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Original Article

The Elimination of Gutta-percha by Chloroform and Orange Oil in Endodontic Retreatment: An Scanning Electron Microscopic Observation

Chowdhury Afrina Parvin[1], Khandoker Rumon[2], Sheikh Manjura Hoque[3], Ridwana Kawsar[4], Md. Shihab Uddin[5], Mozammal Hossain[6]

[1] *Department of Conservative Dentistry and Endodontics, Sir Salimullah Medical College, Dental Unit, Dhaka, Bangladesh*
[2] *Department of Pedodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, Bangladesh*
[3] *Materials Science Division, Atomic Energy Centre, Kazi Nazrul Islam Avenue, Ramna, Dhaka, Bangladesh.*
[4] *Department of Conservative Dentistry and Endodontics, Shaheed Suhrawardy Medical College, Dental Unit, Dhaka, Bangladesh*
[5] *Department of Pedodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, Bangladesh*
[6] *Department of Conservative Dentistry and Endodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, Bangladesh.*

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Abstract *- This study aimed to find morphological differences following removing obturated material using chloroform and orange oil in endodontic retrieval with a Scanning Electron Microscope (SEM). The 30 anterior maxillary teeth are permanently extracted, following biomechanical adjustment using a step back method, closed with gutta-percha and sealer, and keep them in 100% moisture condition at 37^0 C for 14 days. Teeth were then randomly assigned to 2 groups according to the gutta-percha solvent used to remove the obturated substances: Group I (Chloroform, Obtusol, HAI Dental, Bangladesh) and Group II (Orange Oil, RC Clean, Pyrax Polymers, India). Then came the elimination of the gutta-percha using the Hedstrom file (size: 20 to 40). For the central and lateral incisor teeth, the apical file size was 40, whereas a file size of 35 was used for the lateral incisor to reach the working height. After removal, the opening of the dentinal tubules was checked by scanning electron microscope (SEM). Data were collected through a data collection checklist and coded and analyzed using version SPSS 22. The study revealed that the number of open dentinal tubules under SEM among the two solvent groups was not statistically significant (P> 0.05). It can be concluded that orange oil can be a substitute for chloroform to dissolve gutta-percha in root canal retreatment.*

Keywords *- Morphological analysis, Cleaning, Gutta-percha solvent, Dentinal tubules.*

1. Introduction

Natural teeth are preserved through endodontic treatment where diseased or damaged tooth pulp is removed, and the pulp space is filled with a non-functional substance such as gutta-percha and sealer. Although the success rate of endodontic treatment has reached a level of 86% to 93%,[1] failure in most cases is associated with inadequate cleaning of the root system or inadequate prevention of oral microorganisms from the root canal..[4,5] Endodontic retreatment is a type of 2- non-surgical and surgery.

Non-surgical reconstruction includes eliminating the obturated material commonly produced by the gutta-percha and endodontic sealing material from the root canal.[5–8] However, removing total obturated material from the root canal is necessary to ensure clean room walls.[9] This helps chemo-mechanical repair and disinfection to achieve the ideal condition for new root filling.[10-12]

The techniques used to eliminate gutta-percha and sealer include ultrasonic methods, [13] stainless steel files (K-file and H-file), hot plugs[14,] and many other rotating retrofitting systems. To remove the filling material without damage to the dentinal walls, chemical solvents are used to soften gutta-percha.[15-17] Organic solvents should be used during decontamination to decrease the resistance of the obturated material, [18] thus making their removal easier. [4]

A suitable gutta-percha solvent requires the following features; the result of high melting, low surface tension, ease to use, quick action, and long life. During the recovery process, when the filling material is unknown, it is very important to have different types of solvents, using the most effective one.[7] Among the chemical solvents, chloroform, xylene, eucalyptus oil, and orange oil are widely used. [19-22]

Chloroform has been used as a gutta-percha solvent since 1850.[23] It is one of the most widely used solvents due to its high performance. Another name is trichloromethane (CHCl3), a natural solvent that is very effective in dissolving gutta-percha. It is widely used in dental work because of its quick action, easy use, and low cost. Chloroform, however, can produce cytotoxic effects on the periapical areas and therefore need caution during use.[24,25]

On the other hand, orange oil can be used because of its good solvency and biocompatible properties in periapical tissues without any harmful effects.[22] It can also be used to remove the epoxy-resin and calcium hydroxide-based sealers. But previous research was inconclusive regarding the efficacy of chloroform and orange oil for gutta-percha removal, and another reported that the efficacy associated with chloroform and orange oil in the dispersal of gutta-percha did not make much difference.[26] Other studies have reported that chloroform reported a higher concentration of soluble gutta-percha than other solvents,[27] but Oyama et al.[28] revealed that orange oil was more effective in softening the gutta-percha than chloroform.

