
	Equal variances not assumed			16.653	0.001**	-1.0967	0.26124	-1.6487	-0.54463
APICAL	Equal variances assumed	0.101	0.753	22	0	-2.3183	0.20808	-2.74987	-1.88679
	Equal variances not assumed			21.631	0	-2.3183	0.20808	-2.7503	-1.88637

Table- 11 Student 't' test between Group 2a & Group 2c

Independent Samples 't' Test of Group 2a & 2c									
Location		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
CORONAL	Equal variances assumed	0.853	0.366	22	0.001**	-1.1108	0.28292	-1.69758	-0.52408
	Equal variances not assumed			20.186	0.001**	-1.1108	0.28292	-1.70066	-0.52101
MIDDLE	Equal variances assumed	5.006	0.036	22	0**	-1.0967	0.26124	-1.63844	-0.55489
	Equal variances not assumed			16.653	0.001**	-1.0967	0.26124	-1.6487	-0.54463
APICAL	Equal variances assumed	0.101	0.753	22	0**	-2.3183	0.20808	-2.74987	-1.88679
	Equal variances not assumed			21.631	0**	-2.3183	0.20808	-2.7503	-1.88637

Table- 12 Student 't' test between Group 2b & Group 2c

Independent Samples 't' Test of Group 2b & 2c									
Location		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
CORONAL	Equal variances assumed	0.393	0.537	22	0.058	-0.5817	0.2909	-1.18495	0.02162
	Equal variances not assumed			19.749	0.059	-0.5817	0.2909	-1.18896	0.02563
MIDDLE	Equal variances assumed	0.156	0.696	22	0.015	-0.78	0.29682	-1.39556	-0.16444
	Equal variances not assumed			21.041	0.016	-0.78	0.29682	-1.3972	-0.1628
APICAL	Equal variances assumed	3.312	0.082	22	0**	-1.3775	0.2556	-1.90758	-0.84742
	Equal variances not assumed			18.65	0**	-1.3775	0.2556	-1.91315	-0.84185

Graph-2

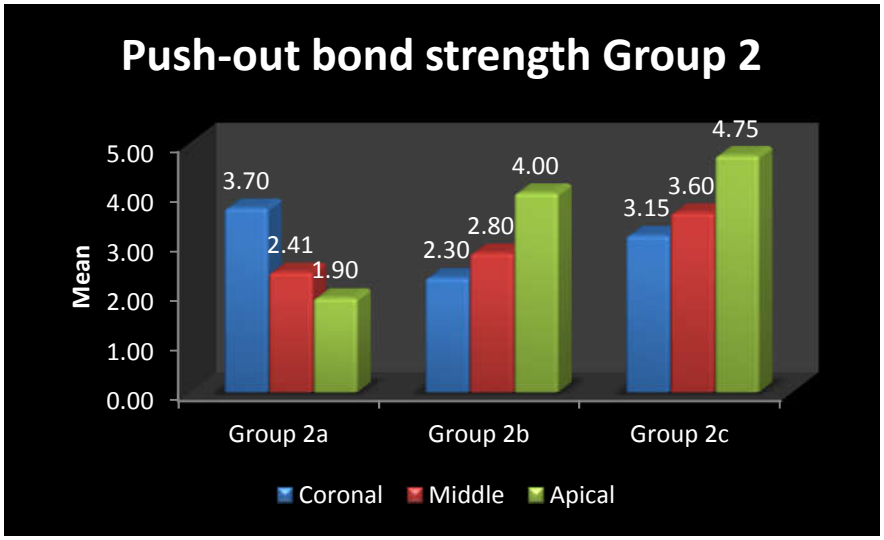


Table-13 One-way Analysis of Variance (ANOVA) for push-out bond strength test for group 2

Group 2		N	Mean	SD	SE	ANOVA	p
CORONAL	Group 2a	12	3.702	0.66	0.19	3.213	0.001**
	Group 2b	12	2.303	0.34	0.1		
	Group 2c	12	3.151	0.51	0.15		
	Total	36	3.052	0.67	0.11		
MIDDLE	Group 2a	12	2.413	0.36	0.1	4.087	0.001**
	Group 2b	12	2.796	0.58	0.17		
	Group 2c	12	3.603	0.51	0.15		
	Total	36	2.937	0.69	0.12		
APICAL	Group 2a	12	1.898	0.42	0.12	7.92	0.002**
	Group 2b	12	4.004	0.68	0.2		
	Group 2c	12	4.753	0.66	0.19		
	Total	36	3.552	0.79	0.13		

Graph 2 shows the mean push- out bond strength values of subgroup 2a,2b and 2c and it is observed that the push-out bond strength values was significantly higher in the apical third region between subgroup 2c (Metapex intracanal medicament removed with distilled water, passive ultrasonic irrigation with 17%EDTA and final rinse with 95% Ethanol) and subgroup 2b (Metapex intracanal medicament removed with distilled water and passive ultrasonic irrigation with 17%EDTA) and least in subgroup 2a (Metapex intracanal medicament removed with distilled water).

Table 13 shows the mean push -out bond strength values of subgroup 2a,2b and 2c in the coronal, middle and the apical third regions and it was observed that the push-out bond strength values was significantly higher in the apical third region in subgroup 2c (Metapex intracanal medicament removed with distilled water, passive ultrasonic irrigation with 17%EDTA and final rinse with 95% Ethanol), followed by subgroup 2b (Metapex intracanal medicament removed with distilled water and passive ultrasonic irrigation with 17%EDTA) and least in subgroup 2a(Metapex intracanal medicament removed with distilled water).

Table 14 Push out bond strength values in Group 3 (Mpa)

SI.No.	Group 3a			Group 3b			Group 3c		
	C	M	A	C	M	A	C	M	A
1	5.75	6.12	3.67	4.29	6.22	6.27	6.23	5.19	8.23
2	5.65	5.17	3.81	3.77	5.24	7.13	4.10	6.13	6.65
3	5.62	4.22	3.34	2.61	4.91	6.19	3.52	5.37	6.48
4	6.17	3.72	2.45	3.51	4.47	6.47	3.05	4.88	8.28
5	5.81	5.26	3.56	3.95	5.42	5.15	3.50	5.37	7.93
6	5.82	4.13	4.19	3.76	5.37	7.48	4.29	4.95	6.21
7	6.12	5.35	3.32	3.32	4.74	6.65	4.75	5.61	7.48
8	5.51	4.73	3.12	3.72	5.24	6.35	4.25	4.91	7.53
9	5.49	5.15	3.18	4.47	5.43	7.21	4.32	6.08	6.85
10	5.48	4.18	3.58	3.41	5.28	5.47	3.94	5.11	6.47
11	5.87	4.57	4.17	3.31	5.19	7.71	4.25	5.02	7.89
12	6.25	4.58	3.62	3.62	5.69	5.37	3.20	5.24	6.47

Table 14 shows push-out bond strength values for group 3 in the coronal, middle and apical third region. In group 3a triple antibiotic paste was removed using distilled water. The push-out bond strength in this group was highest in the coronal followed by middle and the least in the apical third. In group 3b where triple antibiotic paste was removed using passive ultrasonic irrigation, the push-out bond strength was the highest in the apical third region, followed by the middle third region and the least in the coronal third region. In group 3c triple antibiotic paste was removed from the canal using distilled water, passive ultrasonic irrigation and was followed by final rinse with 95% ethanol. In this group push-out bond strength was the highest in the apical third region, followed by middle third and coronal third region.

