

Original Article

Effect of different intracanal medicaments on the fracture resistance of the human root

Saeed Rahimi¹, Negin Ghasemi¹, Golchin Jabbari², Zahra Zaheri³, Zahra Sadat Torabi⁴, Naghmeh Rahimi Darehchi⁵

¹Dental and Peridontal Research Center, Dental Faculty, Tabriz University of Medical Sciences, ³Dental Faculty, Tabriz University of Medical Sciences, Tabriz, ²Department of Endodontics, Dental Faculty, Urmia University of Medical Sciences, Urmia, ⁴Department of Oral and Maxillofacial Surgery, Dental Faculty, Shahid Beheshti University of Medical Sciences, Tehran, Iran, ⁵Semmelweis Dental School, Budapest, Hungary, Europe

ABSTRACT

Background: The effect of different intracanal medicaments on root fracture resistance has not been thoroughly investigated in the short and long term. To assess the effect of calcium hydroxide (CH), CH combined with Chlorhexidine (CHX), double antibiotic paste (DAP), and simvastatin as intracanal medicaments on the fracture resistance of the human root. One hundred and twenty single-rooted mandibular premolars which were extracted for periodontal reasons were collected for this *in vitro* study.

Materials and Methods: This was an *in vitro* study. All teeth were decoronated. Root canals were prepared by the Pro taper system, and %2.5 NaOCl was used for irrigation. The smear layer was removed using %5.25 NaOCl and 17% ethylenediaminetetraacetic acid each for 3 min. The samples were randomly divided into five groups based on the medicament: (1) CH (2) CH + CHX (3) Simvastatin (4) DAP (5) Control group. All specimens in each group were incubated for 1 week (Subgroup A) and 1 month (Subgroup B). Then, medicaments were removed and filled with gutta-percha and AH26 sealer. All samples were tested for fracture resistance. The data were statistically evaluated with the SPSS software 17. ANOVA and Mann-Whitney U and Wilcoxon tests were used for the analysis of the data. $P = 0.05$ was considered statistically significant.

Results: Although CH and CH + CHX increased the fracture resistance in a 1-week period, there was no significant difference between the groups after 1 month.

Conclusion: Under the limitations of this study, CH and CH + CHX, DAP and simvastatin do not have a negative effect on root fracture resistance when used as intracanal medicaments for <1 month.

Key Words: Calcium hydroxide, chlorhexidine, root canal, simvastatin, therapy

Received: 19-Jul-2020
Revised: 05-Jun-2021
Accepted: 10-Jul-2021
Published: 28-Jan-2022

Address for correspondence:

Dr. Zahra Sadat Torabi,
Department of Oral and
Maxillofacial Surgery, Dental
Faculty, Shahid Beheshti
University of Medical
Sciences, Tehran, Iran.
E-mail: ztorabie@yahoo.
com

INTRODUCTION

Intracanal medicaments have been used for disinfection purposes between the sessions of endodontic procedures. The time it takes for the

medicament to be effective varies depending on the procedure and potency of the material.^[1,2]

Root fracture is associated with several known factors that weaken tooth structure, including decays,

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Rahimi S, Ghasemi N, Jabbari G, Zaheri Z, Torabi ZS, Darehchi NR. Effect of different intracanal medicaments on the fracture resistance of the human root. Dent Res J 2022;19:9.

Access this article online	
	<p>Website: www.drj.ir www.drjjournal.net www.ncbi.nlm.nih.gov/pmc/journals/1480</p>

access cavity and canal preparation, and presumably, intracanal medicaments.^[3-5] Increased root fragility related to intracanal medicaments may be due to demineralization effect of these materials which in long-term intervals can have a negative effect on the radicular structure.^[6]

Calcium hydroxide (CH) is a widely accepted well studied endodontic material with high pH and wide antimicrobial activity that is being used as intracanal dressing.^[7] The disadvantages include ineffectiveness against *Enterococcus faecalis* and *Candida albicans* and also its denaturing effect on dentinal structures which leads to decreased fracture resistance.^[6,8,9] This adverse effect might be more significant because of need for prolonged use of this material to achieve effectiveness, especially in the treatment of traumatized teeth.^[6]

