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EFFECT OF SODIUM HYPOCHLORITE AND CITRIC ACID IRRIGATION, INDIVIDUALLY AND IN ALTERNATION, ON DENTIN MICROHARDNESS AT THE FURCATION AREA OF MANDIBULAR MOLARS.

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ABSTRACT **Aims:** Aim of the study was to evaluate the effect of irrigation regimens on dentin microhardness at the furcation area of mandibular molars, using sodium hypochlorite and citric acid individually and in alternation. **Methods and Material:** Twenty mandibular molars were used in the study. The occlusal surface was removed and the pulp chamber was exposed. The roots were cut transversally 5 mm below the cementoenamel junction, to produce 20 tooth blocks. The apical opening of canal was sealed with composite resin and the pulp chamber access was left open. The tooth blocks were embedded in self-curing, fast setting acrylic resin. The tooth block sets were distributed into 4 groups of 5 specimens each, according to the irrigation regimens: 3 % NaOCl, 10% citric acid, 3 % NaOCl + 10% citric acid and distilled water (control). After the irrigation treatment, the tooth sets were bisected longitudinally in a mesiodistal direction and the Knoop microhardness of dentin at the furcation area was evaluated. **Results:** The results of this study indicated that all irrigation solutions, except for distilled water (control), decreased dentin microhardness. Citric acid showed a significant difference when compared to NaOCl, and Citric acid+ NaOCl showed a maximum decrease in microhardness. **Conclusions:** From the results of the present study, it may be concluded that 10% Citric acid, alone or in combination with 3% NaOCl significantly reduced the dentin microhardness at the furcation area in mandibular molars.

KEYWORDS : irrigating solutions, microhardness, citric acid, sodium hypochlorite

INTRODUCTION

Along with root canal instrumentation irrigation is an essential part of root canal debridement. In addition to disinfection, removal of the smear layer from the radicular wall is also facilitated by irrigants.[1]

Sodium hypochlorite (NaOCl), in concentrations ranging from 0.5% to 6%, is the most widely used irrigating solution in endodontics. However, despite ability to dissolve organic tissues and its excellent antimicrobial potential, it is not effective in removing the smear layer. For this reason, NaOCl is usually used in combination with a chelating agent such as EDTA. [2] Decalcifying solutions such as citric acid and EDTA have been reported as suitable to remove the smear layer.[3]

The combination of auxiliary solutions is necessary to achieve the desired outcomes because although several chemical agents are available with different properties, as far as cleaning of root canals is concerned, no currently available endodontic irrigant fulfills all the ideal physicochemical properties to act simultaneously on the organic and inorganic components of smear layer.[4]

Therefore, use of chelating agents such as citric acid (CA) or EDTA as adjunct removes smear layer better than many acids such as polyacrylic acid, lactic acid, and phosphoric acid. Studies showed that sequential use of citric acid and NaOCl solutions gave the best results for smear layer removal. [5] Human dentin is composed of approximately 20% of organic material, 70% of inorganic material, and 10% of water. Collagen constitutes ninety percent of the organic matter, which plays a major mechanical role in dentin.[6]

NaOCl causes denaturation of collagen and oxidation of the organic matrix, changing the chemical structure of dentin and also affects its mechanical properties.[7] Because of the exposure of collagen and decrease in surface microhardness the demineralizing activity of this substance can be observed in root dentin, which facilitates the action of endodontic instruments, especially in narrow root canals. Furthermore, chelating solutions such as citric acid, EDTA and different combinations of irrigants also promote a reduction of microhardness on the most superficial layer of dentin. [8,9]

During smear layer removal, irrigation materials cause alterations in the chemical composition of dentin, which may result in microhardness decrease. It facilitates the instrumentation throughout the root canal. However, when it becomes considerable, it may also weaken the root structure.[10]

Extensive scientific literature is present on the action of different demineralizing solutions and chelating on the microhardness of canal lumen and root dentin thirds. However, little is known about the action of the different chelating agents on the microhardness of the furcation area of teeth.

