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ASSESSMENT OF IMPACT OF VARIOUS INTRACANAL MEDICAMENTS ON FRACTURE RESISTANCE OF ENDODONTICALLY TREATED TEETH IN PDL SIMULATED SAMPLES - AN IN VITRO STUDY

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ABSTRACT

Background: Intracanal medicaments have long been used for disinfection purposes between the sessions of endodontic procedures. This study aims to assess the impact of various intracanal medicaments on the fracture resistance of endodontically treated teeth. ***Materials and Methods:*** A total of 200 single-rooted mandibular premolars which were extracted for periodontal reasons were collected for this in vitro study. All roots were randomly assigned to five study groups (40 roots in each group); Group 1: Calcium Hydroxide (CH), Group 2: Combined use of Calcium Hydroxide and Chlorhexidine 2%, Group 3: Triple Antibiotic Paste (TAP), Group 4: Simvastatin and Group 5: Control group without addition of any substances. All specimens in each group were incubated for 1 month (Subgroup A) and 2 months (Subgroup B). Then, medicaments were removed and filled with gutta-percha and AH26 sealer. All samples were tested for fracture resistance. One way ANOVA, Tukey post hoc test and Paired t test were used for the comparison between the groups. ***Results:*** Calcium Hydroxide and Calcium Hydroxide with Chlorhexidine increased the fracture resistance in a 1 month period and Simvastatin increased the fracture resistance after 2 months. ***Conclusion:*** No negative impact is observed with the medicaments, Calcium Hydroxide, Calcium Hydroxide + Chlorhexidine, Triple Antibiotic Paste and Simvastatin on the fracture resistance of endodontically treated teeth.

KEYWORDS: Calcium Hydroxide, Chlorhexidine, Triple Antibiotic Paste, Simvastatin, root canal therapy.

INTRODUCTION

The goals of root canal treatment are complete debridement of infected tissue and a reduction in the bacterial infection inside the canal. Chemical cleaning of the root canal system removes most of the root canal irritants; however, complete debridement is not always achievable due to complex root canal anatomy with the presence of accessory canals, fins and other communications between the main canals.[1-2] The use of intracanal dressings is recommended to disinfect the root canal system and these dressings are considered to be an important aspect of root canal treatment. Many materials have been introduced as intracanal medicaments. Chlorhexidine Gluconate (CHX) has been widely used as a medicament in the treatment of infected root canal systems because it has broad spectrum antimicrobial activity, substantivity, low toxicity, and water solubility.[3-6] Triple Antibiotic Paste (TAP) is a mixture of metronidazole, ciprofloxacin and minocycline and has been shown to be very effective in eliminating endodontic pathogens in vitro and in situ. Recent trend in endodontics attends the use of biologic medication extracted from natural plants to decrease cytotoxic reactions of most of the commercial intracanal medicaments.[7-10]

Calcium hydroxide (CH) is widely used as intracanal dressing but it has denaturing effect on dentinal structures which leads to decreased fracture resistance.[11] Double antibiotic paste (DAP) is a mixture of metronidazole and ciprofloxacin and has been used in endodontic regeneration with favourable results although

it has strong demineralizing effect.[12,13] Simvastatin is a 33-hydroxy--methylglutaryl coenzyme whose angiogenesis potential, anti-inflammatory property and bone regenerating properties can be of use in endodontic regeneration.[14-16]

Dentinal strength is determined by the link between hydroxyapatite and collagenous fibrils. Exposure of root dentin to the root canal medicaments was shown to affect its physical characteristics and subsequently affects its fracture resistance. The aim of the present study was to evaluate the impact of various intracanal medicaments on the fracture resistance of endodontically treated teeth.

MATERIALS AND METHODS

Preparation of samples

After obtaining the approval from ethical committee, 200 single-rooted mandibular premolars, extracted for periodontal and orthodontic reasons were obtained. After scaling and root planing all teeth were decoronated below the CEJ with diamond disk under water coolant, to leave 13 mm of length. Working length was determined with K-file #15. Sodium Hypochlorite (2.5%) was used for irrigation. Finally, 5.25% Sodium Hypochlorite and 17% EDTA were applied for smear layer removal, and canals were rinsed and dried with paper points. All roots were randomly assigned to five study groups (40 roots in each group); Group 1: Calcium Hydroxide (CH), Group 2: Combined use of Calcium Hydroxide (CH) and Chlorhexidine CHX 2%, Group 3: Triple Antibiotic Paste TAP, Group 4: Simvastatin and Group 5: Control group without addition of any substances.

METHODOLOGY

All specimens in each group were randomly assigned into two equal subgroups depending on the incubation time. Subgroup A specimens were incubated for 1 month and Subgroup B for 2 months in 37° and 100% moisture 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 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 were used to assess the thickness of the wax layer in two different root levels. Then roots were embedded in self-curing acrylic cylinders. 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 and roots were reinserted in sockets immediately. Finally, samples were tested for fracture resistance with the universal testing machine.

Statistical analysis

The data was tabulated in Microsoft Excel and analysed with SPSS v.24 software. One way ANOVA, Tukey post hoc test and Paired t test were used for the comparison between the groups. The p value≤0.05 was considered as statistically significant.

