Atatürk Üniv. Diş Hek. Fak. Derg.
J Dent Fac Atatürk Uni
Cilt:26, Sayı:1, Yıl: 2016, Sayfa: 52-57

Araştırma/ Research Article

COMPARISON OF THE VERTICAL ROOT FRACTURE RESISTANCE OF TEETH TREATED WITH CALCIUM HYDROXIDE AND LEDERMIX PASTE

KALSİYUM HİDROKSİT VE LEDERMİX PASTA'NIN VERTİKAL KÖK KIRIĞINA OLAN ETKİSİNİN KARŞILAŞTIRILMASI

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Makale Kodu/Article code: 2364
Makale Gönderilme tarihi: 20.07.2015
Kabul Tarihi: 05.02.2016

ABSTRACT

Aim: The aim of this *in vitro* study was to compare the effect of Ledermix paste and Calcium hydroxide ($Ca(OH)_2$) on root fracture resistance.

Materials and Methods: Sixty extracted human mandibular premolars with single canals and straight roots were used. After the crowns were removed, the root canals were prepared with Reciproc R50 files. Smear layer of roots were removed using 17% EDTA followed by 5.25% NaOCl and distilled water. The roots were then randomly divided into four groups (n = 15) according to the medicaments used: Ledermix paste, $Ca(OH)_2$, negative control, and positive control. Samples were stored at 37°C and 100% humidity for 3 weeks. The specimens in experimental and control groups were obturated with cold lateral compaction technique before fracture resistance assessment. Then the apical ends of the roots were embedded vertically inside 4 mm of the acrylic resin. A load was applied on the roots of all teeth to their long axis until fracture occurred. Data were analyzed using one-way analysis of variance (ANOVA) and post-hoc Tukey tests.

Results: There were statistically significant differences between the groups. According to the post-hoc Tukey test, there was statistically significant difference between negative control group and $Ca(OH)_2$ group ($p<0.05$). But no statistically significant difference could be found among $Ca(OH)_2$, Ledermix Paste and positive control groups ($p>0.05$). Additionally, there was no statistically significant difference between Ledermix Paste, negative control and positive control group ($p>0.05$).

Conclusion: The fracture resistance of the teeth was not significantly affected with 3 week application of Ledermix Paste and $Ca(OH)_2$.

Keywords: Calcium hyrdoxide, Ledermix Paste, root fracture, vertical root fracture

ÖZ

Amaç: Bu *in vitro* çalışmanın amacı, kök kanal medikamenti olarak kullanılan Ledermix pasta and Kalsiyum Hidroksit'in ($Ca(OH)_2$ vertikal kök kırığına olan etkisini karşılaştırmaktır.

Gereç ve Yöntem: Bu çalışmada tek köklü ve tek kanallı 60 adet alt çene küçük azı dişleri kullanıldı. Kronlar mine sement sınırından uzaklaştırıldıktan sonra kök kanalları Reciproc R50 eğelerle genişletildi. Smear tabakası % 17 EDTA, % 5,25 NaOCl ve distile su kullanılarak uzaklaştırıldı. Kullanılan medikamen tipine göre kök kanalları dört gruba (n = 15) ayrıldı: Ledermix patı, $Ca(OH)_2$, negatif kontrol ve pozitif kontrol. Örnekler 37 °C and %100 nemli ortamda 3 hafta bekletildi. Deney ve kontrol gruplarında kök kanalları soğuk lateral kondensasyon tekniği kullanılarak doldurulduru. Daha sonra köklerin apikal 4 milimetrelik kısmı akrilik rezin bloklara gömüldü. Universal test cihazında kökün uzun aksına dik gelecek şekilde kuvvet kırık gerçekleşene kadar uygulandı. Veriler tek yönlü varyans analizi ve Tukey çoklu karşılaştırma testi ile analiz edildi.

