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Influence of Triphala on Root Dentin Microhardness: An in Vitro Study

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Abstract

This study aims to evaluate and compare the effect of different concentrations of Triphala (3%, 5%, and 10%) on the microhardness of root canal dentin.

Forty-five freshly extracted non-carious mandibular first premolars were selected and divided into five groups (n=9 per group). Triphala solutions (3%, 5%, and 10%) were prepared using Dimethyl sulfoxide (DMSO) as a solvent. 17% EDTA and normal saline were used as controls. Teeth were decoronated, sectioned vertically, and mounted in acrylic resin. Samples were immersed in their respective solutions for 15 minutes and stored in distilled water until testing. Dentin microhardness was assessed using the Vickers hardness test. Data were analyzed using one-way ANOVA and Tukey's post hoc test, with the significance level set at $P < 0.05$.

All tested solutions reduced dentin microhardness compared to controls. Among the groups, 17% EDTA caused a significant reduction in microhardness ($P < 0.05$). Triphala concentrations (3%, 5%, 10%) demonstrated a similar but statistically insignificant reduction in dentin microhardness, with mean values close to normal saline. The 3% Triphala solution exhibited the least effect on microhardness among the tested concentrations.

To conclude Triphala, particularly at 3% concentration, has minimal impact on dentin microhardness compared to EDTA, making it a potential alternative irrigant for root canal treatment. Its antimicrobial properties, combined with low toxicity and biocompatibility, support its use. Further studies are recommended to evaluate its long-term effects, biocompatibility, staining potential, and substantivity before clinical application.

Keywords: Endodontic irrigants, Root dentin microhardness, Triphala, Vickers hardness test

Introduction

Root canal preparation is achieved through the combined action of endodontic instruments and irrigation solutions[1]. Chemomechanical preparation plays a crucial role in the success of endodontic treatment. It involves the use of instruments and effective irrigating solutions to debride the root canal system. The primary objective of instrumentation and irrigation is to create a clean, debris-free canal, ensuring optimal conditions for subsequent obturation.[2]

When dentin is cut using hand or rotary instruments, the mineralized tissues are not simply shredded or cleaved but instead fractured, generating a significant amount of debris. A large portion of this debris, consisting of fine particles of mineralized collagen matrix, accumulates on the surface, forming what is known as the smear layer[3]. The smear layer, formed during root canal instrumentation, consists of dentin particles, pulp remnants, microorganisms, and residual irrigants. If left intact, it hinders adhesion by blocking sealer penetration and intratubular tag formation. Its removal improves bonding and helps eliminate microbes and toxins, reducing bacterial survival and reproduction[4].

Sodium hypochlorite (NaOCl) is widely used as an irrigant in chemo-mechanical root canal debridement due to its organic tissue dissolving ability[5]. Irrigation with either H_2O_2/NaOCl or EDTA decreased the microhardness value of root dentine. Irrigation solutions significantly impact dentin hardness by altering its structure. Hydrogen peroxide demineralizes the inorganic component and denatures collagen in intertubular dentin, while sodium hypochlorite dissolves the collagen matrix. Their combined use further affects dentin hardness[6]. Dentin micro-hardness is inversely related to the density of dentinal tubules. A reduction in micro-hardness may lead to decreased modulus of elasticity and flexural strength. Thus, assessing micro-hardness helps evaluate changes in the mineral content of dental hard tissues[7]. Therefore, identifying a new, safe, and effective irrigation solution for root canal preparation is recommended.

Due to their antibacterial, anti-inflammatory, astringent, anesthetic, and anticariogenic properties, herbal products have gained attention in dentistry[8]. Nature is rich in medicinal plants like amla, tulsi, nimbu, aloe vera, neem, and lahsun, which serve as potent sources of biologically active compounds beneficial for oral and overall health[9].

Triphala is an Ayurvedic herbal formulation made from the dried, powdered fruits of three medicinal plants: Terminalia bellirica, Terminalia chebula, and Emblica officinalis[10]. Triphala's pharmacological effects are attributed to its composition, which includes tannins, quinones, flavones, flavonoids, flavonols, gallic acid, and vitamin C[11]. Triphala offers several benefits, including ease of use, cost-effectiveness, substantivity, biocompatibility, and germicidal properties [12].

Triphala proved highly effective, nearly matching other agents in smear layer removal. Its high citric acid content makes it an excellent chelating agent, offering great potential for smear layer removal[12]. Triphala resulted in less reduction in root dentin microhardness compared to 5% NaOCl and 17% EDTA[10]. There were no studies showing the optimal concentration of triphala to be used as an endodontic irrigating solution in order to bring about its maximum effects. Therefore, this in vitro study was designed to evaluate the effects of different concentrations of triphala on the microhardness of root dentin.