RESULTS

The highest fracture resistance after 1 month was seen in Group 2 (CH and CHX) which was 655.48 ± 240.22 and the least fracture resistance value was measured in the control group which was 246.74 ± 102.43 and the difference in the fracture resistance between the groups was statistically significant (p=0.004). The highest fracture resistance after 2 month was found in Group 4 (Simvastatin) which was 681.04 ± 258.42 and the least amount was recorded in TAP group which was 324.17 ± 152.08 and the difference in the fracture resistance between the groups was statistically significant (p=0.001) (Table 1).

Pairwise comparisons for the 1 month values showed that statistically significant difference exist between Group 2 and control group (p=0.028), Group 3 and control group (p=0.015), Group 4 and control group (p=0.006), Group 2 and Group 4 (p=0.033) and Group 3 and Group 4 (p=0.041). Pairwise comparisons for the 2 months values showed that statistically significant difference exist between Group 3 and control group (p=0.024), Group 4 and control group (p=0.037) and Group 3 and Group 4 (p=0.001) (Table 2).

Table 3 shows the comparison of the fracture resistance between 1 month and 2 months. Only the Group 4 (Simvastatin) showed statistically significant difference between the time periods (p=0.019).

Table 1: Comparison of fracture resistance between the groups using one way ANOVA.

Time	Groups	Mean	SD	p value
1 month	Calcium Hydroxide	627.12	237.49	0.004
	Calcium Hydroxide and Chlorhexidine	655.48	240.22	
	Triple Antibiotic Paste	437.03	185.15	
	Simvastatin	492.66	197.82	
	Control group	246.74	102.43	
2 months	Calcium Hydroxide	504.61	204.29	0.001
	Calcium Hydroxide and Chlorhexidine	476.34	191.44	
	Triple Antibiotic Paste	324.17	152.08	
	Simvastatin	681.04	258.42	
	Control group	397.92	174.11	

Table 2: Pairwise comparison of fracture resistance between the groups using Tukey post hoc test.

Time	Groups	Compared with	p value
1 month	Calcium Hydroxide	Calcium Hydroxide and Chlorhexidine	0.184
		Triple Antibiotic Paste	0.119
		Simvastatin	0.237
		Control group	0.318
	Calcium Hydroxide and Chlorhexidine	Triple Antibiotic Paste	0.226
		Simvastatin	0.033
		Control group	0.028
	Triple Antibiotic Paste	Simvastatin	0.041
		Control group	0.015
	Simvastatin	Control group	0.006
2 months	Calcium Hydroxide	Calcium Hydroxide and Chlorhexidine	0.306
		Triple Antibiotic Paste	0.415
		Simvastatin	0.117
		Control group	0.325
	Calcium Hydroxide and Chlorhexidine	Triple Antibiotic Paste	0.209
		Simvastatin	0.161
		Control group	0.244
	Triple Antibiotic Paste	Simvastatin	0.001
		Control group	0.024
	Simvastatin	Control group	0.037

Table 3: Comparison of fracture resistance of the groups between the 1 month and 2 months using paired t test.

Groups	Mean difference	p value
Calcium Hydroxide	122.51	0.418
Calcium Hydroxide and Chlorhexidine	179.14	0.293
Triple Antibiotic Paste	112.86	0.353
Simvastatin	188.38	0.019
Control group	151.18	0.281

DISCUSSION

This study was conducted to assess the impact of different intracanal medicaments on the fracture resistance of endodontically treated teeth. Regarding the study's findings, it can be suggested that addition of Chlorhexidine (CHX) to Calcium Hydroxide (CH) is mechanically harmless for dentinal structure in less than a month and might be rational for a better antimicrobial coverage. Similar finding is reported by Rahimi et al. (2022).[17] The simulation of PDL and its shock absorbent properties are another advantage of this study. Yassen et al. (2013)[18] evaluated 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.

In this study, second follow‑up was carried out after 2 months because the duration of application of CH in most of the endodontic treatments is in this range. However, in some regenerative treatment cases, CH has been used for longer periods of time, which might be harmful for dentinal structures. Rosenberg et al. (2007)[19] showed that a Calcium Hydroxide CH root canal dressing reduced the micro tensile fracture strength of teeth by almost 50% between 7 and 84 days. White et al. (2002)[20] suggested a possible advantage of using a minimal (CH) Calcium Hydroxide treatment time in the canal to decrease the weakening of the treated teeth. Longterm intracanal dressing with (CH) Calcium Hydroxide has been found to cause an increase in the fracture risk with regard to the microtensile fracture strength in endodontically treated teeth.[21,22]

Olcay et al. (2018)[23] reported that 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. In the Valera et al. (2015)[24] study, irrigation with 2% (CHX) Chlorhexidine showed a significantly lower fracture resistance than that of the control group. As an intracanal medicament, 0.5% (CHX) Chlorhexidine was added to (CH) Calcium Hydroxide in Prabhakar et al.'s study (2012)[25], and the mixture was applied to the root canal for 30 days. They found no statistically significant changes in the fracture strength values among all of the groups. The relatively long-term exposure of radicular dentine to TAP caused reduction in root resistance to fracture as using of the TAP might cause demineralization of radicular dentine by the effect of the acidic pastes. Reduction in the mineral component in dentin contributes to reduction in the strength of the tooth structure.[26]

CONCLUSION

The study concludes that, no negative impact is observed with the medicaments, Calcium Hydroxide, Calcium Hydroxide + Chlorhexidine, Triple Antibiotic Paste and Simvastatin on the fracture resistance of endodontically treated teeth. Therefore, these medicaments can be clinically used in regenerative treatments.

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