Student ‘t’ test was used to compare different sub groups and it was found that the push - out bond strengths were the highest in subgroup 3c, followed by subgroup 3b and subgroup 3a.

Table- 15 Student ‘t’ test between Group 3a & Group 3b

Independent Samples 't' Test of Group 3a &3b									
Location		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
CORONAL	Equal variances assumed	0.001**	0.996	22	0.47	-0.1442	0.19596	-0.55057	0.26224
	Equal variances not assumed			21.99	0.47	-0.1442	0.19596	-0.55058	0.26225
MIDDLE	Equal variances assumed	2.845	0.106	22	0.042	-0.5017	0.23256	-0.98397	-0.01936
	Equal variances not assumed			19.161	0.044	-0.5017	0.23256	-0.98815	-0.01519
APICAL	Equal variances assumed	9.332	0.006	22	0.016	-0.6592	0.2529	-1.18365	-0.13469
	Equal variances not assumed			13.238	0.021	-0.6592	0.2529	-1.20452	-0.11381

Table- 16 Student 't' test between Group 3a & Group 3c

Independent Samples 't' Test of Group 3a & 3c									
Location		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
CORONAL	Equal variances assumed	1.254	0.275	22	0.037	-0.6158	0.278	-1.19238	-0.03929
	Equal variances not assumed			17.41	0.04	-0.6158	0.278	-1.20132	-0.03035
MIDDLE	Equal variances assumed	2.72	0.113	22	0.024	-0.5567	0.229	-1.03159	-0.08175
	Equal variances not assumed			18.59	0.025	-0.5567	0.229	-1.03669	-0.07665
APICAL	Equal variances assumed	28.208	0.001**	22	0.001**	-1.4108	0.23354	-1.89517	-0.9265
	Equal variances not assumed			13.66	0.001**	-1.4108	0.23354	-1.9129	-0.90877

Table- 17 Student 't' test between Group 3b & Group 3c

Independent Samples 't' Test of Group 3b & 3c									
Location		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
CORONAL	Equal variances assumed	1.234	0.279	22	0.106	-0.4717	0.27944	-1.05119	0.10785
	Equal variances not assumed			17.629	0.109	-0.4717	0.27944	-1.05963	0.1163
MIDDLE	Equal variances assumed	0.041	0.842	22	0.76	-0.055	0.17783	-0.4238	0.3138
	Equal variances not assumed			21.941	0.76	-0.055	0.17783	-0.42386	0.31386
APICAL	Equal variances assumed	0.036	0.852	22	0.031	-0.7517	0.32646	-1.4287	-0.07463
	Equal variances not assumed			21.83	0.031	-0.7517	0.32646	-1.42901	-0.07433

Graph-3

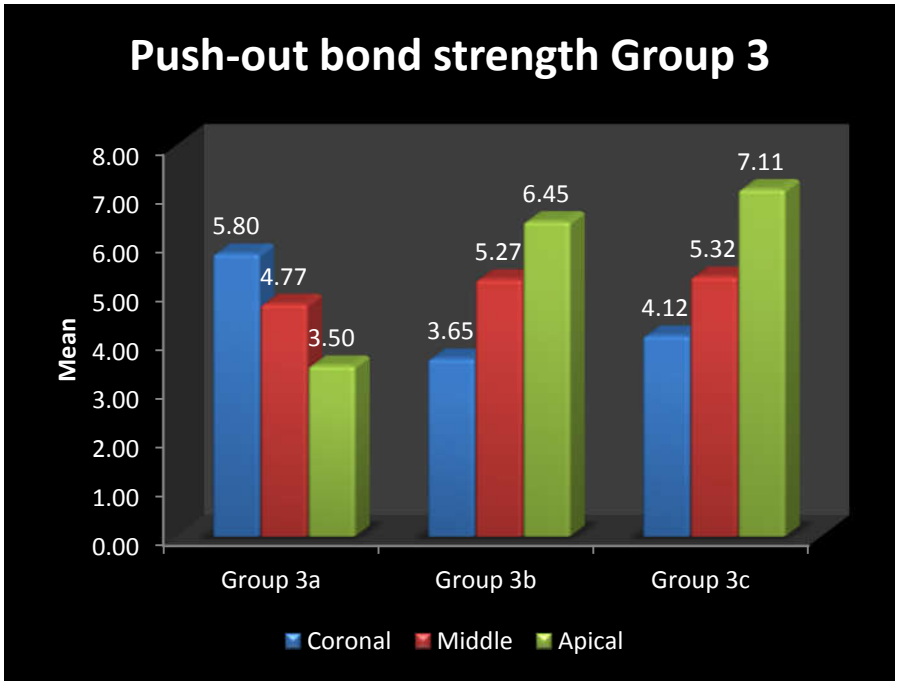


Table-18 One-way Analysis of Variance (ANOVA) for push-out bond strength test for group 3

Group 3		N	Mean	SD	SE	ANOVA	p
CORONAL	Group 3a	12	5.795	0.267	0.077	6.77	0.053
	Group 3b	12	3.645	0.485	0.14		
	Group 3c	12	4.117	0.838	0.242		
	Total	36	4.519	0.661	0.11		
MIDDLE	Group 3a	12	4.765	0.67	0.194	9.28	0.026*
	Group 3b	12	5.267	0.447	0.129		
	Group 3c	12	5.322	0.424	0.122		
	Total	36	5.118	0.57	0.095		
APICAL	Group 3a	12	3.501	0.475	0.137	13.284	0.001**
	Group 3b	12	6.454	0.834	0.241		
	Group 3c	12	7.206	0.764	0.22		

Graph 3 shows the mean push-out bond strength values of Group3 and it is observed that the push-out bond strength values was significantly higher in **subgroup 3c** (Triple antibiotic paste intracanal medicament removed with distilled water, passive ultrasonic irrigation with 17%EDTA and final rinse with 95% Ethanol) in the apical third region followed by the subgroup 3b (Triple antibiotic paste intracanal medicament removed with distilled water and passive ultrasonic irrigation with 17%EDTA) and least in subgroup 3a (Triple antibiotic paste intracanal medicament removed with distilled water).