Aim & Objective

- To compare the effect of different concentrations of Triphala (3%, 5%, 10%) on microhardness of root dentin.

Materials and Methods

Is divided as follows:

- Sample size determination and grouping
- Preparation of experimental solution
- Testing for microhardness

Source of data

45 Freshly extracted non carious permanent human mandibular first premolars

Inclusion criteria

Freshly extracted non carious human mandibular first premolars will be selected

Exclusion criteria

- Teeth with decay, restoration severe attrition and erosion.
- Teeth with fractures and cracks.
- Root canal treated teeth.
- Teeth with anatomical variation.

Materials

- Triphala powder
- Distilled water
- Dimethyl sulfoxide solution (DMSO)
- Normal saline
- Digital weighing machine
- Extracted natural tooth (permanent mandibular first premolar)
- 17%EDTA

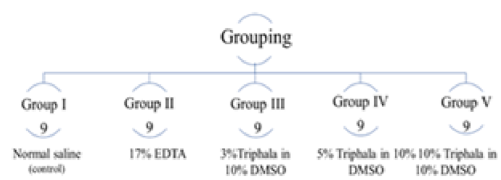
Sample size determination

The sample size has been estimated using Statistical Package for Social Sciences (SPSS) software for windows version 22.0(Armonk, NY IBM Corp). Considering the effect size to be measured (d) at 70%, Power of study at 95% and the alpha error at 5%, the sample size needed is 45. Each study group will consist of 9 samples.

The total sample size is 45

Sample size was estimated by formula

$$n = \frac{2SD^2 (Z_{\alpha/2} + Z_\beta)^2}{d^2}$$



Preparation of experimental solution

Preparation of 10% Dimethyl sulfoxide

270 ml of distilled water added to 30 ml of 100% Dimethyl sulfoxide to prepare 300 ml of 10% Dimethyl sulfoxide; to prepare the 3%, 5% & 10% Triphala solutions

Preparation of 3% Triphala solution in 10% Dimethyl sulfoxide

3mg of Triphala powder weighed in digital weigh (Lenon digital pocket scale) and added to 100ml of 10% Dimethyl sulfoxide to prepare 3% Triphala solution.

Preparation of 5% Triphala solution in 10% Dimethyl sulfoxide

5 mg of Triphala powder weighed in digital weigh (Lenon digital pocket scale) and added to 100 ml of 10% Dimethyl sulfoxide to prepare 5% Triphala solution.

Preparation of 10% Triphala solution in 10% Dimethyl sulfoxide

10 mg of Triphala powder weighed in digital weigh (Lenon digital pocket scale) and added to 100ml of 10% Dimethyl sulfoxide to prepare 10% Triphala solution.

Test for the assessment of microhardness

The samples were decoronated at the level of the cementoenamel junction with the help of a diamond impregnated disc to standardize the canal length. The roots were sectioned longitudinally by placing grooves on the buccal and lingual external surface of roots without penetrating into the canals using a double-faced diamond disc under water cooling, and with the help of chisel, the roots were split into two halves. Specimens thus obtained were then ground polished using a fine gritted silicon carbide abrasive paper (600 grit and 1200 grit). The freshly mixed autopolymerized resin was poured in plastic rings of uniform diameter. All the samples were embedded in acrylic resin blocks of uniform size 2×2 cm with polished side facing outwards. Later, repolishing of the specimen was done after mounting on the resin molds to remove excess material present on the tooth surface. Samples were immersed in the respective solutions for 15 mins. They were then stored in distilled water until analysis Microhardness of all the samples was determined using a Vickers microhardness tester fitted with a 200 g load. The diamond indenter was allowed to sink on the root canal dentin surface for 20 s at the apical third, and the Vickers hardness number was determined. Two indentations were made on each specimen at a mean distance of 100 mm, and the representative hardness value for each specimen was obtained as the average measurement of the three indentations.

Statistical Analysis

Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp., used to perform statistical analyses.

Descriptive statistics

Descriptive analysis includes expression of VHN in terms of mean and standard deviation for each study group.

Inferential statistics

One-way ANOVA test followed by Tukey's post hoc analysis will be used to compare the mean VHN between 5 groups.

The level of significance [P-Value] will be set at P<0.05

Result

The mean and standard deviation of VHN of the root canal dentin for the experimental groups is shown.

