Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2021;11:2s:46-52.

A Comparative Evaluation of Fracture Resistance of Human Root Dentin Exposed to Calcium Hydroxide with Four Different Vehicle as Intracanal Medicament: An In-Vitro Study

Ujjwal Chandra Jha[1*] Gaurav Sharma[2] Abu Mohammad Khan[3] Archana Gautam[4] Fanindra Pandey[5] Ram Mangal Samadhiya[6]

[1]Senior Lecturer, Department of Conservative Dentistry and Endodontics, Department of Endodontics, Rama Dental College, Kanpur, UP, India.
[2]Sr Consultant, Max Smart Superspeciality Hospital, New Delhi, India.
[3]Senior Lecturer, Department of Conservative & Endodontic Dentistry, Maharana Pratap Dental College, Kanpur, UP, India.
[4]Senior Lecturer, Department of Conservative Dentistry and Endodontics, Department of Endodontics, Rama Dental College, Kanpur, UP, India.
[5]Private Practitioner, Delhi, India.
[6]BDS, Private Practitioner, India.

ABSTRACT

Background: The present study was conducted to compare the fracture resistance of radicular dentin when intracanal medicaments such as CH, CHX, CHID, were mixed with LP for 1-week and 1-month time interval.

Material & method: The study was conducted on sixty single-rooted extracted human permanent premolars teeth and complete instrumentation was done. Samples were divided into five groups based on intracanal medicament used: Group 1 - no medicament was placed (CON), group 2 - mixture of 1.5 g of CH and 1 ml of 2% CHX (CHCHX), group 3 - mixture of 1.5 g of CH, 1 ml of CHX and 1 ml of 5% LP solution (CHCHXLP), group 4 – CH and iodoform (CHID), group 5- CHI and 1ml of 5%LP solution (CHIDLP). After storage period of each group for 1-week and 1-month, middle 8 mm root cylinder was sectioned and tested for fracture resistance.

Results: At 1-month time interval, there was a statistically significant difference in fracture resistance between CHCHX and CHCHXLP groups.

Conclusion: Addition of LP has not decreased the fracture resistance of radicular dentin after 1-month.

Keywords: Calcium hydroxide; fracture resistance; intracanal medicament; lycopene.

INTRODUCTION

Calcium hydroxide [Ca(OH)2] was introduced to endodontics by Hermann in 1920 and has been used extensively in multiple endodontic applications. It has been used in various formulations as a liner beneath restorations , pulp-capping agent, interappointment intracanal medicament during endodontic therapy and in apexification procedures. It is often applied within the root canal system for the control of inflammatory root resorption after luxation and avulsion injuries.[1-4]

Despite these clinical successes, reports have surfaced correlating intracanal placement of calcium hydroxide with an increased incidence of tooth fracture, especially in teeth treated prior to full apical closure. Cvek reported that incidence of cervical root fracture is relatively high in endodontically treated immature teeth either spontaneously or due to minor impacts.[5-11]

Calcium hydroxide has been found to be insufficient in the elimination of facultative anaerobes and

Received: Nov. 9, 2020: **Accepted**: Jan. 18, 2021
*Correspondence Dr. Ujjwal Chandra Jha.
Department of Conservative Dentistry and Endodontics, Department of Endodontics, Rama Dental College, Kanpur, UP, India.
Email: Not Disclosed

pISSN 2278-0076
eISSN 2321-9270

yeasts. On the other hand chlorhexidine gluconate has been recommended as an irrigant and intracanal medicament because of its strong antibacterial activity against gram positive and gram negative microorganisms as well as yeast, facultative anaerobes and aerobes. Chlorhexidine was introduced to increase the antibacterial action of traditionally used intracanal medications and to eliminate microorganisms associated with persistent infections and treatment. The mixture of the two has been suggested in the literature to obtain a wide-spectrum antimicrobial action.[12- 17]

Antioxidants are substance that considerably delay or inhibit oxidation of the oxidizable substrate at lower concentrations. LP, the red pigment of ripe tomatoes,watermelons, red chillies and guavas, is a tetraterpene with eight isoprene units composed entirely of carbon and hydrogen. This highly unsaturated hydrocarbon contains 11conjugated and two nonconjugated carbon–carbon doublebonds. It is a strong antioxidant and free radicalscavengerbecause it possesses the property of quenching singlet oxygen. It neutralizes the hydroxyl radicals and stimulates many antioxidative enzymes such as superoxide dismutase, glutathione peroxidase, glutathione reductase and protects cellmembranes from lipid peroxidation.LP has the potential to quench singlet oxygen, scavengevarious free radicals like nitrogen dioxide (NO2), Thiyl (RS), and sulfonyl (RSO2).[18- 24]