Table 18 shows the mean push-out bond strength values of Group3 (3a, 3b, 3c) in the coronal , middle and the apical thirds. It was observed that the push-out bond strength values was significantly higher in **subgroup 3c** (Triple antibiotic paste intracanal medicament removed with distilled water, passive ultrasonic irrigation with 17%EDTA and final rinse with 95% Ethanol) in the apical third region followed by the subgroup 3b (Triple antibiotic paste intracanal medicament removed with distilled water and passive ultrasonic irrigation with 17%EDTA) and least in subgroup 3a (Triple antibiotic paste intracanal medicament removed with distilled water).

Overall Result interpretation

Push-out bond strength results obtained were statistically analyzed using **One-way Analysis of Variance (ANOVA)** as shown in Table 19 & 20. According to the results obtained there is significant difference in all the three groups ($P<0.05$).

Table-19 One-way Analysis of Variance (ANOVA) for push-out bond strength test

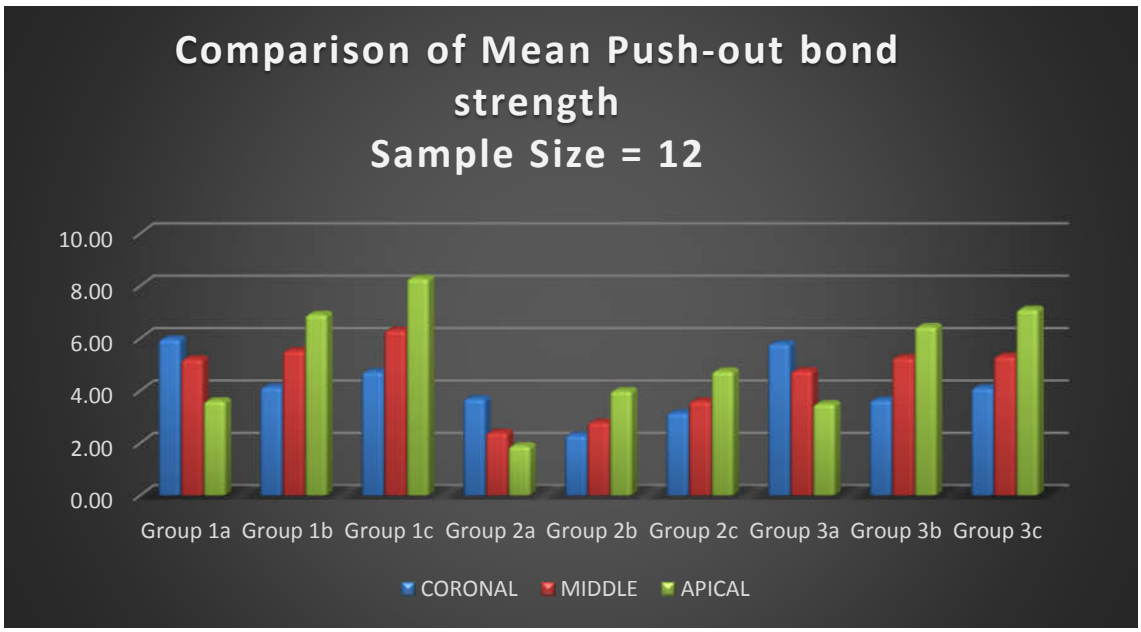
Location	Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
CORONAL (C)	Group 1a	12	5.978	0.54198	0.1565	5.634	6.3227
	Group 1b	12	4.146	0.82411	0.2379	3.6222	4.6694
	Group 1c	12	4.728	0.57991	0.1674	4.359	5.096
	Group 2a	12	3.702	0.65843	0.1901	3.2833	4.12
	Group 2b	12	2.303	0.34124	0.0985	2.0865	2.5201
	Group 2c	12	3.151	0.50798	0.1466	2.8281	3.4736
	Group 3a	12	5.795	0.26746	0.0772	5.6251	5.9649
	Group 3b	12	3.645	0.48498	0.14	3.3369	3.9531
	Group 3c	12	4.117	0.83775	0.2418	3.5844	4.6489
	Total	108	3.456	1.03307	0.0994	3.259	3.6532

MIDDLE (M)	Group 1a	12	5.218	0.42126	0.1216	4.9498	5.4852
	Group 1b	12	5.534	0.64478	0.1861	5.1245	5.9438
	Group 1c	12	6.314	0.80093	0.2312	5.8053	6.8231
	Group 2a	12	2.413	0.35742	0.1032	2.1854	2.6396
	Group 2b	12	2.796	0.57878	0.1671	2.4281	3.1636
	Group 2c	12	3.603	0.50762	0.1465	3.2808	3.9259
	Group 3a	12	4.765	0.67038	0.1935	4.3391	5.1909
	Group 3b	12	5.267	0.44677	0.129	4.9828	5.5505
	Group 3c	12	5.322	0.42413	0.1224	5.0522	5.5911
	Total	108	4.581	1.37129	0.132	4.3196	4.8428
APICAL (A)	Group 1a	12	3.617	0.7901	0.2281	3.1147	4.1187
	Group 1b	12	6.919	0.74707	0.2157	6.4445	7.3938
	Group 1c	12	8.297	0.47523	0.1372	7.9947	8.5986
	Group 2a	12	1.898	0.42207	0.1218	1.6302	2.1665
	Group 2b	12	4.004	0.68261	0.1971	3.5705	4.4379
	Group 2c	12	4.753	0.65655	0.1895	4.3353	5.1697
	Group 3a	12	3.501	0.47498	0.1371	3.199	3.8026
	Group 3b	12	6.454	0.83424	0.2408	5.9241	6.9842
	Group 3c	12	7.206	0.76351	0.2204	6.7207	7.6909
	Total	108	5.901	1.5708	0.1512	5.6012	6.2005

Table-20 ANOVA

Location	Group	Sum of Squares	df	Mean Square	F	Sig.
CORONAL	Between Groups	77.288	8	9.661	25.92	0.001**
	Within Groups	36.905	99	0.373		
	Total	114.193	107			
MIDDLE	Between Groups	170.582	8	21.323	68.93	0.001**
	Within Groups	30.624	99	0.309		
	Total	201.206	107			
APICAL	Between Groups	222.669	8	27.834	66.65	0.001**
	Within Groups	41.345	99	0.418		
	Total	264.015	107			

Graph 4 Overall result comparison of Mean Push-out bond strength



On comparing the overall mean push-out bond strength of the three groups and their corresponding subgroups, push-out bond strength was the highest in subgroup 1a where calcium hydroxide was removed using distilled water, passive ultrasonic irrigation and was finally rinsed with 95% ethanol. It was observed that there was considerable increase in the push-out bond strength values of all samples where 95% ethanol was used as a final rinse, followed by passive ultrasonic irrigation only and the least being the use of distilled water for removal of intracanal medicaments.

