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RESEARCH ARTICLE
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IMPACT OF VARIOUS IRRIGANT MATERIALS ON MICROHARDNESS FOR ROOT DENTIN

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Abstract:
Aim: To investigating how various endodontic irrigants affect the microhardness of dentin in root canals.

Materials and Methods: Twenty recently extracted Upper anterior teeth were horizontally cut at the cementoenamel junction for this in vitro investigation. To create a total of 20 dentin discs, Next, each root's middle third was cut into 4 mm-thick slices. The samples were randomly assigned to four groups, which consisting of 2.5% sodium hypochlorite (NaOCl), 17% EDTA, 2% chlorhexidine solution and saline (as control group), based on the chelating agent that was applied. The dentin's microhardness was measured using Vicker's indenter both before and after two minutes of chelating agent treatment. Tukey's post hoc test, paired t test, and one-way analysis of variance (ANOVA) were used to collect and statistically assess the data.

Results: The groups' microhardness values differed greatly from different groups to control group. The reduction of dentin microhardness by saline was less successful. A greater reduction in microhardness was observed with EDTA, 2.5% sodium hypochlorite (NaOCl), and 2% chlorhexidine.

Conclusion: The microhardness was decreased by all of the chelating solutions. Comparing saline to other materials, less change was seen in the hardness of the root dentin.

Keywords: Chelating Agents, EDTA, Vicker's Microhardness.

INTRODUCTION

The process of chemomechanical debridement in endodontic treatment includes the utilization of both endodontic files with irrigants in combination. Dentinal tubules become occluded with smear layer during root canal debridement, which lowers dentin permeability. The smear layer's organic and inorganic constituents can be completely removed with the help of chelating agents and sodium hypochlorite. Removing the smear layer decreases the possibility of bacterial growth and multiplication while also improving the sealing capacity of root filling materials. Chelators can demineralize root dentin as well as the smear layer. Dentin's microhardness decreases as a result of adding chelating agents, and collagen exposure increases [1].

In 1957, chelating agents were employed for the first time in endodontics to prepare narrow and calcified root canals. Chelation is a physiological process that results in the uptake of multivalent positive ions by specific chemicals [2]. The majority of the inorganic components of dentin are composed of phosphorous and calcium. The use of chelating solutions will change the microstructure and Ca: P ratio of dentin. This increases the permeability and solubility of the root canal dentin, which influences the adherence of dental materials to root dentin [3]. One of the most commonly used chelating agents is 17% EDTA. In addition to these, solutions such as EGTA, EDTAC, 5% NaOCl, phosphoric acid, chlorhexidine and hydrogen peroxide have also been utilized [4-8].

The use of 17% EDTA showed higher bond strength because the smear layer was completely eliminated, according to Ayad et al [9]. The dentin that has been demineralized and micro pores development, provides micromechanical retention that contributes to bond strength.

Therefore, cleaning the root canal walls is an essential aspect to ensuring a successful endodontic treatment. According to Panighi and G'Sell, teeth's mineral content and microhardness are positively correlated. In order to find out whether the dentin has lost or gained minerals, microhardness evaluation is helpful [10]. This in vitro investigation was designed to determine how the microhardness of root dentin was affected by different chelating materials.

MATERIALS AND METHODS

A total of twenty Upper Central teeth that were freshly extracted due to the periodontal issues were gathered. The teeth were selected with the aim of achieving uniformity by considering factors such as shape, size, and absence of caries, particularly in the root regions. On the root surfaces, the debris and soft tissue remnants were carefully cleaned with a sharp scalpel. At the cementoenamel junction, the crowns were sectioned transversely and eliminated away.

Every root was split into slices by a horizontal middle third section. It was 4 mm thick using a diamond disc to make preparation easier. This resulted in a total of 20 discs. After that, the samples were mounted in acrylic resin blocks so that the dentin was visible. To remove any remaining scratches, the superfacial layer of dentin was finished and flattened by abrasive paper discs that wet with water spray. Ultimately, a composite polishing kit was used to polish the specimens. The specimens were divided into four groups at random according to the chelating agents that were used-

G 1- Saline (control).
G 2- 17% EDTA.
G 3- 2.5% (NaOCl).
G 4- 2% Clorhexidine.

Each specimen had its indentations made using a 50 grams load for 15 seconds. Three indentations were made near the root canal on each specimen, and great care was taken to ensure that they did not overlap. The diagonals of the diamond-shaped indentations could be precisely measured digitally because they were visible under an optical microscope.The average of the three indentations was used to calculate each specimen's hardness value, and the average length of the two diagonals was used to calculate the microhardness. Before the specimens were treated with the chelating agents, their microhardness values were measured and recorded. A second set of measurements was taken after the specimens were treated for two minutes with the proper chelating solutions.

Figure 1: Vickers Microhardness testing machine.

RESULTS

Tables 1 and 2 present the average microhardness for each group both pre- and post-treatment. Table 3 presents the analysis of mean microhardness using the Student paired t test before and after treatment for each group.

Groups 1, 2, 3, and 4's mean microhardness values before and after treatment revealed statistically significant changes in hardness values. The results indicated that saline had the highest mean microhardness value, EDTA had the lowest values, and then Clorhexidine and NaOCL. Table 4 presents a multiple comparison using Tukey's Post hoc test of the mean difference in the microhardness between groups after treatment.