In addition to root canal retreatment, very few studies have been done using an SEM scanner (scanning electron microscope) to compare the cleaning efficiency between chloroform and orange oil in extracting fillers from dentinal tubules, and a limited number of data are available about the morphological appearance of the root canal wall after the retreat. Therefore, morphological differences following the removal of obturated substances using chloroform and orange oil in endodontic retreatment were performed with a Scanning Electron Microscope (SEM).

2. Materials and Methods

30 newly extracted maxillary anterior teeth, including 10 central incisors, 10 lateral incisors, and 10 canines, were selected according to the insertion and removal procedure. Teeth were cleaned, stored in saline solution, and then decorated using a diamond disc. Canal lengths are established visually by placing a 10 K-file size in each root up to the apical foramen. Then, the working length was established by minimizing one mm from this location. The working length of the central and lateral incisors was 12 mm, and for canines, it was 16 mm.

The roots were embedded in an acrylic mold for suspension, and biomechanical adjustment of the canal systems was performed in a retrospective process using K-files (Dentsply, Switzerland). The main apical file of the central incisor and canine root canal was a file size of 40 K, and the lateral incisor was a file size of 35 K. A third of the coronal roots were burned by using a Gates-Glidden drill (Size 2 and 3). During root canal preparation, irrigation with 2 ml of 5.25% NaOCl per file conversion was followed. Size # 10 k-file was used to establish copyright after irrigation. After the metal installation was fulfilled, the final spray was done with 17% EDTA for one minute to remove the smear layer.

Each canal was desiccated with 35 and 40 points of paper (Dentsply, Germany) and sealed with gutta-percha and AH Plus sealer (Dentsply, Germany) using a cold side condensation method verifying the balance of the master cone with a radiograph. The master gutta-percha cone size 40 was chosen for the central incisor and canine, and 35 was chosen for the lateral incisor. Nickel-titanium (NiTi) size 20 finger spreader is used until the diffuser is placed more than 5 mm in the canal.

Surplus gutta-percha is eliminated at the entrance to the root canal by a hot plug. Coronal access was then filled with Zinc oxide eugenol supplementation. A single operator took a radiograph (RVG) of each image to confirm the same level of obturation in both buccolingual and mesiodistal views. The specimens were kept in 100% humidity at 37^0 C in the incubator for 14 days for a complete sealer setting. After 2 weeks, the teeth were separated into 2 groups based on solvent applied by random sampling by lottery:
Group I: chloroform (5 central incisors, 5 lateral incisors and 5 canines)
Group II: orange oil (5 medium incisors, 5 rear incisors and 5 canines)

All the roots were re-embedded in acrylic resin mold, and the interim restoration was detached using a size 2 round bur. The No 3 Gates-Glidden drill (Mani Inc, Japan) was employed to take out 2 mm coronal root canal filling to build a gutta-percha reservoir where 0.4ml of chloroform (Obtusol, HAI Dental, Bangladesh) was delivered in batch I., and 0.4ml of orange oil (RC Clean, Pyrex Polymers, India) delivered in batch II. After 2 minutes, to permit the solvent to penetrate, re-installation was started to extract the obturated material using a file size of 20 H. The process continuously repeated 25, 30, 35, and 40H-file and gutta-percha solvent. After every 30 seconds, the waste was eliminated by spraying with 2 ml of 5.25% NaOCl using a 30-gauge irrigation needle before adding the solvent. A total of 1 ml of each solution was applied per root canal. The final location was determined when the main apical file of the ISO # 40 k-file was reached for the working length of the central incisor and canine, as well as the # 35k file of the lateral incisor.
Postponing is complete when no blocked items or markers exist in the last file. Every canal was dehydrated with paper points. Longitudinal grooves were made outside all the roots with a diamond disc and separated by a chisel and a hammer. At the time of separation, the coronal and apical openings were covered with adhesive wax to prevent fragments from entering the hole and contaminating the root walls. Then the middle and apical third portion was applied to the SEM holder (INSPECT, S-50, FEI, Netherlands), and the analysis was performed at 10-15 kV.

Another explorer, unaware of the sample portion, observed only the middle part. SEM view of the specimen was taken at × 3000 magnification, corresponding to the area of 0.0086 μm^2. The number of open dentinal tubules per mm^2 was measured utilizing ImageJ software (an image source based on open source java). The number of open dentinal tubules with no filling material per mm^2 was calculated mathematically using the Mana-Whitney U test; p <0.05 was considered statistically significant.

3. Results

Table 1 shows the quantity of open dentinal tubules between the groups in both the middle and apical thirds. Furthermore, their difference was statistically non-significant (P> 0.05). Figure 1 shows the obturation of the root canal. Figures 2 & 3 showed the cleaning of the middle and apical thirds of the root canal with Chloroform and orange oil, respectively.