The modes of failure was visualized using Stereomicroscope at 32 X magnification and was categorized as cohesive, adhesive and mixed failure. Cohesive and mixed failure modes accounted for most of the failures when compared to that of Adhesive failure for all the three subgroups.

DISCUSSION

The fundamental criteria required for the success of endodontic therapy includes correct diagnosis, thorough cleaning and shaping and three dimensional obturation of the root canal space with biocompatible and dimensionally stable filling material [65].

Although there has been a tremendous improvement in the root canal instrumentation procedures, there is no evidence showing complete cleaning of the rootcanal system with the available instrumentation techniques, because of the ability of the microbes present in the complex anatomy of root canal spaces [66].

Viable microorganisms that remain even after root canal preparation and disinfection contribute significantly to the failure of root canal therapy[67].

Chemomechanical preparation of the root canal significantly reduces the number of microorganisms in the infected root canals. However, the eradication of microorganisms from canal irregularities is enhanced by intracanal medicaments that prevent the proliferation of residual strains, as well as recontamination[68].

Various intracanal medicaments that are placed in the root canal are Calcium hydroxide, Calcium hydroxide combined with iodoform and silicon oil (Metapex), Triple antibiotic paste, Ledermix(steroid)paste, phenols and aldehydes, Bioactive glass, Iodine-potassium iodide, Chlorhexidine gel and a combination of Chlorhexidine mixed with calcium hydroxide. Of all these intracanal medicaments the most popular and widely used intracanal medicaments by the dental practioners are calcium hydroxide and Metapex (Calcium hydroxide combined with iodoform and silicon oil) due to its superior antimicrobial activity. As the infections of the rootcanal are polymicrobial , a single antibiotic could result in an ineffective disinfection of all the canals. So a combination of antibiotics known as Triple antibiotic paste containing

Ciprofloxacin, Metronidazole and Clindamycin was used as an intracanal medicament among the practitioners [69] .

Calcium hydroxide is used as an intracanal medicament in this study because it is the most popular intracanal medicament to date, owing to its well documented antibacterial activity against most of the strains identified in the root canal infections (Law and Massner 2004). Calcium hydroxide was introduced in the field of endodontics by Hermann in 1920. It is an odorless white powder. When in contact with the aqueous fluids, it dissociates into calcium and hydroxyl ions. It acts as a physical barrier for the ingress of bacteria, and it destroys the remaining bacteria by limiting the space for multiplication, shows antiseptic action because of high pH and leaching action on necrotic pulp tissues [70]. In the present study, Calcium hydroxide powder was mixed with distilled water and was placed in the root canal using lentulospiral as an intracanal medicament due to its broad antimicrobial activity.

Calcium hydroxide is not an effective intracanal medicament against all types of bacterial species found in endodontic infections . Therefore , metapex was used an intracanal medicament which exhibited a more potent antibacterial activity within the root canal compared to pure calcium hydroxide [71]. Metapex contains calcium hydroxide, Iodoform and silicon oil . Iodoform is incorporated to improve the antibacterial properties of the material. Silicone oil acts as a vehicle. Metapex was selected in the present study as an intracanal medicament as it is commonly used among the dental practioners.

The infection of the root canal system is said to be polymicrobial. Due to the complexity of root canal infections, it is emphazised that any single antibiotic could not result in an effective disinfection of all canals. So, a combination is needed to address the diverse flora encountered. A combination of antibiotics would decrease

the likelihood of the development of resistant bacterial strains[72] . Hoshino et al. determined that a combination of ciprofloxacin, metronidazole, and minocycline disinfected the infected root canal dentine in vitro. Bacterias may be present within areas of the root canal system that are inaccessible to irrigants and to the mechanical cleaning processes [73]. A combination of antibiotics known as Triple Antibiotic Paste containing metronidazole (nitroimidazole compound that exhibits broad spectrum of activity against protozoa and anaerobic bacteria), Ciprofloxacin (a synthetic fluoroquinolone, has a bactericidal mode of action) and minocycline (a semisynthetic derivative of tetracycline) has been proposed as a root canal medicament due to its antimicrobial effects which diffuse into the root canal dentine to reduce the number of viable organisms[74]. Huang GT et al. in 2008 described crown discoloration associated with Triple Antibiotic Paste containing minocycline [75]. McTigue DJ et al. in 2013 suggested substituting minocycline with Clindamycin [76]. Clindamycin is effective against various endodontic pathogens [77]. So, in the present study, a modified triple antibiotic paste (MTAP) composed of metronidazole, ciprofloxacin, and clindamycin was used as an intracanal medicament. In addition, the paste can also be used traditionally in root canal treatment in infected root canals before root canal obturation because of its good antimicrobial properties. Antibiotic pastes can influence the bond strength of the root fillings negatively or positively.

It has been well established and documented by various studies that the use of intracanal medicaments reduces the bacterial count and also promotes periapical healing. However their complete removal has always been questionable from the canal. Several studies have shown that the remnants of intracanal medicaments before obturation can affect the bond strength between the sealer and dentin , interfere with the sealing ability, and prevent the penetration of sealers into dentinal tubules,

resulting in a potential reduction of epoxy resin-based sealer adaptation to root dentin during the polymerization process[78].

Rodig et al. 2010 used chelating solutions with the Passive Ultrasonic Irrigation and attained better results with EDTA in the removal of calcium hydroxide, in comparison to NaOCl [79]. Van der Sluis *et al*. and Sandra *et al.* studied the role of passive ultrasonic irrigation as a better method of removing various intracanal medicaments from the root canal [80].

Passive ultrasonic irrigation is done with a small size file in an already enlarged canal space. The file moves freely allowing the irrigant to penetrate more easily into all regions of the root canal space [81]. In this study17% EDTA (Ethylene di amine tetra acetic acid) was agitated by passive ultrasonic irrigation as it has the ability to neutralize the calcium hydroxide residues, which prevents the interaction with the sealer, or chelation of calcium hydroxide residues and thus facilitating easier removal[82] . Due to active streaming of the irrigant, its potential to contact a greater surface area of the canal wall is enhanced. Moreover, a large volume of the irrigant allows better debridement [83] . In accordance with these studies there was an increase in push-out bond strength values in subgroup **1b**(Calcium Hydroxide removed with Distilled water and passive ultrasonic irrigation with 17% EDTA), **3b** (Triple antibiotic paste removed with Distilled water, passive ultrasonic irrigation with 17% EDTA) and **2b** (Metapex removed with Distilled water, passive ultrasonic irrigation with 17% EDTA).

