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Assessing the Effectiveness of Several Irrigating Solutions in Removing the Smear Layer from Primary Tooth Root Canals: A Scanning Electron Microscopic Study

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Abstract: ***Background: Within the complex root canal architecture, calcified debris is removed mechanically, and organic debridement is dissolved chemically. An important role in the whole process is played by the irrigation technique, which significantly aids in the removal of germs from the intricate root canal structure. Numerous irrigation solutions, either alone or in combination with sodium hypochlorite, ethylenediaminetetraacetic acid (EDTA), citric acid, tetracycline, and chlorhexidine, have been thoroughly investigated at various doses. The current study was set out to assess and contrast the effectiveness of commonly used chemical agents with respect to their ability to remove the smear layer following instrumentation, as shown by scanning electron microscopy (SEM). Aim: The purpose of this in vitro investigation was to evaluate the effectiveness of hand instrumentation in the removal of the smear layer from the coronal, middle, and apical thirds of the root canals of primary teeth using 0.9% normal saline, 5.25% sodium hypochlorite, MTAD, and ginger extract as the final irrigant. Material and Method: After 40 human removed primary teeth were prepared to a 40# K file, they were randomly assigned to one of four groups (n=10), with the final irrigants being 0.9% Normal Saline, 5.25% Sodium Hypochlorite, MTAD, and Ginger extract. The amount of smear layer covering the dentinal surface of the decoronated teeth was measured after they were divided lengthwise into two halves. The Rome et al. scoring criteria were applied for taking SEM images, and the student t test, Chi-square test, and Kruskal-Wallis test were used to examine the data. Result: When comparing Biopure MTAD to other groups, an intergroup comparison revealed a statistically significant difference in all thirds (p<0.0001). Conclusion: Ginger extract is a herbal substitute for root canal irrigant in primary teeth, and Biopure MTAD is a successful method for removing the smear layer.***

Keywords: Primary teeth, Smear layer, Root canal Irrigant, MTAD, Ginger Extract

1. Introduction

For speech, mastication, maintaining the length of the arch and the proper development of the occlusion, deciduous teeth are just as important as permanent teeth. In deciduous teeth, caries develops quickly and damages the pulpal tissues as a result of microbial infection and the toxins they emit.[1] Pulp therapy, which is the process of removing germs and diseased dentin chemo-mechanically, is required to promote their retention in the oral cavity. However, due of the different morphology of the roots, it becomes a little more complicated in primary teeth. Primary teeth require the use of additional irrigating solutions due to their peculiar internal geometry and confusing characteristics, which include ribbon-shaped canals, internal connections, horizontal anastomoses, and auxiliary canals.[2,3]

As a vital component of pulp therapy, irrigation helps to drain out germs, loose necrotic tissues, and diseased dentin from the root canals more quickly. As a result, the contaminated tissue cannot be extruded periapically or forced farther into the canal space. In addition to makingit easier to instrument the canal space, irrigation-assisted mechanical instrumentation keeps the canal wall lubricated. Thus, selecting an irrigant is essential and should consider the variations in the dentin substrata. The problem occurs while treating a primary tooth because of physiological root resorption, which may permit the solution to extrude apically, producing excruciating pain and potentially harming the subcutaneous tooth.[4-7]

Smear layer, an amorphous structure made of both organic and inorganic materials that covers the dentinal walls of root canals and smear plugs located in the depths of dentinal tubules, is created during root canal instrumentation. The tooth structure and a few non-specific inorganic impurities make up the inorganic material in the smear layer, whereas the heated coagulated proteins, necrotic or viable pulp tissue, odontoblastic processes, saliva, blood cells, and microorganisms could be the organic components. Endodontic irrigants, sometimes referred to as organic and inorganic solvents, are needed to remove the smear layer. The two most often utilised root canal irrigants are sodium hypochlorite and normal saline.[8]

Physiological saline is ineffective at eliminating the smear layer and dentinal debris. Sodium hypochlorite will disintegrate organic tissue but has not been demonstrated to be an efficient smear layer remover at concentrations of 1.0 to 5.25%.[8] Because of their chelating properties, EDTA and citric acid are the irrigants that are most frequently employed to eliminate smear layers. Dentinal erosion has been linked, nevertheless, to the use of EDTA and citric acid irrigation at higher concentrations for more than a minute and in volumes greater than one millilitre. In dentistry,