Hence; the present study was undertaken to evaluate the fracture resistance of human root dentin when exposed to intra canal Ca(OH)2 in combination with chlorhexidine gluconate , iodoform ,chlorhexidine-lycopene, and iodoform-lycopene over a period of one week and one month by horizontally sectioning the root dentin into 8mm thick discs and by subjecting these discs under universal testing machine.

MATERIALS & METHODS

Fifty six freshly extracted single rooted human teeth were selected for the study on the basis of the following criteria-

- No root caries,
- No resorption or fracture,
- Mature, fully formed apices,

Were stored in normal saline

The teeth were sorted by size and type and subsequently randomly assigned to one of the four groups so that each group comprises of 14 similar teeth.

Group I- control group
Group II – Ca(OH)2 with 1ml of 2% Chlorhexidine gluconate with 1ml of 5%lycopene
Group III – Ca(OH)2 with Iodoform (Metapex)
Group IV – Ca(OH)2 with 2% Chlorhexidine gluconate
Group V- Ca(OH)2 with iodoform(Metapex) with 1ml of 5%lycopene

Each tooth was accessed coronally with endo access bur and pulp tissue was extirpated. The canals were instrumented to a size of 20 stainless steel K-file, so that the file extended beyond the apical foramen by 1mm, followed by copious irrigation with normal saline using 25 gauge needle. Subsequently the canals were dried using paper points.

Group I

The root canals of the teeth in this group were filled with normal saline using syringe of 25 gauge needle. The coronal portion was sealed by placing a small cotton pellet into the pulp chamber and then single step self etching dental adhesive(XENO III) was used,followed by composite restoration.Apical seal was done by application of self etch bonding agent followed by composite restoration. The teeth were soaked in saline-soaked gauge throughout the preparation procedures and then stored in 0.9% saline at room temperature in a beaker. Group I formed the control group of the study.

Group II

The root canals of the teeth in Group II were densely filled with Ca(OH)2 with 1ml of 2% Chlorhexidine gluconate with 1ml of 5%lycopene mixed with normal saline using a disposable syringe. Excess paste was intentionally extruded past the apex. The teeth were sealed apically and coronally by placing a small cotton pellet into the pulp chamber and then applying self etching dental adhesive (XENO III) followed by composite restoration. The teeth were then stored in 0.9% saline at room temperature in a beaker.

Group III

The root canals of teeth in Group II were filled with Ca(OH)2 paste – Metapex (META) by using a disposable tip supplied with the syringe and by inserting the tip into the root canal. Excess Ca(OH)2 paste was intentionally extruded past the apex. The teeth were sealed apically and coronally by placing a small cotton pellet into the pulp chamber and then applying self-etching dental adhesive (XENO III) followed by composite restoration. The teeth were than stored in 0.9% saline at room temperature in a beaker.

Group IV

The root canals of teeth in Group IV were filled with Ca(OH)2 mixed with 2% chlorhexidine gluconate. Excess Ca(OH)2 paste was intentionally extruded past the apex. As in previous groups, the teeth were sealed apically and coronally by placing a small cotton pellet into the pulp chamber and then applying self etching dental adhesive followed by composite restoration. The teeth were than stored in 0.9% saline at room temperature in a beaker.

Group V

The root canals of teeth in Group IV were filled with Ca(OH)2 with iodoform(Metapex) with 1ml of 5%lycopene. . Excess paste was intentionally extruded past the apex. As in previous groups, the teeth were sealed apically and coronally by placing a small cotton pellet into the pulp chamber and then applying self-etching dental adhesive followed by composite restoration. The teeth were than stored in 0.9% saline at room temperature in a beaker.

After one week and 30 days, the teeth from each group were sectioned horizontally into 1 mm thick discs starting from apical 1/3rd into 2-3 sections and each horizontal section was placed under universal testing machine and a mounted punch with 1.2 mm cross section was centered between the canal and the outside edge of the dentin disc and lowered onto the specimen at a cross head speed of 2.5 mm/min until the specimen fractured. The test machine software automatically recorded the peak load at fracture and values noted.