Richard W. Stevens et al 2006 evaluated the Leakage and Sealer Penetration in smear-free dentin after a final rinse with 95% Ethanol and found that a final rinse with 95% ethanol increased sealer penetration and decreased leakage.No study was done using 95% Ethanol as final irrigant to remove the intracanal medicaments. So all

the intracanal medicament in the subgroups **1c** (Calcium Hydroxide removed with Distilled water, passive ultrasonic irrigation with 17% EDTA and final rinse with 95% Ethanol), Subgroup **3c** (Triple antibiotic paste removed with Distilled water, passive ultrasonic irrigation with 17% EDTA and final rinse with 95% Ethanol) and Subgroup **2c** (Metapex removed with Distilled water, passive ultrasonic irrigation with 17% EDTA and final rinse with 95% Ethanol)were removed with 95% ethanol as final irrigant.

The last phase is the three dimensional Obturation of the root canal. According to the American Association of Endodontists, obturation is a method used to fill and seal the cleaned and shaped root canal using a root canal sealer and a core filling material. All the samples in the experimental groups were obturated with the gutta-percha core material and AH plus sealer using the matched taper single cone technique(F4). AH plus resin-based Sealers, is used in the present study as it has received greater attention and gained popularity due to its radiopacity, biocompatibility and easy to use.

The AH Plus sealer used in endodontics consists of a paste-paste system, in two tubes of epoxide paste and amine paste in a new double-barrel syringe. Epoxide paste contains Diepoxide, Calcium tungstate, Zirconium oxide, Aerosil Pigment. Amine paste contains 1-adamantane amine, N,N'-dibenzyl-5-oxa-nonandiamine-1,9, TCD-Diamine, Calcium tungstate, Zirconium oxide, and Aerosil Silicone oil [84]. AH Plus is also known to be an epoxy-S bis-phenol resin-based sealer and the mechanism of adhesion to the root canal dentin is by greater penetration into the micro-irregularities, more cohesion between molecules, greater mechanical interlock and better resistance to separation or removal [85].

The advantage of a single cone obturation technique includes its predictability, relative ease of use, conservative preparation and controlled placement of materials[86].

The ideal requirements and characteristics for root canal sealer according to Grossman are it should be tacky when mixed to provide good adhesion between the canal wall when set, should be well compacted, must conform and adhere to the shaped canal walls, should make a hermetic seal, should be radiopaque to be visualized on the radiograph, it should not shrink upon setting, should not discolour the tooth structure, should be bacteriostatic or at least not encourage bacterial growth, should set slowly, should be insoluble in tissue fluids, should be well tolerated by the periapical tissue, should be soluble in common solvents if it is necessary to remove the root canal filling [87] .

Camargo CHR et al 2017 evaluated the adhesion of an endodontic sealer (AH Plus) in root canals and concluded that an intracanal medication based on calcium hydroxide improved the bond strength of AH Plus sealer to dentin walls [88].

Merve Acay et al 2014 evaluated the effects of Triple antibiotic paste on the bond strength of epoxy resin based root canal sealer to dentin and concluded that the Triple antibiotic paste improved the bond strength in the apical and middle thirds [89].

Elya Bartanovsky et al 2014 examined the influence of iodine containing irrigation solutions or dressings, or the addition of iodoform powder to AH 26® (Dentsply) on the bonding strength of epoxy resin based sealer and inferred that the greatest extent of reducing bond strength was found due to addition of iodoform to AH 26 powder. The accepted explanation for the reduced bond strength to some degree is due to reduced surface contact between AH 26 and the dentin wall due to remnants of the material. The different results may be explained by the dependence on

the quantity of the iodine compound, its fluid, or particle form, and the duration of contact between the iodine compound and the dentin wall [90] .

In accordance with the above mentioned studies and a study by Richard W. Stevens et al in 2006 observed an increased Sealer Penetration in Smear-free Dentin after a final rinse with 95% Ethanol . So, all the intracanal medicament in the sub groups 1c, 3c and 2c were rinsed with 95% ethanol as final irrigant , obturated and push-out bond strength test was conducted usin Universal testing machine . It was observed that there was an increase in the push-out bond strength of the subgroups **1c** (Calcium Hydroxide removed with Distilled water, passive ultrasonic irrigation with 17% EDTA and final rinse with 95% Ethanol), Subgroup **3c** (Triple antibiotic paste removed with Distilled water, passive ultrasonic irrigation with 17% EDTA and final rinse with 95% Ethanol) and Subgroup **2c** (Metapex removed with Distilled water, passive ultrasonic irrigation with 17% EDTA and final rinse with 95% Ethanol) where 95% Ethanol was used as final irrigant to remove the intracanal medicaments.

The proposed mechanism is due to the surfactant activity of ethanol. The basic principle is that alcohol reduces the surface tension of root canal sealers , irrigants and the root canal system. Alcohol spreads into the tubules and makes the root canal dry as it evaporates. Hence the alcohol might affect the sealer penetration and seepage of the root canal filling [91]. Another possible reason for the highest bond strength is the formation of a covalent bond between the epoxy group from the sealer and an amino group from the exposed dentin collagen, number and density of dentinal tubules varies along the root canal thirds . However, it has been reported that the alterations in tubular density along the canal walls are unlikely to change the adhesion of root canal sealers .

Thus, considering the results and within the limitation of the present study, it can be concluded that the final rinse with 95% Ethanol on the removal of various intracanal medicaments increased the bond strength AH plus sealer (1c, 3c and 2c).

SUMMARY AND CONCLUSION

Summary

The objective of the present study is to compare the removal of calcium hydroxide, metapex and triple antibiotic paste using 95% ethanol as final irrigant and to evaluate the bond strength of the resin based endodontic sealer by using Universal testing machine.

To assess the modes of bond failure between the interface of the sealer, canal wall and the obturating core using a Stereomicroscope at 32X magnification.

One hundred and eight single - rooted maxillary central incisors with mature apices were selected for the present study. The working length was determined. Samples were divided into 3 groups.

GROUP	INTRACANAL MEDICAMENT USED
Group 1 (n=36/group)	Calcium hydroxide mixed with distilled water
Group 2 (n=36/group)	Calcium hydroxide+Iodoform
Group 3 (n=36/group)	Triple antibiotic paste

The access cavity was then sealed with Cavit and the samples were incubated under 37 ^{0}C at 100% relative humidity for 2 weeks. After 2 weeks the samples were further sub divided as follows to remove intracanal medicaments.

SUB GROUP	INTRACANAL MEDICAMENT REMOVAL
Sub group (1a, 2a & 3a)	Intracanal medicaments were removed with Distilled water.
Sub group (1b, 2b & 3b)	Intracanal medicaments were removed with distilled water and Passive Ultrasonic irrigation with 17%EDTA solution .
Sub group (1c, 2c & 3c)	Intracanal medicaments were removed with distilled water Passive Ultrasonic irrigation with 17%EDTA solution and the root canal was flooded with 95% Ethanol, by inserting a blunt tip syringe as close as to the working as possible. The solution was left in for 10 seconds , and was dried immediately thereafter with paper points.