Chlorhexidine (CHX) is an effective antimicrobial agent, notably, against CH resistant microflora.^[9] Therefore, the combination of CHX and CH has been suggested to avoid persistent endodontic infections. Furthermore, CHX can bind to dentin for a prolonged antibacterial effect.^[10]

Double antibiotic paste (DAP) is a mixture of metronidazole and ciprofloxacin and has been used in endodontic regeneration with favorable results.^[11] Nevertheless, there are concerns about its negative effect on the mechanical properties of radicular dentin which have been attributed to the strong demineralizing effect of this low pH mixture.^[12]

Simvastatin is a 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitor used basically for cardiovascular disease with documented safety and low price.^[13] Interesting properties of this drug have led to innovative use of it in endodontics. It has been suggested that angiogenesis potential and anti-inflammatory and bone regenerating properties of simvastatin might be of use in endodontic regeneration.^[14] Nevertheless, experimental studies on simvastatin are limited, and biomechanical aspects of its use have not been studied thoroughly yet.

Root fracture is one of the most undesirable complications after endodontic treatment that seriously affects the prognosis.^[15] Thus, the aim of this study was to assess the effect of CH, CH combined with CHX, DAP, and simvastatin as intracanal medicaments on fracture resistance of the human root.

MATERIALS AND METHODS

This was an *in vitro* study. After receiving local ethics committee approval, 120 single-rooted mandibular premolars, extracted for periodontal and orthodontic reasons were obtained and stored in chloramine T 0.5% until the study time. All specimens were examined with magnifying loop and plain radiography for the exclusion of any cracked, calcified, previously treated or undeveloped teeth. After scaling and root planning (Cavitron, Dentisply, Ltd, Weybridge, UK), all teeth were decoronated below the CEJ with diamond disk (Sp 1600 Microtome, Leica, Na Block, Germany) under water coolant to leave 13 mm of length. Working length was determined with K-file #15 (Dentisply Mailefer, Balbigue, Switzerland) instrumentation was done using the crown-down technique with rotary system (Dentisply Mailefer, Balbigue, Switzerland) up to main apical file F3 and #35. 2.5% Sodium hypochlorite (MORVABON, Tehran, Iran) was used for irrigation. Finally, 5.25% sodium hypochlorite and 17% ethylenediaminetetraacetic acid (MORVABON, Tehran, Iran) were applied for smear layer removal, and canals were rinsed and dried with paper points.

All roots were randomly assigned to five study groups (24 roots in each group); Group 1: CH (MORVABON, Tehran, Iran), Group 2: Combined use of CH and CHX 2% (MORVABON, Tehran, Iran), Group 3: Simvastatin (Pursina, Tehran, Iran); simvastatin 1% gel was prepared according to method used by Dianat *et al.*,^[16] Group 4: DAP (Metronidazole (Abidi, Tehran, Iran) and Ciprofloxacin (Farabi, Isfahan, Iran); two 250 mg Metronidazole tablet and one 500 mg Ciprofloxacin tablet were grinded and equal portions were mixed with normal saline to form a paste. Group 5: Control group without addition of any substances.

All the root canals in the experimental and control groups were sealed with Cavite dressing (Cavisol, Golchay, Tehran, Iran). All specimens in each group were randomly assigned into two equal subgroups depending on the incubation time. Subgroup A specimens were incubated for 1 week and Subgroup B for 1 month in 37° and 100% moist in incubator. At the end of the incubation period, canals were rinsed with 5.25% sodium hypochlorite and normal saline and were obturated with gutta-percha and AH26 sealer (Dentisply, Dentrey, kostanz, Germany) with lateral compaction technique and were again incubated

for 24 h with previous settings. In the control group, all specimens were obturated with the same technique after canal preparation.