Descriptive Statistics

Dependent Variable: Average microhardness

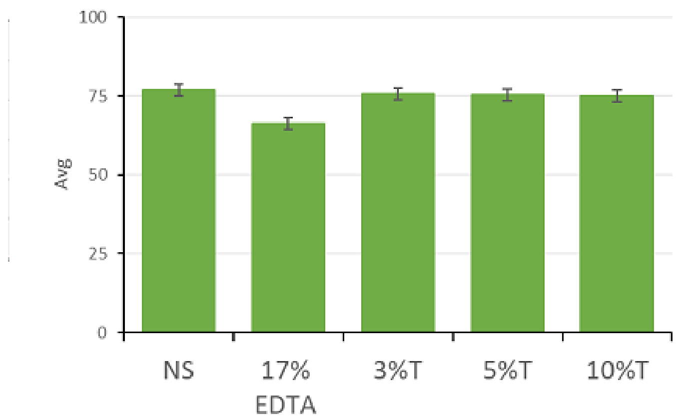
Groups	Mean	Std. Deviation	N
[illegible]	76.8403	.10138	9
[illegible]	66.2730	.05833	9
[illegible]	75.5071	.04948	9
[illegible]	75.4260	.02418	9
[illegible]	75.1654	.01945	9

The result showed decrease in mean dentin microhardness between treated samples and controls in all groups tested without significant statistical difference (P>0.05)

In the control group (Group 1), the mean values of dentin microhardness were 76.91

	Subset				
Groups	1	2	3	4	5
II	66.2730				
V		75.1654			
IV			75.4260		
III				75.5071	
I					76.8403
Sig.	1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = .003.
a. Uses Harmonic Mean Sample Size = 45.000.
b. Alpha = .05.



Discussion

The removal of the smear layer, which can harbor bacteria as well as organic and inorganic residues, is crucial for the successful outcome of endodontic therapy[13]. The canals are simultaneously flushed or irrigated with a solution that disinfects and dissolves organic matter. In addition to its debriding action, irrigation aids instrumentation by lubricating the canals and helping to remove dentinal debris [2].

Irrigating solutions can affect the physicochemical properties of human root canal dentin, such as microhardness, permeability, roughness, and wettability. The determination of microhardness provides indirect evidence of mineral loss or gain in tooth hard structures. The mineral content and the amount of hydroxyapatite in the intertubular substance play a crucial role in defining the intrinsic hardness of dentin. A reduction in dentin microhardness may, therefore, increase the likelihood of fractures or cracks[10]. The Vickers microhardness test was chosen for this study due to its suitability for the assessment. Previous studies have demonstrated the effectiveness and practicality of the Vickers microhardness test in assessing surface changes in dental hard tissues exposed to chemical agents[10,14,15].

Due to deleterious effect of conventional irrigants the use of natural remedies in dental treatments has been on the rise. Herbal and natural products have been a part of dental and medical practice for centuries and are gaining even more popularity today due to their strong antimicrobial activity, biocompatibility, and anti-inflammatory and antioxidant properties[10]. Triphala is an Ayurvedic herbal formulation made from the dried and powdered fruits of three medicinal plants: Terminalia bellirica, Terminalia chebula, and Emblica officinalis. Due to its high citric acid content, Triphala serves as an effective chelating agent and has shown potential in smear layer removal[16]. Previous studies have shown that Triphala has the least impact on the microhardness of root canal dentin compared to other conventional irrigants [1,17]

This study has focused on the evaluation effect of different concentrations of triphala (17%EDTA, 3% Triphala, 5% Triphala and 10% Triphala) on the root dentin microhardness. Saline, used as a negative control as it demonstrated no significant impact on root dentin microhardness. With a pH ranging from 5.5 to 6.0, it is close to the neutral pH of 7. Due to this near-neutral pH, saline likely did not affect the organic-to-inorganic ratio of radicular dentin, thereby preserving its microhardness[18]. This finding aligns with previous studies conducted by Ulusoy et al.[19] and Oliveira et al[20].

Results of this study showed all the irrigation solutions decreased micro-hardness of root canal dentin and, might affect the components of dentin structure.

Among these irrigants only 17% EDTA decreased micro hardness of dentin significantly. The chelating action of EDTA solution weakens the calcified components of dentin, leading to a decrease in microhardness[21]. In contrast different concentrations of Triphala did not have significant effect on decreasing of microhardness. Mahsa et al.[1] found that using Triphala as an irrigating solution had minimal effect on the microhardness of root canal dentin. This may be attributed to the citric acid in Triphala's fruits, which acts as a mild chelating agent. Effect of Triphala on microhardness of dentin was near to Normal saline.

According to this study, all the 3 concentration of Triphala showed similar effect on microhardness of root dentin (75.50, 75.42, 75.16). Hence 3% Triphala can be effectively used as an irrigant as it had the least effect on microhardness among the three concentrations.

Conclusion

Based on the results of the present study Triphala is suggested to have a neutral or positive effect on dentin micro-hardness over time, making it superior to EDTA in terms of its harmless impact on the micro-hardness of root canal dentin. Triphala also has excellent antimicrobial properties

Before recommending Triphala as a new irrigation solution in clinical practice, the study suggests the need for further investigations into its other properties, such as biocompatibility, staining, and substantivity.

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