Bulgular: Gruplar arasında anlamlı fark vardı. Tukey çoklu karşılaştırma testi sonucuna göre $Ca(OH)_2$ ve negatif kontrol grubu arasında istatistiksel olarak anlamlı fark bulundu ($p<0,05$). $Ca(OH)_2$, Ledermix patı ve pozitif kontrol grupları arasında istatistiksel bir fark bulunmamıştır ($p>0.05$). Ayrıca Ledermix patı, negatif kontrol ve pozitif kontrol arasında da istatistiksel olarak fark yoktur ($p>0.05$).

Sonuç: Kök kanal medikamenti olarak kullanılan $Ca(OH)_2$ ve Ledermix Patı'nın 3 haftalık uygulaması dişlerin kırılma direncini etkilememiştir.

Anahtar Kelimeler: Kalsiyum Hidroksit, Ledermix patı, kök kırığı, vertikal kök kırığı

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INTRODUCTION

Root canal medicaments are commonly used in multivisit endodontic treatments due to their help of reduction of bacteria in root canals.[1] Calcium hydroxide ($Ca(OH)_2$) is most commonly used as an intracanal dressing material due to its antimicrobial properties and biocompatibility.[2] Alternative to $Ca(OH)_2$ a lot of medicaments have been used up to date. Ledermix paste is one of these materials. Ledermix paste contains tetracycline antibiotic, demeclocycline- hydrochloride, a corticosteroid, triamcinolone acetonide, in a polyethylene glycol base.[3] Ledermix paste has been used as a root canal medicament due to its ability to relieve postoperative pain in acute apical periodontitis, to prevent root resorption in traumatized teeth.[4, 5] And also triamcinolone and demeclocycline in ledermix paste has a diffusion capacity to dentine tubules.[6]

Root fracture is a major problem for endodontically treated teeth. There have been several factors that might be associated with root fractures in endodontically treated teeth; access cavity preparation, root canal irrigation solutions, root canal medicaments and root canal filling materials.[7-9] Dentin is a mineralized connective tissue, and the organic matrix of dentin is 22%.[10] It has been stated that $Ca(OH)_2$ is an alkaline (12.45 +/- 0.02) [11] material and when used as root canal medicament it neutralizes the acidic components of dentin,[10] and this may increase the susceptibility to root fracture [12, 13] due to weakening of the dentin.[14]

Ledermix Paste is an alkaline material and its alkaline properties (8.13 +/- 0.01) is lower than $Ca(OH)_2$.[11] There have been few studies in the literature evaluating the fracture resistance of roots treated by intracanal medicament $Ca(OH)_2$,[10, 14, 15] but we have not found any in vitro study that evaluating the fracture resistance of roots treated by intracanal medicament Ledermix Paste. The aim of the present study was to evaluate and compare the effect of Ledermix paste and $Ca(OH)_2$ on the fracture resistance of teeth used as a root canal medicament for 3 weeks.

MATERIALS AND METHODS

The study was approved by the Institutional Review Board of Şifa University (Protocol number 210-58), Izmir, Turkey. Sixty extracted, intact, human mandibular premolars with single and straight roots were selected and stored in distilled water. The teeth were examined with a stereomicroscope under 10× magnification (Zeiss, Oberkochen, Germany) to exclude any roots with open apices, root caries, cracks or fractures. The buccolingual (BL) and mesiodistal (MD) dimensions of the root canals were measured using a digital caliper (Teknikel, Istanbul, Turkey). The weights of the roots were measured with a sensitive precision balance (Kern, Balingen, Germany). We equally allocated the roots to each group in an active sense based on their weights and the homogeneity of the groups. Then, the crowns were removed with a water-cooled diamond bur to obtain approximately 15 mm length from the apex. The roots were measured with a digital caliper (Mitutoyo, Hampshire, UK) to standardize their length. The working length was determined with 15 K File by subtracting 1 mm from the apex. Then all the root canals were prepared with Reciproc R50 rotary files (VDW GmbH, Munich, Germany). The smear layer was removed using 3 ml 17% EDTA followed by 3 ml 5.25% NaOCl and 5 ml distilled water and finally, the canals were dried with paper points. Then the roots were distributed into four groups (n = 15).