$P<0.001$ was found in the Multiple assessments of G 1 with G 2, G3, and G 4. When G 2 was compared multiple times to G 3 and G 4, $P = 0.02$ was found. But there was no discernible difference between G 3 and G 4 ($P = 1.00$).

Table 1: The mean Microhardness prior to treatment between all groups, Using the One way ANOVA Test.

Groups	**N**	**Mean**	**SD**	**Min**	**Max**	**P-Value**
G 1	5	84.31	1.12	83.2	85.6	0.99
G 2	5	86.37	1.48	85.7	87.1	
G 3	5	86.27	1.40	84.9	88.3	
G 4	5	86.30	0.92	85.6	87.7	

Table 2: The mean Microhardness after to treatment between all groups, Using the One way ANOVA Test.

Groups	**N**	**Mean**	**SD**	**Min**	**Max**	**P-Value**
G 1	5	83.67	0.98	81.7	84.6	<0.001*
G 2	5	79.77	0.73	78.1	80.4	
G 3	5	81.07	0.68	80.4	82.7	
G 4	5	81.11	0.93	80.2	82.8	

Table 3: The mean Micro Hardness before and after treatment for all groups, Using Tukey's Post hoc Test.

Groups	Time	N	Mean	SD	Mean Diff	p-value
Group 1	Before T	5	84.31	1.12	0.64	0.01*
	After T	5	83.67	0.98		
Group 2	Before T	5	86.37	1.48	6.60	0.001*
	After T	5	79.77	0.73		
Group 3	Before RT	5	86.27	1.40	5.20	0.005*
	After T	5	81.07	0.68		
Group 4	Before T	5	86.30	0.92	5.19	0.001*
	After T	5	81.11	0.93		

Table 4: Different comparison of the Microhardness between all groups after Using Student Paired t Test.

(I) Groups	(J) Groups	Mean Diff. (I-J)	P-Value
G 1	G 2	3.90	<0.001*
	G 3	2.60	<0.001*
	G 4	2.56	<0.001*
G 2	G 3	-1.24	0.02*
	G 4	-1.34	0.02*
G 3	G 4	-0.04	1.00

DISCUSSION

The root canal length, the material's penetration depth, the hardness of the dentin, the length of the application, the pH, and the concentration are some of the variables that influence a chelating agent's effectiveness. There is no chelating or demineralizing effect of saline [11-12]. It therefore had minimal effect on the microhardness of root dentin when compared to the chelating agents. Chelation agents have been shown in several studies to reduce the microhardness of root dentin. Their chelating effect is the cause of this. Dentin contains calcium and phosphate that dissolve in water. The addition of a chelator causes the solution to lose calcium ions. More dentin ions then dissolve, maintaining the consistency of the solubility product [13,14]. This is the process through which chelators decalcify dentin.

Dentin hardness values vary depending on the location; the lower values were at areas near to the pulp. It was pronounced that the microhardness for dentin at the outer layers has higher values than areas near to pulp, according to Pashley et al. The greater number of opened dentinal tubules free of peritubular dentin near the pulp offered the indenter little resistance. Dentinal tubule density was found to decrease from cervical to apical dentin, and Pashley et al. discovered an inverse correlation between dentin microhardness and tubule density [15,16]. It is highly probable that the decrease of hardness at the cervical part is influenced by this histological pattern.

According to a previous study that examined the efficacy of EDTA and NaOCL as chelating agents, The root canal dentin's microhardness was reduced by all solutions, but the reduction was highest when EDTA irrigation was used The root canal dentin's microhardness was reduced by all solutions, but the reduction was highest when EDTA irrigation was used [17]. Additional research evaluated the impact of different chelating materials on the microhardness of root dentin and discovered a noteworthy decrease in microhardness.

The intertubular substance's degree of mineral content and hydroxyapatite content are significant factors influencing dentin's intrinsic hardness. The significant shift in dentin hardness that occurred after the chelating treatment indicates that chelating materials have a significant impact on the structural elements of root dentin.

Root canal dentin microhardness decreases and dentin softens as a result of EDTA's potent demineralizing action. According to studies, smear layer removal can be achieved with EDTA materials for a minute. It works best at pH ranges of (7.3 to 8) and in lower concentrations of (15% to 17%). Removing the smear layer facilitates better intracanal medication or filler material penetration. Saline control and sodium hypochlorite both removed less calcium than other chelators as EDTA, according to research by Wayman et al, [18-19].

Higher EDTA concentrations, might hinder cell growth and show greater cytotoxicity. Furthermore, it showed that this material can be helpful in opening narrow canals. Additional investigation is possible to learn more about the other characteristics of irrigant materials. The chelating mechanism were done by demineralized dentin and the loss of calcium. Higher concentrations and a pH of (1-2) are ideal for the chelating action. [18]

The softening effect of these materials on root dentin may be the cause of the variations in Vicker's hardness. Chemical irrigants are advantageous from a clinical standpoint because they soften the dentin walls, which facilitates the negotiation of narrow, constricted canals. Certain chelating agents cause root dentin erosion. [20-21]. Surface alterations in enamel and dentin may have an impact on how they interact with restorative materials used for coronal sealing and root canal fillings, as well as reduce their ability to withstand bacterial penetration and microleakage. [22-24].

CONCLUSION

The microhardness decreased after treatment with the 2.5% NaOCL, 2% chlorhexidine and 17% EDTA. Saline has the least alteration in microhardness than other chelating agents.

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