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Comparison of the impact of Triphala, calcium hydroxide, and chlorhexidine on root dentin microhardness

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Abstract

Objective: Some endodontic procedures require using intracanal medicament between treatment sessions. The effectiveness of these agents on dentin microhardness is crucial for deciding whether to use them or not. This study aimed to compare the effectiveness of three intracanal medicaments including Triphala, calcium hydroxide ($Ca(OH)_2$) paste, and chlorhexidine (CHX) gel on the root dentin microhardness.

Methods: Forty-eight single canal mature permanent teeth were selected. Mechanical preparation was done using RaCe rotary files. The samples were randomly allocated to four equal groups (n=12), according to the applied intracanal medicament. Group 1 received no medicament, whereas the root canals in groups 2, 3, and 4 were filled with Triphala, Ca(OH)2, and CHX, respectively. Specimens were stored for one week. Then, the roots were sectioned and the Vickers microhardness value was recorded at 0.5 mm from the pulp–dentin interface. Data were analyzed by one-way ANOVA and Tukey test and a P-value < 0.05 was considered statistically significant.

Results: The mean microhardness values in the Triphala and calcium hydroxide groups were comparable to each other (P>0.05) and significantly lower compared to the control and CHX groups (P<0.05). No significant difference in microhardness was found between the CHX and control groups (P>0.05).

Conclusions: Triphala and $Ca(OH)_2$ had similar effects on root dentin microhardness. Given the favorable characteristics of Triphala medicament, it can be considered a suitable alternative to Ca(OH)2 for intracanal application.

Keywords: Calcium hydroxide, Chlorhexidine, Dentin, Hardness, Root canal treatment, Triphala

Introduction

The goal of root canal treatment (RCT) is to eradicate intracanal microbes and prevent re-infection. Mechanical preparation techniques and irrigation procedures are applied to dissolve and eliminate organic debris and destroy bacterial species to minimize the microorganism load within the root canal system. Using inter-appointment intracanal medications has shown promising results in reducing the microorganism load, especially in cases with persistent infections (1, 2).

Calcium hydroxide ($Ca(OH)_2$) is the most favorable root canal medicament. Due to its high pH value (12.8), $Ca(OH)_2$ eliminates remaining microorganisms after chemomechanical preparation when used as a dressing for seven days. $Ca(OH)_2$ shows high tissue solubility (3), but it does not have a bactericidal effect on *Enterococcus (E) faecalis*, which is the most important bacterial species in failed endodontic treatments (3, 4). Using chlorhexidine (CHX) as an intracanal medicament and irrigation solution has recently become popular in endodontic treatment procedures. CHX has a broad range of antibacterial properties and is effective against persistent microorganisms (2, 3). CHX is not a routine intracanal medicament, because of its cytotoxicity and lack of tissue solubility. Furthermore, it might lead to allergic reactions in some individuals (3, 5).

Herbal plant extracts might be used to overcome the shortcomings of the currently available intracanal

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medicaments. Incorporating biologic medications extracted from natural plants in RCT procedures has gained increasing interest over the past few years (6). Triphala is an Indian polyherbal combination. Its powder consists of Emblica officinalis, Terminalia chebula, and Terminalia bellerica; which are three dried plants. This herbal medicine is used for treating multiple conditions such as headaches, diarrhea, and liver disorders. In addition, it has anti-mutagenic, anti-inflammatory, anti-oxidative, and anti-cariogenic properties (1, 7). The results of many studies have shown that Triphala could be considered an efficient antimicrobial, antifungal, and antiviral agent (8-12). Several active compounds in different constituents of Triphala, such as ellagic acid, chebulagic acid, phenols, flavonoids, gallic acid, and tannins, have important roles in its immunosuppressant and immunostimulatory properties, making it a unique immune modulator (13).

Since dentin microhardness depends on dentin surface structure (14, 15), investigating the changes in dentin structure after pulpectomy and applying intracanal medicaments are of great importance (16). A decrease in the hardness of treated dental tissues demonstrates mineral loss and disintegration (17). Given that softened dentine lacks structural support, maintaining or improving dentin microhardness is crucial in endodontic treatments (18).

The literature shows controversial results regarding the detrimental effects of intracanal medicaments on root dentin microhardness (16-18). Shakoui et al demonstrated the antimicrobial properties of Triphala in root canal therapy (19). However, a few studies have investigated the impact of Triphala on the microhardness of root dentin (20).

The relative softening effect of intracanal medicaments and irrigating solutions on dentin walls can affect the adhesion of sealers to root canal walls (20-22). Therefore, the effect of different medications on dentin microhardness is a crucial factor in endodontic treatment planning and merits further research. The present study aimed to examine the microhardness of root dentin in teeth exposed to Triphala, $Ca(OH)_2$, or CHX and compare it with the control.