Group 1: $Ca(OH)_2$ (Calcicure calcium hydroxide paste, Cuxhaven, Germany) was injected into each root canal and packed to the working length with a lentulo spiral. Then, cotton pellets were placed over canal orifices, and coronal parts of the roots were sealed with Cavit (3M ESPE, Neuss, Germany). The teeth were stored at 37°C in 100% humidity for 3 weeks. After 3 weeks, coronal seal was removed. Irrigation needles were placed at 2/3 of the working length and roots were irrigated with 5 ml 5% NaOCl solution using a syringe with a 27-gauge to remove the $Ca(OH)_2$ medicament from the root canals. Then the root canals were dried using paper points and obturated with lateral compaction technique using AH Plus root canal sealer (Dentsply DeTrey GmbH, Konstanz, Germany) and gutta percha. The excess gutta-percha was removed with a hot instrument and condensed vertically. The coronal parts of the roots were sealed with resin-modified glass ionomer cement (Ionoseal, Cuxhaven, Germany), and light cured. Then the samples were stored at 37° C at 100% relative humidity for 1 week to allow the sealer to set.

Group 2: Ledermix Paste (RIEMSER Pharma GmbH, Germany) was placed into each root canal to the working length using paper points. Then, cotton pellets were placed over canal orifices, and coronal parts of the roots were sealed with Cavit (3M ESPE, Neuss, Germany). The teeth were stored at 37°C in 100% humidity for 3 weeks. After 3 weeks, coronal seal was removed. Irrigation needles were placed at 2/3 of the working length and roots were irrigated with 5 ml 5% NaOCl solution using a syringe with a 27-gauge to remove the Ledermix Paste from the root canals. Then the root canals were dried using paper points and obturated with lateral compaction technique using AH Plus root canal sealer (Dentsply DeTrey GmbH, Konstnaz, Germany) and gutta percha. The excess gutta-percha was removed with a hot instrument and condensed vertically. The coronal parts of the roots were sealed with resin-modified glass ionomer cement (Ionoseal, Cuxhaven, Germany), and light cured. Then the samples were stored at 37°C at 100% relative humidity for 1 week to allow the sealer to set.

Group 3 (Negative control): The root canals were left empty and not obturated with gutta-percha and AH Plus root canal sealer.

Group 4 (Positive control): No root canal medicament was placed to the root canals. The cotton pellets were placed over canal orifices, and coronal parts of the roots were sealed with Cavit (3M ESPE, Neuss, Germany). The teeth were stored at 37°C in 100% humidity for 3 weeks. After 3 weeks, coronal seal was removed. Irrigation needles were placed at 2/3 of the working length and roots were irrigated with 5 ml 5% NaOCl solution using a syringe with a 27-gauge and then the root canals were dried using paper points and obturated with lateral compaction technique using AH Plus root canal sealer (Dentsply DeTrey GmbH, Konstanz, Germany) and gutta percha. The excess gutta-percha was removed with a hot instrument and condensed vertically. The coronal parts of the roots were sealed with resin-modified glass ionomer cement (Ionoseal, Cuxhaven, Germany), and light cured.

Acrylic resin blocks with 30 mm height and 10 mm diameter were prepared using self-cured acrylic resin (Imicryl, Konya, Turkey). The apical ends of the roots were embedded vertically in 4 mm of the acrylic resin and then the roots were kept wet at 37°C in 100% humidity until they were ready to be tested. The universal testing machine (Shimadzu Corporation, Kyoto, Japan) was used at the speed of 1 mm/min and a load was applied on the crown of all teeth to their long axis until fracture. The values measured at the moment of fracture were recorded in Newton.

Statistical analysis

The BL and MD dimensions and weights were subjected to a Kolmogorov-Smirnov statistical test to evaluate the normality of these continuous variables. A one-way analysis of variance test was used to evaluate the difference among the BL and MD dimensions, and the weight of the samples. The fracture tests of the teeth were statistically analyzed using One-way analysis of variance with Tukey post hoc tests. Correlations between fracture data and BL and MD dimensions, and weights were evaluated using the Pearson correlation test. The testing was performed at the 95% level of confidence ($P < 0.05$).