A single gutta percha cone of size F4 was then coated with AH Plus sealer and placed into the canals. The access cavity was sealed with Cavit and the specimens were stored in 100% relative humidity at 37°C for 2 weeks. After two weeks push□out test was performed. After the test procedure, each specimen was visually examined under a stereomicroscope at 32X magnification to evaluate the failure type.

Conclusion

It was observed that the there was considerable increase in the pushout bond strength values of all samples where 95% ethanol was used as a final rinse, followed by passive ultrasonic irrigation only and the least being the use of distilled water for removal of intracanal medicaments.

The modes of failure was visualized using a Stereomicroscope at 32 X magnification and was categorized as cohesive, adhesive and mixed failure. Cohesive and mixed failure modes accounted for most of the failures when compared to that of Adhesive failure for all the three subgroups.

BIBLIOGRAPHY

1. Cohen S (2006). *Pathways of the Pulp.* Mosby. *ISBN* 978-0-323-03067-0.
2. Nanci A (2012). Ten Cate's Oral Histology: Development, Structure, and Function. Mosby. *ISBN* 978-0-323-07846-7.
3. Patel S (2013). The Principles of Endodontics. *OUP Oxford.* ISBN 978-0-19-965751-3.
4. Shakouie, Sahar, et al. "Effects of different intra canal medicaments on the push out bond strength of endodontic sealers." *Journal of clinical and experimental dentistry* 9.3 (2017): 443.
5. Parhizkar, Ardavan, Hanieh Nojehdehian, and Saeed Asgary. "Triple antibiotic paste: momentous roles and applications in endodontics: a review." *Restorative dentistry & endodontics* 43.3 (2018).
6. Mohammadi, Z., S. Shalavi, and M. Yazdizadeh. "Antimicrobial activity of calcium hydroxide in endodontics: a review." *Chonnam medical journal* 48.3 (2012): 133-140.
7. Pannu, Rohit, and Vikas Berwal. "Calcium Hydroxide in Dentistry: A Review." *Journal Of Applied Dental and Medical Sciences* 3 (2017): 3.
8. Estrela, Carlos, et al. "Influence of iodoform on antimicrobial potential of calcium hydroxide." *Journal of Applied Oral Science* 14.1 (2006): 33-37.
9. Mohammadi, Z., S. Shalavi, and M. Yazdizadeh. "Antimicrobial activity of calcium hydroxide in endodontics: a review." *Chonnam medical journal* 48.3 (2012): 133-140.

10. Shakouie, Sahar, et al. "Effects of different intra canal medicaments on the push out bond strength of endodontic sealers." *Journal of clinical and experimental dentistry* 9.3 (2017): 443.
11. Mohammadi, Zahed, et al. "A review on triple antibiotic paste as a suitable material used in regenerative endodontics." *Iranian endodontic journal* 13.1 (2018): 1.
12. Prather, Blake T., et al. "Effects of two combinations of triple antibiotic paste used in endodontic regeneration on root microhardness and chemical structure of radicular dentine." *Journal of oral science* 56.4 (2014): 245-251
13. Bhuyan, A. C., Mukut Seal, and Kartik Pendharkar. "Effectiveness of four different techniques in removing intracanal medicament from the root canals: An in vitro study." *Contemporary clinical dentistry* 6.3 (2015): 309.
14. van der Sluis LWM, Versluis M, Wu MK, Wesselink PR.” Passive ultrasonic irrigation of the root canal: a review of the literature*: International Endodontic Journal*, 40, 415–426, 2007
15. Mozo, Sandra, Carmen Llena, and Leopoldo Forner. "Review of ultrasonic irrigation in endodontics: increasing action of irrigating solutions." *Medicina oral, patologia oral cirugia bucal* 17.3 (2012): 512.
16. Kumar, Narasimiah Suresh, Ajitha Palanivelu, and L. Lakshmi Narayanan. "Evaluation of the apical sealing ability and adaptation to the dentin of two resin-based Sealers: An in vitro study." *Journal of conservative dentistry*: JCD 16.5 (2013): 449.
17. Toursavadkohi, S., F. Zameni, and M. Afkar. "Comparison of Tubular Penetration of AH26, EasySeal, and Sure-Seal Root Canal Sealers in Single-

Rooted Teeth Using Scanning Electron Microscopy." *Journal of Research in Dental and Maxillofacial Science* 3.3 (2018): 28.

18. Mohan, Rayapudi Phani, and Annappa Raghavendra Vivekananda Pai. "The comparison between two irrigation regimens on the dentine wettability for an epoxy resin based sealer by measuring its contact angle formed to the irrigated dentine." *Journal of conservative dentistry: JCD* 18.4 (2015): 275.
19. Nandini, Suresh, Natanasabapathy Velmurugan, and Deivanayagam Kandaswamy. "Removal efficiency of calcium hydroxide intracanal medicament with two calcium chelators: volumetric analysis using spiral CT, an in vitro study." *Journal of Endodontics* 32.11 (2006): 1097-1101.
20. Stevens, Richard W., James M. Strother, and Scott B. McClanahan. "Leakage and sealer penetration in smear-free dentin after a final rinse with 95% ethanol." *Journal of endodontics* 32.8 (2006): 785-788.
21. Sathorn, C., P. Parashos, and H. Messer. "Antibacterial efficacy of calcium hydroxide intracanal dressing: a systematic review and meta□analysis." *International endodontic journal* 40.1 (2007): 2-10.
22. Saif, Sherma, et al. "Effect of irrigants and cementum injury on diffusion of hydroxyl ions through the dentinal tubules." *Journal of endodontics* 34.1 (2008): 50-52.
23. Saito, Koichi, et al. "Effect of shortened irrigation times with 17% ethylene diamine tetra-acetic acid on smear layer removal after rotary canal instrumentation." *Journal of endodontics* 34.8 (2008): 1011-1014.
24. Nunes, Vinicius Humberto, et al. "Adhesion of Epiphany and AH Plus sealers to human root dentin treated with different solutions." *Brazilian dental journal* 19.1 (2008): 46-50.

25. Barbizam, João Vicente Baroni, et al. "Effect of calcium hydroxide intracanal dressing on the bond strength of a resin-based endodontic sealer." *Brazilian dental journal* 19.3 (2008): 224-227
26. Salgado, Ricardo Julio Cabrales, et al. "Comparison of different irrigants on calcium hydroxide medication removal: microscopic cleanliness evaluation." *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 107.4 (2009): 580-584.
27. Kuah, Hong-Guan, et al. "The effect of EDTA with and without ultrasonics on removal of the smear layer." *Journal of Endodontics* 35.3 (2009): 393-396.
28. Rödig, T., et al. "Efficacy of different irrigants in the removal of calcium hydroxide from root canals." *International endodontic journal* 43.6 (2010): 519-527.
29. Balvedi, R. P. A., et al. "A comparison of two techniques for the removal of calcium hydroxide from root canals." *International endodontic journal* 43.9 (2010): 763-768.
30. Jiang, Lei-Meng, et al. "Influence of the oscillation direction of an ultrasonic file on the cleaning efficacy of passive ultrasonic irrigation." *Journal of endodontics* 36.8 (2010): 1372-1376.
31. Taşdemir, T., et al. "Efficacy of several techniques for the removal of calcium hydroxide medicament from root canals." *International endodontic journal* 44.6 (2011): 505-509.
32. Heward, Sarah, and Christine M. Sedgley. "Effects of intracanal mineral trioxide aggregate and calcium hydroxide during four weeks on pH changes in simulated root surface resorption defects: an in vitro study using matched pairs of human teeth." *Journal of endodontics* 37.1 (2011): 40-44.