RESULTS

The aim of the present study was to evaluate the fracture resistance of root dentin when exposed to intracanal Ca(OH)2 in combination with iodoform, chlorhexidine gluconate, iodoform-lycopene, chlorhexidine gluconate-lycopene. The mean force (in Newton) needed to fracture at two different time intervals for different groups. *P < 0.05: Showing statistically significant decrease in fracture resistance Intragroup analysis that is comparison of fracture resistance values within groups at 1-week and 1-month time interval, *P < 0.05: Showing statistically significant difference in fracture resistance, SD: Standard deviation, SE: Standard error.

Table 1: Mean force at two different time period

Group	1 week	1 month	P
Control	736.30	706.10	0.273
CHCNX	707.70	594.80	0.016
CHCHXLP	719.00	674.50	0.257
CHID	721.00	630.20	0.216
CHIDLP	720.00	677.00	0.251

Table 2: Intragroup analysis of groups at 1-week and 1 month time interval

S No.	Groups	Time interval	Mean	SD	SE	P
1	CON - CHCHX	1week 1month	28.600 111.300	91.791 113.364	29.027 35.849	0.350 0.013
2	CON-CHCHXLP	1week 1month	17.300 31.600	79.921 74.778	25.273 23.647	0.511 0.214
3	CON-CHID	1week 1month	3.25 11.24	5.088 11.211	20.21 17.20	0.311 0.211

4	CON-CHIDLP	1week 1month	0.441 5.210	112.20 97.32	15.20 17.00	0.220 0.191
5	CHCHX-CHCHXLP	1week 1month	-11.30 -79.700	125.555 110.210	39.704 34.851	0.782 0.048
6	CHCHX-CHID	1week 1month	22.10 17.80	111.02 107.20	35.20 30.20	0.074 0.052
7	CHCHX-CHIDL	1week 1month	17.20 12.20	112.20 109.00	31.20 30.20	0.210 0.121
8	CHCHXLP-CHID	1week 1month	13.20 15.00	110.21 107.20	25.20 24.21	0.228 0.221
9	CHCHXLP-CHIDLP	1week 1month	11.21 10.20	102.20 107.10	23.20 25.20	0.111 0.121
10	CHID-CHIDLP	1week 1month	11.25 16.21	102.20 103.21	26.30 21..27	0.221 0.331

DISCUSSION

The aim of this study was to investigate whether the addition of natural antioxidant LP to CH-CHX mixture as intracanal medicament has any influence on fracture resistance of radicular dentin. The tested null hypothesis was rejected because there was a statistical significance difference in fracture resistance of CHCHXLP group. Human mature permanent teeth were chosen in the study as an increase in frequency of fracture with immature teeth has been reported because of incomplete root development and subsequent thinner dentinal walls. To simulate the routine clinical conditions and to include its effect also 3% sodium hypochlorite has been used a common irrigant between the succeeding files during cleaning and shaping procedure of all the samples.

In the present study, the mean compressive strength of samples in control group shows higher values than the groups with intracanal medicament, at 1-week and 1-month period. This shows the process of dissolution, denaturation and hydrolysis of the organic structure of radicular dentin due to medicaments. Doyon et al. stated that there may be disruption in collagen fibers and hydroxyapatite crystals interaction at alkaline pH due to CH, which may negatively influence the mechanical properties of radicular dentin.[1]

Calcium hydroxide has been used in endodontic treatment of human teeth, often overextended periods of time. Literature supports that there was decrease in fracture resistance of radicular dentin when CH was used as intracanal medicament. In the systematic review by Yassen and Platt[13] many authors (Doyon et al. [2005][1], Rosenberg et al. [2007][25]) quoted that strength of radicular dentin was significantly decreased at a period of >1-month. So, time would be required for CH to penetrate into dentin and denature the collagen fibrils making dentin susceptible to fracture.

In the present study in CHCHX group, there was a significant decrease in fracture resistance of radicular dentin after 1-month time interval. Although this combination has proven to be synergistic in decreasing the microbial growth, it has negative effect on fracture resistance of radicular dentin. This may be mainly because of the release of reactive oxygen species (ROS) by CHX in an alkaline environment. ROS are small, short-lived, and highly reactive radicals formed by incomplete one-electron reduction of oxygen.