Materials and methods

Tooth collection and sample preparation

The study design was approved by the research council and the ethics committee of Birjand University of Medical Sciences (IR.BUMS.REC.1401.281). Forty-eight single-rooted closed apex premolar teeth were selected. Teeth with any sort of restorations, signs of root resorption, cracks or fractures, carious lesions, and previous RCT were discarded. In addition, only samples with the same mesiodistal and buccolingual root dimensions (±8%) were selected. A scaler was used to remove the soft tissue remnants and debris from the root surfaces. The specimens were immersed in thymol (0.1%) for 72 hours and used within six months after extraction (20).

For root canal therapy, the access cavity was prepared. A K-file#10 (Dentsply, Maillefer, Ballaigues, Switzerland) was inserted into the canal until the tip appeared from the apical foramen. Determination of working length (WL) was done by deducing 1 mm from this length. The canals were enlarged by Race rotary files (FKG, Dentaire, La-Chaux-de-Fonds, Switzerland) with a 6% taper up to file #40. During instrumentation procedures, 2 mL of 2.25% sodium hypochlorite was used for irrigation. Finally, the root canals were rinsed using a normal saline solution to eliminate the irrigation solutions and remnant debris. Then, the canals were dried using absorbent paper.

Application of medicaments

The specimens were randomly allocated to four equal groups (n=12). The study groups were as follows:

Group 1 ($Ca(OH)_2$): The $Ca(OH)_2$ powder (Dentonics, Monroe, NC, USA) was mixed with distilled water in a 3:2 ratio (wt/vol) to achieve a paste consistency (18).

Group 2 (Triphala): The Triphala powder (IMPCOPS Ltd., Chennai, India) was dissolved in 10% dimethyl sulfoxide (SD Fine Chemicals, Chennai, India) to obtain a paste consistency (20).

Group 3 (CHX): A volume of 100 mL of 2% chlorhexidine gluconate solution (Chloraxid; Cerkamed, Poland) at pH=7.0 was mixed with 1 g of hydroxyethyl cellulose (1% natrosol) and 8 g water-soluble gel base.

Control group: No medication was used in root canals in the control group.

In the $Ca(OH)_2$ and Triphala groups, the prepared paste was applied in the root canals using a lentulo spiral and compacted using different pluggers. In the CHX group, the gel was injected into the root canals using a 27-gauge needle (21).

Flowable composite resin material (TPH3; Dentsply Caulk, Milford, DE, USA) was used to seal the apical surface of the root canals. Subsequently, the endodontic cavities were restored with Coltosol temporary filling material (Coltosol; Coltene, Switzerland).

Figure 1. The microscopic view of a tooth cross-section. Microhardness was measured at 0.5 mm from the pulp–dentin junction.

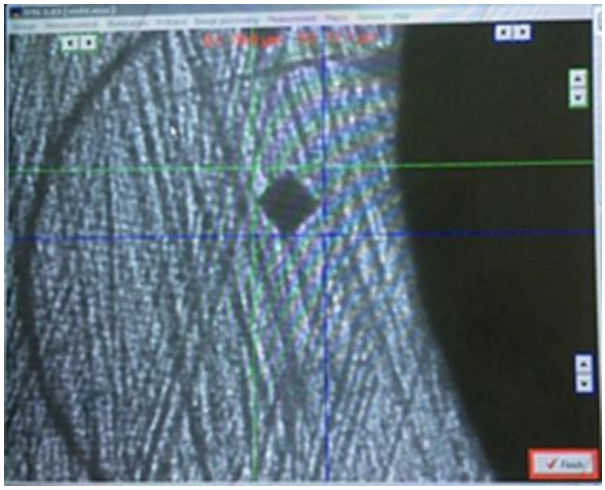

Figure 2. Microhardness measurement on a sample using a Vickers hardness device

Preparation of root samples

Following one week of storage in 100% relative humidity at 37°C, teeth were decoronated at 0.5 mm apically to the facial cementoenamel junction using a saw (Buehler Ltd., Lake Bluff, USA) under water coolant. Coronal and apical thirds of the roots were discarded and a root segment of 4 mm was obtained from the middle third of each root. This root segment was sectioned into buccal and lingual parts, and these sections were used for microhardness evaluation. The sections were rinsed under distilled water to remove any medicament residue.

Microhardness evaluation

The sections were placed on particular rods, and the coronal surfaces of the samples were polished with a polishing unit (Struers Rotopol 31/Rotoforce 4; Struers, Cleveland, PA, USA) with 1200-, 2400-, and 4000-grit abrasive papers (Struers, Cleveland, PA, USA), and polishing suspension. The samples were ultimately sonicated in deionized water for three minutes. Microhardness evaluations were carried out using a Vickers hardness indentation device (UHL VMHT Auto, Walter UHL Technische Mikroskopie, Germany). These evaluations took place on the polished surface of each section, at 0.5 mm from the pulp–dentin interface (Figure 1). Three indentations were made using a 50 g load perpendicular to the surface for 15 seconds. The Vickers microhardness value was recorded at each indentation (Figure 2) and the mean microhardness value was calculated and reported for each specimen.