33. Wiseman, Anne, et al. "Efficacy of sonic and ultrasonic activation for removal of calcium hydroxide from mesial canals of mandibular molars: a microtomographic study." *Journal of endodontics* 37.2 (2011): 235-238.
34. de Assis, Danielle Ferreira, Maíra do Prado, and Renata A. Simão. "Evaluation of the interaction between endodontic sealers and dentin treated with different irrigant solutions." *Journal of endodontics* 37.11 (2011): 1550-1552.
35. Ballal, N. V., et al. "Comparative evaluation of different chelators in removal of calcium hydroxide preparations from root canals." *Australian dental journal* 57.3 (2012): 344-348.
36. Vijayaraghavan, Rangasamy, et al. "Triple antibiotic paste in root canal therapy." *Journal of pharmacy & bioallied sciences* Suppl 2 (2012): S230.
37. Neelakantan, P., et al. "Continuous chelation irrigation improves the adhesion of epoxy resin□based root canal sealer to root dentine." *International Endodontic Journal* 45.12 (2012): 1097-1102.
38. Nainan, Mohan Thomas, D. N. Nirupama, and Shiny Benjamin. "Comparison of the efficacy of ethylene diamine tetraacetic acid and maleic acid in the removal of three calcium hydroxide intra-canal dressings: A spiral computerized tomography volumetric analysis." *Journal of conservative dentistry*: JCD 16.1 (2013): 56.
39. ÜSTÜN, Yakup, Soley Arslan, and Tuğrul ASLAN. "Effects of calcium hydroxide and propolis intracanal medicaments on bond strength of resin-based endodontic sealer as assessed by push-out test." *Dental materials journal* (2013).

40. Prado, Maíra, Renata A. Simão, and Brenda PFA Gomes. "Effect of different irrigation protocols on resin sealer bond strength to dentin." *Journal of endodontics* 39.5 (2013): 689-692 .
41. Vineeta, Nikhil, Sachin Gupta, and Aditi Chandra. "Retrievabilty of calcium hydroxide intracanal medicament with Chitosan from root canals: An in vitro CBCT volumetric analysis." *Journal of conservative dentistry*: JCD 17.5 (2014): 454.
42. Akcay, Merve, et al. "Effect of calcium hydroxide and double and triple antibiotic pastes on the bond strength of epoxy resin–based sealer to root canal dentin." *Journal of endodontics* 40.10 (2014): 1663-1667.
43. Berkhoff, Julie A., et al. "Evaluation of triple antibiotic paste removal by different irrigation procedures." *Journal of endodontics* 40.8 (2014): 1172-1177.
44. Scelza, M. Z., et al. "Influence of a new push□out test method on the bond strength of three resin□based sealers." *International endodontic journal* 48.8 (2015): 801-806.
45. Guiotti, Flávia Angélica, et al. "Effect of calcium hydroxide dressing on push-out bond strength of endodontic sealers to root canal dentin." *Brazilian oral research* 28.1 (2014): 1-7.
46. Prather, Blake T., et al. "Effects of two combinations of triple antibiotic paste used in endodontic regeneration on root microhardness and chemical structure of radicular dentine." *Journal of oral science* 56.4 (2014): 245-251.
47. Topçuoğlu, Hüseyin Sinan, et al. "The Effect of Different Final Irrigant Activation Techniques on the Bond Strength of an Epoxy Resin–based

Endodontic Sealer: A Preliminary Study." *Journal of endodontics* 40.6 (2014): 862-866.

48. Michelon C, Frighetto M, Lang PM, BELLO MD, Pillar R, Serpa GF, BIER CA. Efficacy of passive ultrasonic irrigation in removing root filling material during endodontic retreatment. *Revista de Odontologia da UNESP*. 2016 Feb;45(1):15-20.
49. Busanello, Fernanda Hoffmann, et al. "Passive ultrasonic irrigation in calcium hydroxide removal from root canals: a sem/eds analysis." *Journal of Research in Dentistry* 3.3 (2015): 668-677**.**
50. Bhuyan, A. C., Mukut Seal, and Kartik Pendharkar. "Effectiveness of four different techniques in removing intracanal medicament from the root canals: An in vitro study." *Contemporary clinical dentistry* 6.3 (2015): 309.
51. Jain, Preeti, Vimala Nilker, and Lalitagauri Mandke. "An in vitro evaluation of calcium hydroxide medication removal using various irrigants and methods." *SRM Journal of Research in Dental Sciences* 6.1 (2015): 17.
52. Busanello, Fernanda Hoffmann, et al. "Passive ultrasonic irrigation in calcium hydroxide removal from root canals: a sem/eds analysis." *Journal of Research in Dentistry* 3.3 (2015): 668-677.
53. Deniz Sungur, Derya, et al. "Push-out bond strength and dentinal tubule penetration of different root canal sealers used with coated core materials." *Restorative dentistry & endodontics* 41.2 (2016): 114-120.
54. Radeva, elka n., and desislava m. Tsanova. "efficacy of different endodontic irrigation protocols in calcium hydroxide removal." *Journal of IMAB–Annual Proceeding Scientific Papers* 22.4 (2016): 1355-1359.