There was no statistical difference between all the groups at 1-week. At 1-month period, fracture resistance was high in control group, and there is a statistical significance difference between control and CHCHX group and between CHCHX and CHCHXLP group.

In the present study when antioxidants like LP was added to the mixture of CH and CHX, there was no significant decrease in fracture resistance of radicular dentin at 1-week and 1-month interval. Though there is decrease in numerical value, this is not a statistically significant difference.

Antioxidants are substances that considerably delay or inhibit oxidation of the oxidizable substrate at

lower concentrations. LP, the red pigment of ripe tomatoes, watermelons, red chillies and guavas, is a tetraterpene with eight isoprene units composed entirely of carbon and hydrogen. This highly unsaturated hydrocarbon contains 11 conjugated and two nonconjugated carbon–carbon double bonds. It is a strong antioxidant and free radical-scavenger because it possesses the property of quenching singlet oxygen. It neutralizes the hydroxyl radicals and stimulates many antioxidative enzymes such as superoxide dismutase, glutathione peroxidase, glutathione reductase and protects cell membranes from lipid peroxidation.

LP has the potential to quench singlet oxygen, scavenge various free radicals like nitrogen dioxide (NO2), Thiyl (RS), and sulfonyl (RSO2). Mageshwaran et al conducted a study on ROS counteraction by antioxidants against Enterococcus faecalis in agar diffusion test by mass spectrometer. They concluded that CH and CHX combination group produced excessive amount of ROS, which are detrimental to the host tissues and reduced ROS formation in CH, CHX and LP combination group. The results of present study showed the decreased fracture resistance of radicular dentin in CH-CHX group which could be due to the release of ROS. In the present study CHCHXLP group, the LP might have neutralized the ROS produced in CHCHX combinations and resulted in no statistical significance difference in compressive strength of radicular dentin at 1-week and 1-month time interval.[23]

The quenching of ROS by LP may be due to its structure containing high number of conjugated double bonds, which has the maximum oxygen-quenching ability. This is a physical quenching process that is, the carotenoid remains intact and can undergo further cycles of single oxygen quenching. Further, LP effectively deactivates the electronically excited sensitizer molecules that are involved in the generation of radicals and singlet oxygen.

The null hypothesis of this study is that there would be no difference in the fracture resistance of radicular dentin after addition of LP to CH-CHX mixture at 1-week and 1-month time interval was rejected. This is because there is a significant difference in increased compressive strengthof radicular dentin in CHCHXLP when compared to CHCHX group.

CONCLUSION

Addition of LP to CH , CHID, CHX mixture has not decreased the fracture resistance of radicular dentin after 1week and 1-month. However, this result is more encouraging and need to be validated with a larger sample size and long-term evaluation with in vitro models and randomized control trials before extrapolating these results into the clinical scenario.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Doyon GE, Dumsha T, von Fraunhofer JA. Fracture resistance of human root dentin exposed to intracanal calcium hydroxide. J Endod 2005;31:895-7.

2. Manzur A, González AM, Pozos A, Silva-Herzog D, Friedman S. Bacterial quantification in teeth with apical periodontitis related to instrumentation and different intracanal medications: A randomized clinical trial. J Endod 2007;33:114-8.

3. Allard U, Stromberg U, Stromberg T. Endodontic treatment of experimentally induced apical periodontitis in dogs. Endod Dent Traumatol 1987;3:240-4.

4. Lu Y, Liu T, Li X, Li H, Pi G. Histologic evaluation of direct pulp capping with a self-etching adhesive and calcium hydroxide in beagles. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;102:e78-84.

5. Leonardo MR, Hernandez ME, Silva LA, Tanomaru-Filho M. Effect of a calcium hydroxide-based root canal dressing on periapical repair in dogs: A histological study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;102:680-5.

6. Hasselgren G, Olsson B, Cvek M. Effects of calcium hydroxide and sodium hypochlorite on the dissolution of necrotic porcine muscle tissue. J Endod 1988;14:125-7.

7. Buck RA, Cai J, Eleazer PD, Staat RH, Hurst HE. Detoxification of endotoxin by endodontic irrigants and calcium hydroxide. J Endod 2001;27:325-7.