BioPure MTAD has been introduced as a last irrigant for the elimination of smear layers.[9,10]

Researchers have been searching for herbal alternatives to common root canal irrigants, such as MorindaCitrifolia, Neem leaf extract (Azadirachta indica), Triphala and Green tea polyphenols, German chamomile. These undesirable characteristics of commonly used root canal irrigants include tissue toxicity, risk of emphysema, allergic potential, and disagreeable smell and taste.[11-13] Thus, the current study has employed ginger extract (zingiber Officinale) as an endodontic irrigant.This study set out to determine how well different irrigating solutions, such as MTAD, 0.9% normal saline, 5.25% sodium hypochlorite, and ginger extract, worked as final irrigants to remove the smear layer from the coronal, middle, and apical thirds of primary teeth's root canals following manual instrumentation.

2. Material and Method

The Institutional Ethical Committee gave its clearance before this in vitro investigation started. 40 removed single-rooted deciduous teeth were used in the investigation. The samples were randomly assigned to four groups, with seven teeth in each group, based on the final irrigant solution. Using 0.9% normal saline as a negative control group, (Group I).; Group II 5.2% sodium hypochlorite, Group III was provided by Biopure MTAD, a combination of tetracycline, citric acid, and detergent (Tween 80) from Dentsply, Tulsa Dental Specialist, U.S.; and Group IV was provided by an alcoholic extract of ginger. (Fresh ginger extract prepared in a soxhlet equipment at Daksh Laboratory).

Teeth were removed for a variety of causes, including trauma, excessively retained teeth, orthodontic extractions, and the study included primary incisors that still had at least two thirds of their roots in place. The study excluded teeth having internal resorption, aberrant root morphology, and teeth undergoing endodontic treatment. Human deciduous single-rooted teeth extracts were gathered, cleaned, and preserved in 0.9% saline at 4˚C until needed. They were then handled in accordance with the Centres for Disease Control's (CDC) recommendations and guidelines.

In order to facilitate a smooth split for scanning electron microscopic examination, 40 extracted human deciduous anterior teeth were decoronated at the level of the cemento-enamel junction (CEJ) and superficial grooves were placed mesiodistally along the longitudinal axis in cementum not extending to the root canal. A diamond disc (UKAM, USA) mounted on a low speed hand piece was used for this purpose. Each group's instrumentation was completed using a different set of "K" files (Mani, Prime Dental Product Pvt Ltd.). The #10 K-file was inserted into the canal until the apical foramen could barely see it. One millimetre was subtracted from this point to determine the working length.Using the step-back technique, biomechanical preparation was carried out throughout the whole working length of the canal, with file numbers sequentially #15, #20, #25, #30, #35, and #40. Irrigation was done with 3ml of 0.9% Normal Saline for 10 seconds in between each instrument. The prior instrument was swapped out for one with a greater diameter only after it was able to travel freely within the canal. 26 gauge needles were employed in the current study for irrigation, and the depth of the irrigation needle was determined by deducting 2 mm from the working length.

In order to create an in vivo apical counter pressure and stop irrigant from extruding through the apical foramen, sticky wax was used to plug the apical ends of the roots before to the final irrigation. After that, the samples were arbitrarily split into four groups according to the final irrigation. To spread the solution along the canal surface, #40 gutta percha is used to agitate the solution. With the exception of Biopure MTAD, all samples were ultimately irrigated with 10 ml of distilled water to prevent crystals from settling inside the canals, and absorbent paper point #40 was used to dry them.

Using a medical mallet and a BP knife (blade #15) to cut through the pre-made grooves, the teeth were divided longitudinally, and each half was left in a 2% glutaraldehyde solution for a full day. Every tooth's opposite half was thrown away. After that, the samples were taken to the testing facility and placed in a sterile, non-contaminated plastic container in order to undergo scanning electron microscopy analysis. The teeth were placed in a desiccator for at least twenty-four hours after being dehydrated using increasing concentrations of ethyl alcohol (70%, 90%, 95%, and twice at 100%).