So the aim of this study was to evaluate the effect of different irrigation regimens on dentin microhardness at the furcation area of mandibular molars, using 3% NaOCl and 10% Citric acid, individually and in alternation.

METHODS

Twenty human mandibular molars were used in the study.

Preparation of Tooth Blocks

A water-cooled double-faced diamond disc in a high-speed handpiece was used, to remove the occlusal surface and expose the pulp chamber . Both the mesial and distal roots were cut transversally approximately 5 mm below the cementoenamel junction and discarded. Such 20 tooth blocks were produced.

A Hedströem file (Kerr UK, Peterborough, UK) was used to remove the pulp tissue remaining in the canal lumen with. Light-cured composite resin was used to seal the opening of canal. The access to the pulp chamber was left open. sterile saline was used to store tooth blocks for 24h. Then the tooth blocks were embedded in self-curing, fast setting acrylic resin, leaving the occlusal side open.

Preparation of 10% Citric Acid Solution

10% Citric acid solution was prepared by adding 10 g of Citric acid in pure form to 100 ml of distilled water

Irrigation of Tooth Blocks With Different Irrigants

The tooth/ acrylic resin block sets were distributed randomly into 4 groups consisting of 5 specimens each. The distribution was done according to the irrigation regimens: 3% NaOCl, 10% Citric acid, 3% NaOCl + 10% Citric acid and distilled water (control). A standardized volume of 0.5 mL of each irrigating solution was delivered directly to pulp chamber using a 2cc syringe.

After 10 min, Rinsing of the pulp chamber was done with 10 mL of distilled water to remove any residues of the tested solution. In the group where both chemical irrigants were used, 0.5 mL of 3% NaOCl was delivered for 10 min, followed by aspiration, delivery of 0.5 mL of 10% Citric acid for 10 min and final flush with 10 mL of distilled water.

Sectioning of Tooth Blocks

Bisection of the tooth/acrylic resin block sets were longitudinally in a mesiodistal direction after the treatments using diamond disc. Those halves that were considered as the most representative of the furcation area were selected.

Polishing of Specimens

400-, 500- and 600-grit silicon carbide papers were used to ground wet the specimens. These were polished with felt discs embedded in aluminum oxide paste at low speed. The specimens were washed in running water for 4 h, dried with gauze and examination was done at ×40 magnification to confirm their smoothness. It is not possible to visualize the indentations on non-polished surfaces.

These procedures are essential as microhardness measurement is only possible on smooth dentin surface.

Microhardness Testing

A #15 scalpel blade was used to delimit the furcation area to be examined by tracing two orthogonal lines, which started from a point located on the outer surface of the root in the most concave portion of the furcation, which extended up to the pulp chamber floor, towards the entrance of mesial and distal canals . A Hardness tester (HT 03 PRIMA) (Fig 1)was used for measuring dentin microhardness in this region under 1g load and 15 s dwell time. Five indentations were made in each specimen which were spaced 200 µm from each other (Fig 2), following a direction parallel to the bisecting line between the orthogonal lines, starting from the pulp chamber floor towards the point .

Fig 1- Microhardness testing machine

Fig 2- Image with indentations on the specimen

The representative dentin microhardness value for each specimen was obtained by the average of the values for the five indentations. Data was analyzed statistically by one-way ANOVA and Tukey's multiple-comparison test using GraphPad InStat, v.3, software (GraphPad Software Inc., San Diego, CA, USA). For all analysis a significance level of 5% was set.