Statistical analysis

The Shapiro-Wilk test was employed to assess if the data followed a normal distribution. Due to the normal distribution of the data ($P>0.05$), one-way analysis of variance (ANOVA) was used to compare the means of root dentine microhardness among the groups, followed by post hoc Tukey's test for pairwise comparisons. The analysis was conducted using SPSS 23.0 software (IBM Corp., Armonk, NY, USA), and a $P<0.05$ was considered significant.

Results

Table 1 presents the mean microhardness values in each experimental group. The highest and lowest microhardness values were observed in the control and Triphala groups, respectively. ANOVA test revealed a

Table 1. The means ± standard deviations (SD) of Vickers hardness values in the study groups

Group	Mean±SD
Control	52.50±2.06[a]
Ca(OH)2	41.33±1.90[b]
CHX	48.39±1.98[a]
Triphala	40.77±1.24[b]
P-value	<0.001

$Ca(OH)_2$: Calcium hydroxide, CHX: Chlorhexidine

statistically significant difference in the mean microhardness values among the experimental groups (P<0.001). According to the post-hoc Tukey test, the mean microhardness values in the Triphala and Ca(OH)2 groups were comparable to each other (P>0.05) and significantly lower than the control and CHX groups (P<0.05). There was no significant difference in microhardness of teeth treated with CHX compared to the control group (P>0.05).

Discussion

This study investigated the effect of using the Triphala mixture as an intracanal medicament on root dentine microhardness. The result was compared with other intracanal medicaments including CHX gel or $Ca(OH)_2$ paste. Vickers microhardness testing was used due to its less sensitivity to surface conditions, and the ability to evaluate fine samples with high precision (15, 17).

In the $Ca(OH)_2$ group, microhardness was significantly lower compared to that in the control and CHX groups. This finding aligns with that of Yoldas et al. (18) who used two different compositions of $Ca(OH)_2$ and showed that both compositions caused a significant reduction in dentin microhardness. After application of $Ca(OH)_2$, pH increases which might decrease the organic matrix support of dentin, leading to the fracture of protein structure and rupture of the connections between hydroxyapatite (HA) crystals and collagen fibers. These changes negatively impact the mechanical characteristics of dentin (18).

Triphala is an Indian herbal mixture, with anti-inflammatory, anticariogenic, and anti-bacterial properties (7, 10, 11). In a study by Shakouie et al. (19) the antimicrobial effect of Triphala as an intracanal irrigation solution was similar to 2.5% and 5% sodium hypochlorite (NaOCl) and even greater than 0.5% and 1% NaOCl. A study by Thomas et al. (23) stated that using Triphala and diode laser was more efficient in eliminating *E. faecalis* colonies compared to using $Ca(OH)_2$.

Microhardness in the CHX group was significantly higher than that of the other test groups and comparable to that of the control group. This indicates that CHX at the conditions used in this study, had no significant impact on dentin hardness. In contrast to the outcomes of this study, Prabhakar et al. (24) found a significant decrease in dentin microhardness after the application of high concentrations of CHX (2% gel) compared to the control group. In their study microhardness value was 45.4 one week after using CHX gel (24), which was lower than the 48.4 value found in the present study. This difference may be due to different specimen preparation methods. Prabhakar et al. (24) prepared dentin blocks of 2 mm thickness and used saturated solutions of the medicaments, whereas our study conducted microhardness testing after shaping the root canals and applying the intracanal medicament. Oliveira et al. (21) reported a significant decrease in root dentin microhardness after using 2% CHX as an intracanal irrigant for 15 minutes. Ferraz et al. (25) found that a 2% CHX gel resulted in smoother and cleaner root canal surfaces, suggesting a softening effect on root dentin.

The outcomes of this study showed a significant decrease in microhardness after seven days of placing Triphala in the root canals, which was comparable to that of $Ca(OH)_2$. Due to its anti-inflammatory, anti-oxidative, anti-cariogenic, and antibacterial effects (6-13), incorporating Triphala extract in endodontic procedures seems promising. However, the negative effect of Triphala on root dentin microhardness should not be overlooked. Thomas et al. (23) concluded that citric acids of fruits can remove the smear layer and might provide a chelation effect. It has also been reported that Triphala extract contains acid components including ascorbic acid (7, 10, 11). Therefore, the significant impact of this medication on the microhardness of dentinal walls can be attributed to the demineralizing effect of these acids and the disruption of collagen fibers.

It is recommended that future studies use microscope sections to precisely evaluate the structural changes in dentin walls and the depth of dentin softening after using Triphala as an intracanal medicament. Further studies are also suggested to assess dentin staining and tissue responses after long-term use of Triphala in the clinical setting.

Conclusions

Within its limitation, this study revealed that the impact of Triphala paste on reducing root dentin microhardness was comparable to that of $Ca(OH)_2$. Therefore, given its favorable characteristics, this herbal extract can be considered a viable intracanal alternative to Ca(OH)2.

Conflict of interest

None declared.

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