To simulate the PDL and create a 0.2-mm gap external surface of each root was covered with a thin layer of melted wax and dried. Calipers (Yates-Motloid, Chicago, Illinois, USA) were used to assess the thickness of the wax layer in two different root levels. Then roots were embedded in self-curing acrylic cylinders (AcroPars, Tehran, Iran). After polymerization was completed, roots were removed and the wax layer was removed with warm water. Simulated acrylic sockets were filled with poly vinyl siloxane (Impregum Soft, 3M ESPE, Seefeld, Germany) and roots were reinserted in sockets immediately. Finally, samples were tested for fracture resistance with the universal testing machine (Hounsfield Test Equipment, Model: H5K-S, Surrey, England).

The statistical analysis of the data was performed using the SPSS software version 17.0 (SPSS Inc., Chicago, IL, USA) where $P = 0.05$ was considered statistically significant. The Kolmogorov–Smirnov test was used to assess the normality of the data.

RESULTS

Descriptive findings are presented in Table 1. According to the results, the highest fracture resistance after 1 week was seen in CH and CHX group (643.53 ± 445.13) and CH group (613.62 ± 345.13), respectively, while the least fracture resistance value was measured in the control group (185.55 ± 231.12). Due to nonnormal distribution of data in two groups in the 1-week interval, Mann–Whitney U -test was used for the comparative analysis. According to the results, the difference between CH and CHX group and CH group with the control group was statistically significant ($P = 0.03$ and 0.02 , respectively), but there was no significant difference between these two groups or other experimental groups with the control group [Table 2].

Based on the values measured after 1 month, the highest fracture resistance was related to Simvastatin group with an average of 657.78 ± 449.01 and the least amount was recorded in DAP group (308.08 ± 238.52). Normality of data and homogeneity of variances was confirmed in the 1-month interval. Thus, according to the one-way

ANOVA test results, fracture resistance amount was not significantly different between the study groups ($P = 0.13$).

According to Wilcoxon test results, there was no statistically significant difference between the fracture resistance of each study group in 1 week as compared to fracture resistance in 1 month [Table 3].

DISCUSSION

This study was conducted to investigate the effect of different intracanal medicaments on the fracture resistance of radicular dentin. According to our findings, CH and CH combined with CHX, DAP, and simvastatin do not have a significant negative effect on root fracture resistance when used as intracanal medicament for <1 month.

Table 1: Descriptive data of fracture resistance in study groups

Study group	Mean±SD	
	1 week	1 month
Calcium hydroxide	613.62±345.31	495.98±375.08
Calcium hydroxide and chlorhexidine	643.53±445.31	428.38±322.59
Double antibiotic paste	413.83±282.18	308.08±238.52
Simvastatin	469.15±161.18	657.78±449.01
Control group	231.12±185.55	409.94±249.05

SD: Standard deviation

Table 2: Comparison of fracture resistance results between all study groups in 1 week interval

Study group	Compared to	P
Control group	Calcium hydroxide	0.02
	Calcium hydroxide + chlorhexidine	0.03
	Dual antibiotic paste	1.00
	Simvastatin	0.22
Calcium hydroxide	Calcium hydroxide + chlorhexidine	1.00
	Dual antibiotic paste	1.00
	Simvastatin	1.00
Calcium hydroxide and chlorhexidine	Dual antibiotic paste	1.00
	Simvastatin	1.00
Simvastatin	Dual antibiotic paste	1.00

Table 3: Comparative results of fracture resistance in 1 week and 1 month for each study group (Wilcoxon test results)

Study group	Mean difference	P
Calcium hydroxide	117.64	0.308
Calcium hydroxide and chlorhexidine	215.15	0.182
Double antibiotic paste	105.75	0.388
Simvastatin	-188.63	0.239
Control group	-178.82	0.158

Although CH has been widely used for endodontic treatments, its antimicrobial inefficiency in persistent endodontic infections is considerable.^[17] Addition of CHX as a potent antimicrobial agent has long been studied to overcome this problem, but the results have been controversial.^[18]

An unexpected finding of our study was the significant increase in fracture resistance of samples treated with CH (with or without CHX) after 1 week of incubation. This observed effect might be associated with denaturing effect of CH which might result in better penetration of obturation materials into radicular dentin and subsequent improvement in fracture resistance. However, the lack of this observation on the samples incubated for 1 month might reflect the negative influence of progressive denaturation on fracture resistance. Further specifically designed studies with larger sample sizes are required to evaluate these findings.