55. Jain, Atul, et al. "An in vitro study: Evaluation of intracanal calcium hydroxide removal with different file systems." *Indian Journal of Dental Sciences* 9.1 (2017): 26.
56. Kaur, Manjeet, et al. "Comparative Evaluation of Anti Microbial effects of Triple Antibiotic Paste and Amox and its derivatives against E. faecalis: An in vitro study." *Journal of clinical and experimental dentistry* 9.6 (2017): e799.
57. Mehta, Shibha, et al. "Comparative evaluation of antimicrobial efficacy of triple antibiotic paste, calcium hydroxide, and a proton pump inhibitor against resistant root canal pathogens." *European journal of dentistry* 11.1 (2017): 53.
58. Camargo, Carlos Henrique Ribeiro, et al. "Calcium Hydroxide improves epoxy sealer adhesion on root dentin." *Brazilian Dental Science* 20.2 (2017): 108-113.
59. Shakouie, Sahar, et al. "Effects of different intra canal medicaments on the push out bond strength of endodontic sealers." *Journal of clinical and experimental dentistry* 9.3 (2017): 443.
60. Ghabraei, Sholeh, et al. "Effect of intra-canal calcium hydroxide remnants on the push-out bond strength of two endodontic sealers." *Iranian endodontic journal* 12.2 (2017): 168.
61. Parhizkar, Ardavan, Hanieh Nojehdehian, and Saeed Asgary. "Triple antibiotic paste: momentous roles and applications in endodontics: a review." *Restorative dentistry & endodontics* 43.3 (2018).
62. Mohammadi, Zahed, et al. "A review on triple antibiotic paste as a suitable material used in regenerative endodontics." *Iranian endodontic journal* 13.1 (2018)

63. Raghu, Ramya, et al. "Retrievability of calcium hydroxide intracanal medicament with three calcium chelators, ethylenediaminetetraacetic acid, citric acid, and chitosan from root canals: An in vitro cone beam computed tomography volumetric analysis." *Journal of conservative dentistry*: JCD20.1 (2017): 25.

64. Tamil, Sowmiya, et al. "A comparative evaluation of intracanal calcium hydroxide removal with hand file, rotary file, and passive ultrasonic irrigation: An in vitro study." *Journal of Pharmacy & Bioallied Sciences* 11.Suppl 2 (2019): S442.

65. Peters, Ove A. "Current challenges and concepts in the preparation of root canal systems: a review." *Journal of endodontics* 30.8 (2004): 559-567.

66. Baugh, Dean, and James Wallace. "The role of apical instrumentation in root canal treatment: a review of the literature." *Journal of endodontics* 31.5 (2005): 333-340.

67. Mattigatti S, Jain D, Ratnakar P, Moturi S, Varma S, Rairam S. Antimicrobial Effect of Conventional Root Canal Medicaments vs Propolis Against Enterococcus faecalis, Staphylococcus aureus and Candida albicans.
J Contemp Dent Pract 2012;13(3):305-309

68. Raghu, Ramya, et al. "Retrievability of calcium hydroxide intracanal medicament with three calcium chelators, ethylenediaminetetraacetic acid, citric acid, and chitosan from root canals: An in vitro cone beam computed tomography volumetric analysis." *Journal of conservative dentistry*: JCD 20.1 (2017): 25.

69. Mohammadi, Z., and P. V. Abbott. "On the local applications of antibiotics and antibiotic□based agents in endodontics and dental traumatology." *International endodontic journal* 42.7 (2009): 555-567.
70. Mohammadi, Z., S. Shalavi, and M. Yazdizadeh. "Antimicrobial activity of calcium hydroxide in endodontics: a review." *Chonnam medical journal* 48.3 (2012): 133-140.
71. Shakouie, Sahar, et al. "Effects of different intra canal medicaments on the push out bond strength of endodontic sealers." *Journal of clinical and experimental dentistry* 9.3 (2017): 443.
72. Vijayaraghavan, Rangasamy, et al. "Triple antibiotic paste in root canal therapy." *Journal of pharmacy & bio allied sciences* Suppl 2 (2012): S230.
73. Hoshino E, Kurihara-Ando N, Sato I, et al. In vitro antibacterial susceptibility of bacteria taken from infected root dentine to a mixture of ciprofloxacin, metronidazole and minocycline. *Int Endod J* 1996;29:125-130.
74. William W 3rd, Teixeira F, Levin L, Sigurdsson A, Trope M. Disinfection of immature teeth with a triple antibiotic paste. *J Endod* 2005;31:439-43.
75. Huang GT. A paradigm shift in endodontic management of immature teeth: Conservation of stem cells for regeneration. *J Dent* 2008;36:379-86.
76. McTigue, Dennis J., Kumar Subramanian, and Ashok Kumar. "Case series: management of immature permanent teeth with pulpal necrosis: a case series." *Pediatric dentistry* 35.1 (2013): 55-60.
77. Bansal, Ramta, and Aditya Jain. "Overview on the current antibiotic containing agents used in endodontics." *North American journal of medical sciences* 6.8 (2014): 351.

78. Sokhi, Rithima R., et al. "Effect of calcium hydroxide based intracanal medicaments on the apical sealing ability of resin-based sealer and gutta-percha obturated root canals." *Journal of clinical and diagnostic research*: JCDR 11.1 (2017): ZC75.
79. Rödig T, Vogel S, Zapf A, Hülsmann M. Efficacy of different in the removal of calcium hydroxide from root canals. *Int Endod J* 2010; 43(6):519-27.
80. van der Sluis LW, Wu MK, Wesselink PR. The evaluation of removal of calcium hydroxide paste from an artificial standardized groove in the apical root canal using different irrigation methodologies.
Int Endod J. 2007;40:52–57.
81. Tasdemir, Tamer, et al. "Effect of passive ultrasonic irrigation on apical extrusion of irrigating solution." *European journal of dentistry* 2 (2008): 198.
82. Mohammadi, Zahed, Sousan Shalavi, and Hamid Jafarzadeh. "Ethylenediaminetetraacetic acid in endodontics." *European journal of dentistry* 7.Suppl 1 (2013): S135.
83. Gu, Li-sha, et al. "Review of contemporary irrigant agitation techniques and devices." *Journal of endodontics* 35.6 (2009): 791-804.
84. Marín-Bauza, Gabriela Alexandra, et al. "Physicochemical properties of endodontic sealers of different bases." *Journal of Applied Oral Science* 20.4 (2012): 455-461.
85. Nunes, Vinicius Humberto, et al. "Adhesion of Epiphany and AH Plus sealers to human root dentin treated with different solutions." *Brazilian dental journal* 19.1 (2008): 46-50.

86. Punia, Sandhya Kapoor, Prasannalatha Nadig, and Vikas Punia. "An in vitro assessment of apical microleakage in root canals obturated with gutta-flow, resilon, thermafil and lateral condensation: A stereomicroscopic study. " *Journal of conservative dentistry: JCD* 14.2 (2011): 173.
87. Schilder, Herbert. "Filling root canals in three dimensions." *Journal of endodontics* 32.4 (2006): 281-290.
88. Boţa, gabriela, and alina cristian. "the impact of calcium hydroxide on the penetration of root filing material in side canals." *Acta Medica Transilvanica* 22.4 (2017).
89. Akcay, Merve, et al. "Effect of calcium hydroxide and double and triple antibiotic pastes on the bond strength of epoxy resin–based sealer to root canal dentin." *Journal of endodontics* 40.10 (2014): 1663-1667.
90. Dental, DocTalk. "The effect of iodine-containing materials on the bonding strength of AH 26®."
91. Thiruvenkadam, G., et al. "Effect of 95% ethanol as a final irrigant before root canal obturation in primary teeth: An in vitro study." *International journal of clinical pediatric dentistry* 9.1 (2016): 21.