8. Tanomaru JM, Leonardo MR, Tanomaru Filho M, Bonetti Filho I, Silva LA. Effect of different irrigation solutions and calcium hydroxide on bacterial LPS. Int Endod J 2003;36:733-9.

9. Vaghela DJ, Kandaswamy D, Venkateshbabu N, Jamini N, Ganesh A. Disinfection of dentinal tubules with two different formulations of calcium hydroxide as compared to 2% chlorhexidine: As intracanal medicaments against Enterococcus faecalis and Candida albicans: An in vitro study. J Conserv Dent 2011;14:182-6.

10. Sinha N, Patil S, Dodwad PK, Patil AC, Singh B. Evaluation of antimicrobial efficacy of calcium hydroxide paste, chlorhexidine gel, and a combination of both as intracanal medicament: An in vivo comparative study. J Conserv Dent 2013;16:65-70.

11. Bhardwaj A, Ballal S, Velmurugan N. Comparative evaluation of the antimicrobial activity of natural extracts of Morinda citrifolia, papain and aloe vera (all in gel formulation), 2% chlorhexidine gel and calcium hydroxide, against Enterococcus faecalis: An in vitro study. J Conserv Dent 2012;15:293-7.

12. Aggarwal V, Miglani S, Singla M. Conventional apexification and revascularization induced maturogenesis of two non-vital, immature teeth in same patient: 24 months follow up of a case. J Conserv Dent 2012;15:68-72.

13. Yassen GH, Platt JA. The effect of nonsetting calcium hydroxide on root fracture and mechanical properties of radicular dentine: A systematic review. Int Endod J 2013;46:112-8.

14. Zarei M, Afkhami F, Malek Poor Z. Fracture resistance of human root dentin exposed to calcium hydroxide intervisit medication at various time periods: An in vitro study. Dent Traumatol 2013;29:156-60.

15. Prabhakar AR, Hadakar SG, Raju OS. Comparative evaluation of pH and antibacterial effect of various calcium hydroxide combinations on E. faecalis and its effect on root strength: An in vitro study. Contemp Clin Dent 2012;3:42-7.

16. Arumugam MT, Nesamani R, Kittappa K, Sanjeev K, Sekar M. Effect of various antioxidants on the shear bond strength of composite resin to bleached enamel: An in vitro study. J Conserv Dent 2014;17:22-6.

17. Abraham S, Ghonmode WN, Saujanya KP, Jaju N, Tambe VH, Yawalikar PP. Effect of grape seed extracts on bond strength of bleached enamel using fifth and seventh generation bonding agents. J Int Oral Health 2013;5:101-7.

18. Yeung SY, Huang CS, Chan CP, Lin CP, Lin HN, Lee PH, et al. Antioxidant and pro-oxidant properties of chlorhexidine and its interaction with calcium hydroxide solutions. Int Endod J 2007;40:837-44.

19. Chapple IL. Reactive oxygen species and antioxidants in inflammatory diseases. J Clin Periodontol 1997;24:287-96.

20. Waris G, Ahsan H. Reactive oxygen species: Role in the development of cancer and various chronic conditions. J Carcinog 2006;5:14.

21. Subhash K, Bose C, Agrawal BK. Effect of short term supplementation of tomatoes on antioxidant enzymes and lipid peroxidation in type-II diabetes. Indian J Clin Biochem 2007;22: 95-8.

22. Stahl W, Sies H. Bioactivity and protective effects of natural carotenoids. Biochim Biophys Acta 2005;1740:101-7.

23. Mageshwaran T, Ebenezar AR, Madhanamadhubala M, Kavitha S, Mahalaxmi S. Counteraction of reactive oxygen species and determination of antibacterial efficacy of proanthocyanidin and lycopene when mixed with calcium hydroxide and chlorhexidine mixture. 2018; 23: 22- 27

24. An in vitro comparative study. J Conserv Dent 2012;15:337-41. 24. Yoldas O, Dogan C, Seydaoglu G. The effect of two different calcium hydroxide combinations on root dentin microhardness. Int Endod J 2004;37: 828-31.

25. Rosenberg B, Murray PE, Namero K. The effect of calcium hydroxide root filling on dentin fracture strength. Dent Traumatol 2007; 23:26-9.