RESULTS

The statistical analysis approved the standardization of roots among groups according to weight, BL and MD diameters. According to the Pearson correlation test, there were no statistically significant differences among the correlations between fracture load and MD ($r = .015$, $P = .910$), between fracture load and BL ($r= .020$, $P= .877$), and between fracture load and weight ($r = .-043$, $P = .742$).

All of the roots were fractured vertically in the labiolingual direction that extended along the long axis of the root to the apex (Figure 1). The mean, standard deviation, minimum and maximum values of the groups were shown in Table 1. According to the results of the present study, there were no statistically significant differences among $Ca(OH)_2$, (860±113 N), Ledermix Paste (759±153 N) and positive control (829±186 N). Additionally, there was no statistically significant difference between Ledermix Paste, negative control and positive control group ($p>0.05$). But there was statistically significant difference between negative control group (709±83 N) and $Ca(OH)_2$ group (860±113 N).

Table 1. The mean, standart deviation, minimum and maximum values of the groups

Group	N	Mean	Std. Deviation	Minimum	Maximum	Significance*
$Ca(OH)_2$	15	860	113	797	923	a
Ledermix Paste	15	759	153	673	844	ab
Negative Control	15	709	83	662	755	b
Positive Control	15	829	186	726	932	ab

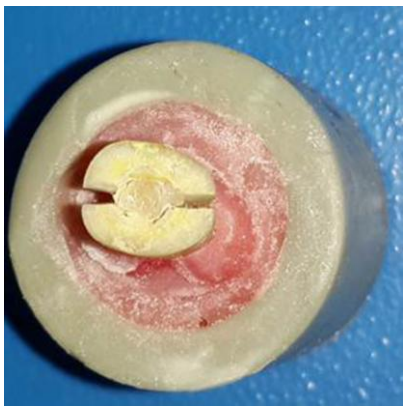

Figure 1. Vertically fractured root in the labiolingual direction that extended along the long axis

DISCUSSION

In evaluation of the fracture resistance of teeth, standardization is an important factor in terms of reliability of the results. In the present study BL, MD dimensions and weights of the teeth were measured and there were no statistically significant differences among the teeth. And also in the present study root canal medicaments were placed to the root canals after irrigation to duplicate the conditions more closely to clinical application. To standardize and not affect the volume of the irrigation solution to the fracture resistance of teeth, 5 ml of NaOCl was used for each tooth. We stored root canal medicaments in the root canals for 3 weeks. Because, we aimed to evaluate the short time usage of root canal medicament Ledermix paste and $Ca(OH)_2$ effect on root fracture.

It has been reported that gutta-percha could not affect the fracture resistance of endodontically treated teeth.[16-19] El-Ma'aita et al.[20] stated that the vertical root fracture resistance of the teeth would not change after obturation of the root canals with gutta-percha and AH plus root canal sealer. In the present study, after medication we obturated the root canals with gutta-percha and AH plus root canal sealer to duplicate the conditions more closely to clinical application in all groups.

Organic matrix of dentin consists of phosphate and carboxylate groups, which has a role in the bonding of hydroxyapatite and collagen fibers.[10] Alkaline chemicals can dissolve the acidic component of organic matrix in dentin.[10] If the organic matrix of the dentin denaturates, which has a role in the bonding of hydroxyapatite and collagen fibers, it results in weakening of the dentin.[14] Root canal treatments are generally finished in a single session, but, especially in very painfully acute apical periodontitis or abscesses, treatment of a root resorption due to trauma, total elimination of the microorganisms from the root canal with root canal preparation and irrigation is impossible, root canal treatment should be finished in the other session after using root canal medicaments.[4, 5, 21]