Regarding the current study's findings, it can be suggested that addition of CHX to CH is mechanically harmless for dentinal structure in less than a month and might be rational for a better antimicrobial coverage. This finding is consistent with Prabhakar *et al.* study results.^[19] However, conducting randomized clinical studies is crucial to support this claim.

Simvastatin is known to have antimicrobial activity against bacteria and reduces the formation of *Staphylococcus aureus* biofilms.^[20,21]

DAP and simvastatin had no significant effect on fracture resistance. To our knowledge, this is the first study to assess the biomechanical effects of these materials on radicular dentin. Anti-inflammatory effects of simvastatin through the reduction of interleukin 6 and 8 have been established. Therefore, the local application of simvastatin as an intracanal medicament or as a combination with previously studied materials might lead to improved results without jeopardizing fracture resistance of radicular dentin.^[22]

One of the advantages of this study compared to previous similar studies is that human premolars were used instead of bovine specimens.^[3,23] The simulation of PDL and its shock absorbent properties are another advantage of this study. These properties have been overlooked in many similar previous studies. In 2013, Yassen *et al.*^[24] assessed the effect of intracanal medicaments on root fracture using 5 mm cervical root cylinders as specimens and

reported a significant time-dependent decrease on fracture resistance with DAP and CH application; however, a closer look at the mechanism of this negative effect highlights the importance of PDL simulation. Mechanical changes have been related to collagen degradation of radicular dentin due to the high pH of CH as first described by Andreasen *et al.*^[3] in 2002. Decreased collagen component leads to increased brittleness which can be adjusted by PDL shock absorber effect. Contrary to Yassen *et al.* findings, when PDL simulation was applied by Zarei *et al.*^[25] in 2012, no significant reduction in fracture resistance was seen in 1 month. These findings are in agreement with the present study, although different testing machines were used.

In this study, second follow-up was carried out after 1 month because the duration of application of CH in most of the endodontic treatments is in this range.^[26] However, in some regenerative treatment cases, CH has been used for longer periods of time, which might be harmful for dentinal structures.^[27]

According to Olcay *et al.*,^[28] weakening of coronal structure after endodontic treatment is a crucial factor in root fracture susceptibility and is more important than intracanal medicament type. Hence, in this study, roots were decoronated to eliminate crown weakness as a confounding factor.

CONCLUSION

In conclusion, under the limitations of this study, CH, CH + CHX, DAP, and simvastatin do not have a negative effect on root fracture resistance at 1-month interval when used as intracanal medicaments. Thus, the studied medicaments can be used in regenerative treatments without concerns about negative mechanical effects on root resistance and future studies can focus on other aspects of them.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

REFERENCES

1. Mohammadi Z, Shalavi S, Yazdizadeh M. Antimicrobial activity of calcium hydroxide in endodontics: A review. *Chonnam Med J* 2012;48:133-40.