After being mounted on metallic stubs and sputter-coated with a layer of gold-palladium particles measuring approximately 35 nm to create a conductive surface, the dried specimens were examined under a 2,000X scanning electron microscope at magnifications of the coronal, middle, and apical thirds of the dentinal surface. For comparative purposes, a set of uniform photos at a 2000X magnification was taken in the coronal, middle, and apical third. The Rome et al.14 rating criteria method was used to analyse the scanning electron microscopic pictures. A score of 0-No smear layer, all dentinal tubules open, and no tubule erosion, 1. There is no smear layer; 2. There is minimum smear layer > 50% of the dentinal tubules visible; 3. All dentinal tubules are open and eroding.3- Moderate smear layer: less than 50% of dentinal tubules are open; and 4-Heavy smear layer: dentinal tubule outline is completely destroyed.

3. Result

The Biopure MTAD's mean rank (Table I) in the coronal third was statistically very significant ($p<0.0001$) and significantly lower than that of each of the separate groups. The correctness of the Biopure MTAD is confirmed by the lower ranks of smear layer removal efficacy, which are highest for normal saline, lowest for sodium hypochlorite, and ginger extract. Group III (Biopure MTAD) was compared to all other groups, which revealed a highly significant result ($p<0.0001$). Group IV (ginger extract) was next, then Group II (5.25% sodium hypochlorite), and Group I (normal saline) was last.

Table 1: Mean rank of all experimental group at respective third using Kruskal-Wallis test and Chi-Square test

	Group	N	Mean Rank	Chi-Sqaure test	df	Asymp. sig
Coronal third	Normal saline (Group I)	10	22.32	23.38	2	0.0001
	5.25% sodium hypochlorite (Group II)	**10**	18.43			
	Biopure MTAD(Group III)	**10**	5.00			
	Ginger extract (Group IV)	**10**	15.00			
Middle third	Normal saline (Group I)	**10**	23.00	21.58	2	0.0001
	5.25% sodium hypochlorite (Group II)	**10**	20.71			
	Biopure MTAD (Group III)	**10**	5.14			
	Ginger extract (Group IV)	**10**	12.34			
Apical third	Normal saline (Group I)	**10**	22.32	24.87	3	0.0001
	5.25% sodium hypochlorite (Group II)	**10**	19.45			
	Biopure MTAD (Group III)	**10**	3.00			
	Ginger extract (Group IV)	**10**	13.11			

4. Discussion

Many chemical substances have already been recognized as efficient for smear layer removal in permanent teeth; however, their effects on primary dentition have not yet been evaluated. Considering the anatomical, histological, and chemical differences between permanent and primary dentitions results obtained in permanent teeth cannot be transposed to primary teeth. Therefore, present study was conducted to evaluate the effectiveness of hand instrumentation in the removal of the smear layer from the coronal, middle, and apical thirds of the root canals of primary teeth using 0.9% normal saline, 5.25% sodium hypochlorite, MTAD, and ginger extract as the final irrigant. Overall, the study's findings supported earlier publications that found saline alone causes a sludge layer composed of leftover debris that obstructed the dentinal tubules. These reports also showed that a thick smear layer was seen in specimens irrigated with normal saline solution at all levels. It is recommended to use 5.25% Sodium Hypochlorite in conjunction with a biocompatible chelating agent for primary teeth because of its strong antibacterial properties and cost-effectiveness. However, this solution is not effective in removing the smear layer, as demonstrated by multiple studies. When MTAD is used for the necessary amount of time alone with manual agitation, it effectively removes the smear layer from three quarters of the primary tooth's root canal.This suggests that MTAD be used in conjunction with manual agitation for primary teeth. The ginger extract (Group IV) results are intriguing; they showed partial smear layer elimination that was more successful than 5.25% Sodium Hypoclorite (Group II) but less successful than Biopure MTAD (Group III). It can be used as a more advanced root canal irrigant in pediatric dentistry as studies have demonstrated its antibacterial efficacy.

5. Conclusion

The present study's findings support the notion that Biopure MTAD is a useful method for removing the smear layer without appreciably altering the dentinal tubules' structural integrity. The study recommends using the novel remedy Biopure MTAD and the herbal substitute ginger extract for primary teeth, however due to the study's limitations, more in vivo and in vitro research will be needed to evaluate their efficacy.

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