Table 1. Quantity of open dentinal tubules per mm^2 between two solvent groups (n=15)

	Quantity of open dentinal tubules per mm^2				*P* Value
Tooth	Group I (n=15)		Group II (n=15)		
	Mean ± SD	Range (min,max)	Mean ± SD	Range (min, max)	
Middle third					
Central Incisor	14197±648.82	13563, 15232	13960±1024.5	12975, 15465	0.465^{ns}
Lateral Incisor	14519±510.4	13862, 15135	14416±705.08	13481, 15348	0.917^{ns}
Canine	14319±587.51	13620, 14863	14737±782.76	13597, 15794	0.465^{ns}
Apical third					
Central Incisor	7232.2±503.86	6685, 7972	8121.8±1022.1	7093, 9790	0.076^{ns}
Lateral Incisor	7103.8±256.76	6748, 7398	7010.2±558.89	6279, 7790	0.602^{ns}
Canine	7039.4±366.06	6512, 7459	7058.8±696.13	6127, 8052	0.917^{ns}

ns= not significant

Table 1 *P*-value from the Mann-Whitney U test shows that the difference between solvent groups was not statistically significant (p>0.05).

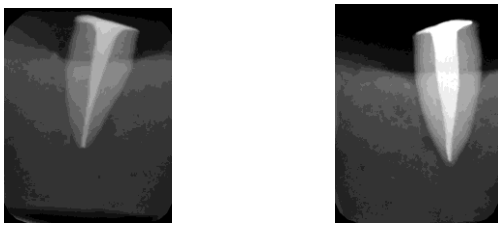

Fig. 1. Representative post-operative radiographs. It shows that root canals were obturated fully.

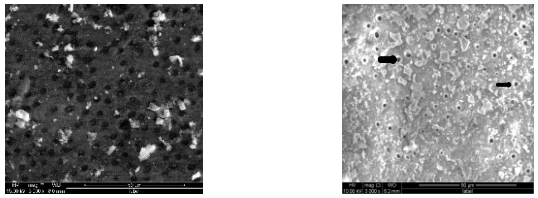

Fig. 2 The middle third shows the open dentinal tubules, Chloroform (Left), and Orange oil (Right) (×3000) magnification.

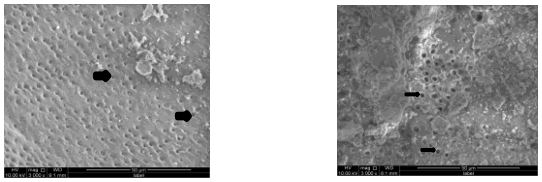

Fig. 3 The apical third showing open dentinal tubules. Chloroform (Left) and Orange oil (Right) (×3000) magnification.

4. Discussion

The result of this observation confirmed that the differences between the action of chloroform and orange oil in dissolving obturated material were insignificant. The difference in the quantity of open dentinal tubules per mm^2 in each group under SEM was insignificant. Numerous studies on retardation have been performed as in vitro studies. The number of gutta-percha extracts was evaluated using radiographs, dental separation, and histological tests or electron microscopic (SEM) scans. The present study used SEM tests of retractable teeth to compare the cleaning efficiency between chloroform and orange oil groups. SEM micrographs show dentinal tubules that do not contain residues. In addition, the number of free-flowing tubules per mm^2 during the third apical area was analyzed with image software J.

The apical third of all samples showed a small number of clean tubules compared to the middle third of the root. But the differences were not significant. Similarly, using SEM, Scelza et al.[29] discovered no difference in the number of open tubules following the decomposition of chloroform and orange oil in one-third of the root. Other studies have shown that solvent effectiveness depends on calculating gutta-percha residues according to location. This result is similar to our current study.

The present study's outcome also supports earlier examinations' finding that it is impossible to find root canals without debris.[31,12] In an in vitro study using maxillary canine teeth due to their straight canal and circular anatomic shape, Scelza et al.[29] indicate that it may be easier to eliminate the obturated material. Similarly, Horvath et al.[32] used the human maxillary incisor and

canine teeth in their study. In the present study, we also used the anterior maxillary teeth, including the central incisor, the lateral incisor, and the canine teeth, to mimic the clinical setting. In many cases, root canal curvatures ranging from 20 to 400,30,33 can affect the cleaning. However, there was no significant effect in gutta-percha removal with chloroform and orange oil solvents, according to Caper et al. [30] studies. This result was similar to our study.

5. Conclusion

The difference between the effectiveness of chloroform and orange oil in gutta-percha and sealer removal during retreatment was not significant.

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