2. Turk T, Ozisik B, Aydin B. Time-dependent effectiveness of the intracanal medicaments used for pulp revascularization on the dislocation resistance of MTA. *BMC Oral Health* 2015;15:130.
3. Andreasen JO, Farik B, Munksgaard EC. Long-term calcium hydroxide as a root canal dressing may increase risk of root fracture. *Dent Traumatol* 2002;18:134-7.
4. Gher ME Jr., Dunlap RM, Anderson MH, Kuhl LV. Clinical survey of fractured teeth. *J Am Dent Assoc* 1987;114:174-7.
5. Howe CA, McKendry DJ. Effect of endodontic access preparation on resistance to crown-root fracture. *J Am Dent Assoc* 1990;121:712-5.
6. 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.
7. Siqueira JF Jr., Lopes HP. Mechanisms of antimicrobial activity of calcium hydroxide: A critical review. *Int Endod J* 1999;32:361-9.
8. Ercan E, Dalli M, Dülgergil CT. *In vitro* assessment of the effectiveness of chlorhexidine gel and calcium hydroxide paste with chlorhexidine against *Enterococcus faecalis* and *Candida albicans*. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006;102:e27-31.
9. Sundqvist G, Figdor D, Persson S, Sjögren U. Microbiologic analysis of teeth with failed endodontic treatment and the outcome of conservative re-treatment. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1998;85:86-93.
10. Gomes BP, Vianna ME, Sena NT, Zaia AA, Ferraz CC, de Souza Filho FJ. *In vitro* evaluation of the antimicrobial activity of calcium hydroxide combined with chlorhexidine gel used as intracanal medicament. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006;102:544-50.
11. Kontakiotis EG, Filippatos CG, Tzanetakis GN, Agraftoti A. Regenerative endodontic therapy: A data analysis of clinical protocols. *J Endod* 2015;41:146-54.
12. Prather BT, Ehrlich Y, Spolnik K, Platt JA, Yassen GH. Effects of two combinations of triple antibiotic paste used in endodontic regeneration on root microhardness and chemical structure of radicular dentine. *J Oral Sci* 2014;56:245-51.
13. Wu Z, Liu C, Zang G, Sun H. The effect of simvastatin on remodelling of the alveolar bone following tooth extraction. *Int J Oral Maxillofac Surg* 2008;37:170-6.
14. Asl Aminabadi N, Maljaei E, Erfanparast L, Ala Aghbali A, Hamishehkar H, Najafpour E. Simvastatin versus calcium hydroxide direct pulp capping of human primary molars: A randomized clinical trial. *J Dent Res Dent Clin Dent Prospects* 2013;7:8-14.
15. Tamse A. Vertical root fractures in endodontically treated teeth: Diagnostic signs and clinical management. *Endod Top* 2006;13:84-94.
16. Dianat O, Mashhadiabbas F, Ahangari Z, Saedi S, Motamedian SR. Histologic comparison of direct pulp capping of rat molars with MTA and different concentrations of simvastatin gel. *J Oral Sci* 2018;60:57-63.
17. Mohammadi Z, Dummer PM. Properties and applications of calcium hydroxide in endodontics and dental traumatology. *Int Endod J* 2011;44:697-730.
18. Ghatole K, Gowdra RH, Azher S, Sabharwal S, Singh VT, Sundararajan BV. Enhancing the antibacterial activity of the gold standard intracanal medicament with incorporation of silver zeolite: An *in vitro* study. *J Int Soc Prev Community Dent* 2016;6:75-9.
19. 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.
20. Graziano TS, Cuzzullin MC, Franco GC, Schwartz-Filho HO, de Andrade ED, Groppo FC, *et al.* Statins and antimicrobial effects: Simvastatin as a potential drug against *Staphylococcus aureus* biofilm. *PLoS One* 2015;10:e0128098.
21. Hasan F, Ikram R, Simjee SU, Iftakhar K, Asadullah K. Effectiveness of simvastatin 1% oral gel and mouthwash used as an adjunct treatment of scaling and root planning in the treatment of periodontal diseases. *Pak J Pharm Sci* 2019;32:2673-7.
22. Sakoda K, Yamamoto M, Negishi Y, Liao JK, Node K, Izumi Y. Simvastatin decreases IL-6 and IL-8 production in epithelial cells. *J Dent Res* 2006;85:520-3.
23. Hawkins JJ, Torabinejad M, Li Y, Retamozo B. Effect of three calcium hydroxide formulations on fracture resistance of dentin over time. *Dent Traumatol* 2015;31:380-4.
24. Yassen GH, Vail MM, Chu TG, Platt JA. The effect of medicaments used in endodontic regeneration on root fracture and microhardness of radicular dentine. *Int Endod J* 2013;46:688-95.
25. 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.
26. Lacević A, Vranić E, Zulić I. Clinical application of calcium hydroxide in dental pathology and endodontics. *Bosn J Basic Med Sci* 2003;3:26-9.
27. Lee Y. Effect of calcium hydroxide application time on dentin. *Restor Dent Endod* 2013;38:186.
28. Olcay K, Coban AN, Belli S. Effects of intracanal medicaments and the remaining cavity wall on fracture strength of endodontically treated molars. *Braz Dent Sci* 2018;21:79-87.