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Retrievability of triple antibiotic paste from root canals with different irrigating soutions: An *in vitro* volumetric analysis using cone beam computed tomography

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Abstract
Objective: This *in vitro* study compared the amount of triple antibiotic paste (TAP) remaining in the canal, after removal with normal saline, 3% sodium hypochlorite, 17% EDTA, 0.5% peracetic acid in combination with sonic activation and the volume was analysed using CBCT.
Material and method: Forty extracted single canal mandibular premolars were selected. Access cavities were prepared and the root canals were subjected to biomechanical preparation. TAP was placed into the canals until the material extruded through the apex. Volumetric analysis was performed using CBCT. The samples were randomly divided into four groups on the basis of irrigants (saline, 3% sodium hypochlorite, 17% EDTA, 0.5% peracetic acid) and sonic activation in each group used for removal. A second CBCT was done and the volume of remaining material in each tooth was estimated as before. Volumetric analysis and percentage difference was calculated and statistically analysed using ANOVA and post-hoc test. All the experimental irrigants failed to remove TAP completely from root canals. 0.5% peracetic acid (remaining volume was 43.6) showed better removal efficacy than others.
Conclusion: Combination of 0.5% peracetic acid and sonic activation results in lower amount of TAP remnants compared to other groups.

Keywords: Cone beam computed tomography, ethylenediamintetracaeticacid, intracanal medicament, peracetic acid, sonics, triple antibiotic paste

1. Introduction
Endodontic treatment is important for the prevention and control of pulpal and periradicular infection. The main goal of root canal therapy is elimination of bacteria and their byproducts from root canal system. Biomechanical preparation of root canal significantly reduces the number of microorganisms [1]. The reduction in proliferation and recontamination of microorganisms from root canal irregularities is enhanced by intracanal medicaments [2].
Since, endodontic infection of root canal system is considered as polymicrobial (i.e. consisting of different species of bacteria and other microorganisms) [3]. Triple antibiotic paste has been recommended as an intracanal medicament during root canal therapy and for regenerative endodontic treatment Triple antibiotic paste was developed by Hoshino *et al.* in 1996 and combination of Ciprofloxacin, Metronidazole and Minocycline [4].
Prior to obturation, TAP should be completely eliminated from root canal because residue of triple antibiotic paste can negatively influence the sealing properties of root canal fillings [2]. The most common irrigation solutions used are copious irrigation using sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) in combination with hand filling. This technique is not efficient as it leaves 40% intracanal medicament residues within the root canal [5]. Hence, citric acid, maleic acid, and peracetic acid (PAA) has been investigated [6].
Different irrigation systems have been recommended to increase the penetration of irrigation solutions within the root canal system.[5] Peracetic acid (PAA) is one of the strongest disinfectant. It has antibacterial, antiviral, sporicidal and antifungal effects [7]. PAA is used for elimination of biofilm [8]. In smear layer removal, 2.25% PAA solution showed comparable effect as 17% EDTA [9]. In oral cavity it is recommended in lower concentrations such as 0.5%

because 2.25% PAA cause caustic effect on oral mucosa [10]. Hence, in present study 0.5% peracetic acid was used.

Various methods are used to measure the remaining triple antibiotic paste in the root canal. These are stereomicroscopy, scanning electron microscopy, spiral computed tomography (CT). Recently, cone beam computed tomography (CBCT) has been found to be more superior. In this method, three-dimensional volume measurements are possible without sectioning the specimens. Hence, it is a considered as more accurate and faster method [5].

Hence, the current *in vitro* study evaluated the effects of different irrigating solutions in combination with sonic activation against removal of triple antibiotic paste from root canals and the volume of triple antibiotic paste removed was analysed using CBCT.

2. Materials and methods

Forty extracted single canal mandibular premolars free of fracture, cracks, or any other defects were selected. Access cavities were prepared and the root canals were subjected to chemomechanical preparation using rotary Pro Taper files (Densply-Mailiefer, Ballaigues, Switzerland) till F4 and 2 ml of 3% NaOCl was used as an irrigant after each instrument and 2ml of 17% EDTA for final flush. Canals were dried with paper points.

2.1 Triple antibiotic paste preparation and application

Equal portion of metronidazole B.no-1802 (Century Drugs, Dhar, India), ciprofloxacin B.no-18009 (Cadila Pharmaceuticals, Ahmedabad, India), minocycline B.no-2961753 (Sun Pharmaceuticals, Solan, India) were mixed with distilled water (a powder/liquid ratio of 3:1) and bismuth trioxide was added in the ratio of 1:8 by weight for radiopacity. TAP was placed into the canals with lentulospiral until the material extruded through the apex.

Excess material was wiped off with moist cotton. The access cavities were temporarily sealed with a cotton pellet and Cavit and were stored at 37°C and 100% relative humidity for 7 days. Subsequently, the teeth were mounted in a modeling wax for the purpose of CBCT.

After CBCT imaging, the volume of the filled material in each tooth was estimated using the 3D Slicer software.

The samples were randomly divided into four groups on the basis of irrigant used for removal.