The effect of long time and short time usage of $Ca(OH)_2$ on the root fracture has been studied in the literature and the results of these studies are controversial.[10, 14, 15, 22, 23] Batur et al. [10] indicated that long-term $Ca(OH)_2$ treatment could significantly reduce the fracture resistance of the teeth. White et al.[22] studied the effect of $Ca(OH)_2$ on the fracture resistance of bovine dentine for 5 weeks and found that $Ca(OH)_2$ reduced 32% of the fracture strength of bovine dentine. Rosenberg et al.[14] studied the effect of $Ca(OH)_2$ on microtensile fracture strength used in root canals between 7-84 days, and found that $Ca(OH)_2$ reduced the fracture strength of dentin by 50%. Andreasen et al.[15] studied the effect of $Ca(OH)_2$ on the fracture resistance of dentine for 0.5 to 12 months and found that the fracture strength of teeth did not change in 30 days but the fracture resistance of the teeth reduced after 1 month. Sahebi et al.[24] studied the effects of the short-term usage of calcium hydroxide on the strength of human permanent dentin using compressive forces and found a significant reduction in the root strength within 30 days of application of calcium hydroxide. In the present study we aimed to evaluate whether there were any effects on dentin as a result of short time (3 weeks) usage of root canal medicaments $Ca(OH)_2$ and Ledermix paste

in mature teeth. According to the results of the present study, there were no statistically significant differences between $Ca(OH)_2$ and positive control groups. We might say that $Ca(OH)_2$ could not affect the fracture resistance of mature teeth after application for 3 weeks. The results of the present study were similar to the results of the study carried out by Andreasen et al.[15]

It has been stated that alkaline based materials have decreased the fracture resistance of dentine.[12, 13] Ledermix Paste is an alkaline based material.[11] In the present study we evaluated the effect of shrot time usage of Ledermix Paste on the effect of root fracture and there were no statistically significant differences among $Ca(OH)_2$, Ledermix Paste and positive control groups. We might say that Ledermix paste could not affect the fracture resistance of mature teeth after usage for 3 weeks. In the present study we did not study the effect of Ledermix paste on the fracture resistance of mature teeth after long time usage. It is unclear whether the fracture resistance of dentin might be affected if the Ledermix paste is used more than 3 weeks. It might be studied in future studies.

CONCLUSİONS

Within the limits of this study, it can be concluded that the fracture resistance of the teeth was not significantly affected with 3 week application of $Ca(OH)_2$ and Ledermix Paste in root canals. Based on our findings, the usage of Ledermix Paste for 3 weeks in infected mature teeth with apical periodontitis, to relieve postoperative pain in acute apical periodontitis and to prevent root resorption in traumatized teeth does not affect the fracture resistance of mature teeth.

Acknowledgements: The authors deny any conflicts of interest. I affirm that I/We have no financial affiliation (e.g., employment, direct payment, stock holdings, retainers, consultantships, patent licensing arrangements or honoraria), or involvement with any commercial organization with direct financial interest in the subject or materials discussed in this manuscript, nor have any such arrangements existed in the past three years.