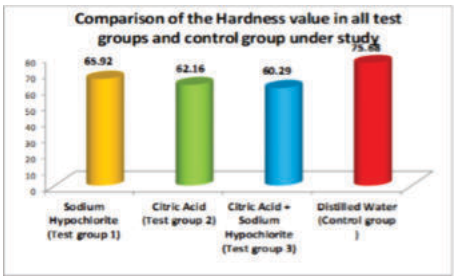
RESULTS

Table No.1: Comparison of the Hardness value in all test groups and control group under study:

Groups	Mean ± SD	Minimum	Maximum
Sodium Hypochlorite Test group 1	65.92±5.37	58.937	70.324
Citric Acid Test group 2	62.16±3.76	56.036	65.100
Citric Acid + Sodium Hypochlorite Test group 3	60.29±3.53	55.724	64.012
Distilled Water Control group	75.68±2.48	71.837	77.908

ONE WAY ANOVA TEST (Tuckey Kramer Multiple Comparison Test) For all four groups comparison:

By applying ONE WAY ANOVA TEST and Post hoc Tuckey Kramer Multiple Comparison Test there is a significant difference between mean values of hardness values in all test groups and control group compared together. (p=0.0001)



Graph No: 1 Comparison of hardness value in all test groups and control group under study.

RESULT:

By applying Student's Unpaired 't' test there is a significant difference in the mean values of hardness value when Sodium Hypochlorite (Test Group 1) compared with Citric Acid + Sodium Hypochlorite (Test Group 3) and compared with Distilled Water (Control Group).

By applying Student's Unpaired 't' test there is a significant difference in the mean values of hardness value when Citric Acid (Test group 2) compared with Distilled Water (Control Group).

By applying Student's Unpaired 't' test there is a significant difference in the mean values of hardness value when Citric Acid + Sodium Hypochlorite (Test group 3) compared with Distilled Water (Control Group).

DISCUSSION:

Because of its excellent antimicrobial action, capacity of dissolving organic tissue remnants NaOCl has been systematically used as an endodontic irrigant for the chemomechanical preparation of root canals. By lubricating the dentin canal walls it improves the action of instruments and drills.[11] Microhardness determination can provide indirect evidence of mineral loss or gain in the dental hard tissues.[12] In previous studies Knoop indenter microhardness test has been used to measure dentin microhardness and the practicality and suitability of this test for evaluating surface changes of dental hard tissues treated with chemical agents has been demonstrated. [13,14]

NaOCl has been used as an endodontic irrigant for the chemomechanical preparation of root canals because of its antimicrobial action, capacity of dissolving organic tissue remnants and improving the action of instruments by lubricating the dentin canal walls.[15] In the present study, 3% NaOCl reduced significantly dentin microhardness at the furcation area when compared with distilled water (control group). Kinney et al.[16] suggested that the decrease in hardness is caused by a decrease in stiffness of intertubular dentin matrix caused by heterogeneous distribution of the mineral phase within the collagen matrix.

Slutzky and Goldberg et al.[17] found that root canal irrigation with 2.5% and 6% NaOCl reduced dentin microhardness at a depth of 500 µm from the canal lumen. According to the authors, both the irrigation period and the concentration affect the action of NaOCl in reducing microhardness.

Oliveira et al.[18] stated that the use of 1% NaOCl for 15 min was sufficient to reduce dentin microhardness at depths up to 1,000 µm from the canal lumen. When compared with other irrigating solutions citric acid solutions had the strongest effect on reducing dentin microhardness. The chelating action of citric acid solution has a demineralizing effect on the calcified dentin components.[19] Reduced dentin microhardness could be beneficial under some clinical conditions as it would increase dentin permeability, which may

improve the penetration of irrigating solutions into the dentinal tubules, allowing greater root canal disinfection.[20]

Kruzic and Ritchie reported that the destruction of the collagen matrix in dental hard mineralized tissues results in a more brittle substrate that might precipitate fatigue crack propagation during cyclic stresses.[21]

CONCLUSION:

From the results of the present study, it may be concluded that 10% citric acid, alone or in combination with 3% NaOCl significantly reduced dentin microhardness at the furcation area in mandibular molars. Therefore, care should be taken during the chemomechanical preparation of these teeth, especially those with weakened furcation area.

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