1. Group I (n = 10) control group: Triple antibiotic paste retrieved with 1 ml of normal saline + sonic agitation for 1 min + final rinse with 1 ml of distilled water.
2. Group II (n =10): Triple antiobiotic paste retrieved with 1 ml of 3% sodium hypochlorite (Maarc Dental, Mumbai, India) + sonic agitation for 1 min + final rinse with 1 ml of distilled water.
3. Group III (n =10): Triple antibiotic paste retrieved with 1 ml of 17% EDTA solution (Maarc Dental, Mumbai, India) + sonic agitation for 1 min + final rinse with 1 ml of distilled water.
4. Group IV (n =10): Triple antibiotic paste retrieved with 1 ml of 0.5% peracetic acid (PAA) (Prime laboratory, Pune) + sonic agitation for 1 min + final rinse with 1 ml of distilled water.
5. A second CBCT was done and the volume of remaining material in each tooth was estimated as before.

2.2 Outcome assessment

The calculation of triple antibiotic paste volume in each specimen was performed using the 3D Slicer software. Volume of triple antibiotic paste was expressed as cubic mm.

The removal efficiency was calculated as

[(A-B) 100/A], where

A: volume of the material packed into the root canal.

B: volume of remaining material after retrieval procedure.

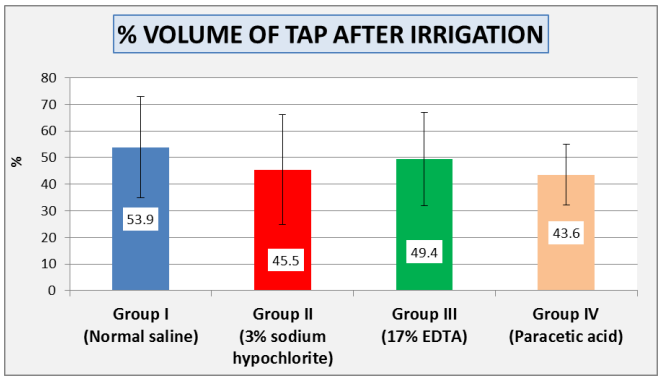
The data were statistically analyzed using ANOVA test and post hoc test.

3. Results & discussion

Results

1. None of the experimental irrigating solution with sonic activation was able to completely removed triple antibiotic paste.
2. The removal efficacy of triple antibiotic paste removed by 0.5 Peracetic acid (Group IV) was more, the remaining volume was 43.6. (P< 0.05), followed by 3% sodium hypochlorite (Group II), the remaining volume was 45.5 followed by 17% EDTA (Group III) the remaining volume was 49.4.
3. The removal efficacy of normal saline (Group I) was least, the remaining volume was 53.9%.

3.1 Tables and Figures



Graph 1: Percentage volume of TAP after irrigation

Discussion

The design of current study is similar to that described by Raghu R *et al.* and well suited to evaluate removal of TAP from roots canals and volume of remaining material was analyzed using CBCT [5]. The advantage of this method was it analyzed the volume of material in each specimen.

Previous studies showed that TAP could be used clinically in the treatment of teeth with periradicular lesions and as part of endodontic regeneration technique due to its good antimicrobial and biocompatible properties [11].

Triple antibiotic paste should be removed from the canal before the final procedures because

- Interfere penetration of sealers into dentinal tubules [5]
- Ruparel *et al.* stated that TAP had detrimental effect on human stem cells in the apical papilla when it was used in regenerative treatment [12].
- Minocycline cause tooth discoloration [11]

Various methods are used to measure TAP remnants after the removal of from the root canal. These techniques require longitudinal sectioning of the tooth and digital imaging to measure the surface area covered by TAP. Many authors used scanning electron microscopy for evaluation [13, 14]. The disadvantage of these techniques is that they analyze surface area covered with TAP, not the volume and require sectioning

of tooth which may cause loss of material and may influence the results. In the present study, CBCT was used for the calculation of remaining TAP as this technique not only enables volumetric analysis but also no sectioning is required and therefore no loss of material [15].

The finding of current study showed that it is difficult to completely remove TAP from the root canals. Berkhoff *et al*. [16] stated that TAP was not completely removed from the root canal system and this may be due to

- Apparent high diffusion and binding of TAP to dentinal wall.
- Minocycline in TAP binds to calcium ions via chelation to form an insoluble complex in the tooth.

When type of irrigant is considered, 0.5% peracetic acid showed better removal efficacy compared to other groups. Sagsen *et al*. [17] evaluated the effect of peracetic acid on removing calcium hydroxide from the root canals and concluded that 1% of peracetic acid was superior for removal of calcium hydroxide from canals. This may be due to its ability to release free oxygen and hydroxyl radicals when it decomposes into oxygen and acetic acid. This acetic acid is responsible for the inorganic material dissolution and capable of removing insoluble complex of TAP from root canals [18].

In present study, sonic activation was used to enhance the removal of TAP from the root canals. Akman *et al*. [19] compared the efficacy of conventional syringe technique and irrigation activation regimens in the removal of modified triple antibiotic paste from root canal walls and concluded that the use of irrigation activation regimens significantly improves the removal of modified triple antibiotic paste from root canals when compared with conventional irrigation.

The possible explanation is that the oscillation amplitude of the sonically activated irrigation needle is higher at the tip than at the attached end resulting in increased fluid velocity at that point. Hence it creates turbulent waves of irrigating solution which allow the irrigants to penetrate more easily into all regions of root canal space [20].

4. Conclusions

Within the limitation of this study it can be concluded that

- None of experimental irrigating solutions was able to completely remove triple antibiotic paste from root canals.
- 0.5% peracetic acid showed better removal efficacy while normal saline was less effective.

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