REFERENCES

1. Chou K, George R, Walsh LJ. Effectiveness of different intracanal irrigation techniques in removing intracanal paste medicaments. Australian endodontic journal : the journal of the Australian Society of Endodontology Inc 2014;40:21-5.
2. Estrela C, Pimenta FC, Ito IY, Bammann LL. Antimicrobial evaluation of calcium hydroxide in infected dentinal tubules. Journal of endodontics 1999;25:416-8.
3. Athanassiadis B, Abbott PV, Walsh LJ. The use of calcium hydroxide, antibiotics and biocides as antimicrobial medicaments in endodontics. Australian dental journal 2007;52:S64-82.
4. Ehrmann EH, Messer HH, Adams GG. The relationship of intracanal medicaments to postoperative pain in endodontics. International endodontic journal 2003;36:868-75.
5. Pierce A, Lindskog S. The effect of an antibiotic/corticosteroid paste on inflammatory root resorption in vivo. Oral surgery, oral medicine, and oral pathology 1987;64:216-20.
6. Abbott PV. Medicaments: aids to success in endodontics. Part 1. A review of the literature. Australian dental journal 1990;35:438-48.
7. Gher ME, Jr., Dunlap RM, Anderson MH, Kuhl LV. Clinical survey of fractured teeth. Journal of the American Dental Association 1987;114:174-7.
8. Howe CA, McKendry DJ. Effect of endodontic access preparation on resistance to crown-root fracture. Journal of the American Dental Association 1990;121:712-5.
9. Fuat A, Şimşek N, Yildirim G, Polat T. Post Materials in Restoration of Endodontically Treated Teeth. Atatürk Üniv Diş Hek Fak Derg 2014;24:153-7.
10. Batur YB, Erdemir U, Sancakli HS. The long-term effect of calcium hydroxide application on dentin fracture strength of endodontically treated teeth. Dental traumatology : official publication of International Association for Dental Traumatology 2013;29:461-4.
11. Anderson M, Seow WK. PH of endodontic medicaments used in pediatric dentistry: effects of dyadic combinations. The Journal of clinical pediatric dentistry 1990;15:42-5.

12. Fuss Z, Lustig J, Katz A, Tamse A. An evaluation of endodontically treated vertical root fractured teeth: impact of operative procedures. Journal of endodontics 2001;27:46-8.
13. Cvek M. Prognosis of luxated non-vital maxillary incisors treated with calcium hydroxide and filled with gutta-percha. A retrospective clinical study. Endodontics & dental traumatology 1992;8:45-55.
14. Rosenberg B, Murray PE, Namerow K. The effect of calcium hydroxide root filling on dentin fracture strength. Dental traumatology : official publication of International Association for Dental Traumatology 2007;23:26-9.
15. Andreasen JO, Farik B, Munksgaard EC. Long-term calcium hydroxide as a root canal dressing may increase risk of root fracture. Dental traumatology : official publication of International Association for Dental Traumatology 2002;18:134-7.
16. Hammad M, Qualtrough A, Silikas N. Effect of new obturating materials on vertical root fracture resistance of endodontically treated teeth. Journal of endodontics 2007;33:732-6.
17. Bortoluzzi EA, Souza EM, Reis JM, Esberard RM, Tanomaru-Filho M. Fracture strength of bovine incisors after intra-radicular treatment with MTA in an experimental immature tooth model. International endodontic journal 2007;40:684-91.
18. Soares CJ, Pizi EC, Fonseca RB, Martins LR. Influence of root embedment material and periodontal ligament simulation on fracture resistance tests. Brazilian oral research 2005;19:11-6.
19. Khan S, Inamdar MN, Munaga S, Ali SA, Rawtiya M, Ahmad E. Evaluation of Fracture Resistance of Endodontically Treated Teeth Filled with Gutta-Percha and Resilon Obturating Material: An In Vitro Study. Journal of international oral health : JIOH 2015;7:21-5.
20. El-Ma AM, Qualtrough AJ, Watts DC. Resistance to vertical fracture of MTA-filled roots. Dental traumatology : official publication of International Association for Dental Traumatology 2014;30:36-42.
21. Siqueira JF, Jr., de Uzeda M. Disinfection by calcium hydroxide pastes of dentinal tubules infected with two obligate and one facultative anaerobic bacteria. Journal of endodontics 1996;22:674-6.
22. White JD, Lacefield WR, Chavers LS, Eleazer PD. The effect of three commonly used endodontic materials on the strength and hardness of root dentin. Journal of endodontics 2002;28:828-30.
23. Valera MC, Albuquerque MT, Yamasaki MC, Vassallo FN, da Silva DA, Nagata JY. Fracture resistance of weakened bovine teeth after long-term use of calcium hydroxide. Dental traumatology : official publication of International Association for Dental Traumatology 2015;31:385-9.
24. Sahebi S, Moazami F, Abbott P. The effects of short-term calcium hydroxide application on the strength of dentine. Dental traumatology : official publication of International Association for Dental Traumatology 2010;26:43-6.

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