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RESEARCH ARTICLE

AN INVITRO EVALUATION OF APICAL SEALING ABILITY IN TEETH TREATED WITH TWO DEMINERALIZING AGENTS AND RETROFILLED WITH MTA PLUS

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ABSTRACT

Aim: Comparative evaluation of effect of two demineralising agents on the apical microleakage in root end cavities filled with MTA Plus. **Materials and Method**: Forty five single rooted teeth were selected and biomechanical preparation was done upto F2 Protaper. Root canals were obturated with AH Plus sealer and Guttapercha. Access cavities were sealed with GIC. Apical root-resection was then performed by removing 3mm of the apex at 90° to the long axis of the root with a straight fissure bur. Root-end cavities were prepared using diamond fissure bur upto 3mm. The teeth were randomly allotted into three groups of 15 each. **Group A:** root-end cavities demineralized with citric acid 10% (1 min). **Group B:** root-end cavities demineralized with 17% EDTA (1 min). **Group C:** root-end cavities with no demineralizing agent (Control Group). All the groups were retro filled with MTA Plus. The samples were then stored in 100% humidity for 24-hours and coated with nail varnish except the resected root end. After drying, they were immersed in methylene blue dye for 24-hours. The teeth were sectioned and examined under stereomicroscope. **Results**: Control group with no demineralizing agent showed least mean microleakage (0.166±0.040mm) and group demineralised with 17% EDTA showed highest mean microleakage (0.210±0.16mm) **Conclusion :** Removal of smear layer increases dentin permeability, facilitating bacterial penetration, hence it can be concluded that application of demineralising agents during apical surgery **cannot** be recommended.

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INTRODUCTION

The primary goal of the endodontic therapy is to provide fluid tight seal of all portals of communication between the root canal space and periradicular tissue (Torabinejad *et al*., 1993). The preferred treatment of failing endodontic cases is nonsurgical retreatment. However, it is not feasible to carry out a retreatment procedure in all clinical situations. This might be due to the anatomical variations of the root canal system, procedural errors such as inadequate instrumentation, separated instruments or presence of extensive restorations, post and core etc (Bergenholtz *et al*., 1979). When nonsurgical endodontic treatment is not successful, surgical endodontic therapy is indicated which involves exposure of the root apex, resection of the apical end of the root, root-end preparation, and insertion of a root-end filling material (Girish, 2013). Root end resection is a significant step in apical surgery which aids in removing the pathologic process, anatomical variations and to gain access to the root canal system.

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The aim of placing a root end filling material following root□end resection is to establish an effective barrier between the root canal system and the periapical tissues (Valois, 2004) It has been demonstrated that insufficient apical seal is a one of the major causes of endodontic surgical failure (Kim, 2006). Smear layer is produced during instrumentation of the root end surface during apical surgery using either manual, rotary or ultrasonic, which consists of organic and inorganic material including bacteria and its byproducts (Sen, 1995). It has been reported that application of chelating agents and acids, removes smear layer thereby improving the adhesion and penetration of root□end filling materials. This makes the root surface more biocompatible, optimizes periodontal healing and provides an effective apical root end seal (Peters, 1992). On the other hand, smear layer removal can increase dentin permeability, allowing penetration of bacteria from the periapical region and secondary infection of dentinal tubules if the sealing fails (Sen, 1995). EDTA is the most commonly used demineralising and chelating agent in Endodontics. It has been reported to remove the smear layer in less than one minute owing to its rapid phosphorous releasing effect (Parmar, 2004). However, 17% EDTA is not efficient in removal of smear layer especially in the apical third of the root

canal system (Ballal *et al*., 2009). Citric acid is a biological and organic acid, that has been studied for its decalcifying and cleansing action. It has been reported that that 1% citric acid at pH 1.0 was the best solution to remove calcium from the root dentin (Sousa, 2005). The purpose of this study was to compare and evaluate the effect of two demineralising agents (EDTA17% and Citric acid10%) on the apical microleakage in root end cavities filled with MTA Plus

MATERIALS AND METHODS

Forty-five single rooted teeth were selected and decoronated. Working length was determined and biomechanical preparation of the root canals was done up to size F2 ProTaper system. Root canals were obturated with AH Plus sealer and Guttapercha. Access cavities were sealed with Glass ionomer cement. Apical root-resection was then performed by removing 3mm of the apex at 90° to the long axis of the root with a straight fissure bur with high speed handpiece and water coolant. Root-end cavities were prepared using diamond fissure bur upto a depth of 3mm. The teeth were randomly allotted into three groups of 15 each.

Group A: root end demineralized with citric10% citric acid (1 min).

Group B: root-end cavities demineralized with 17% EDTA (1 min).

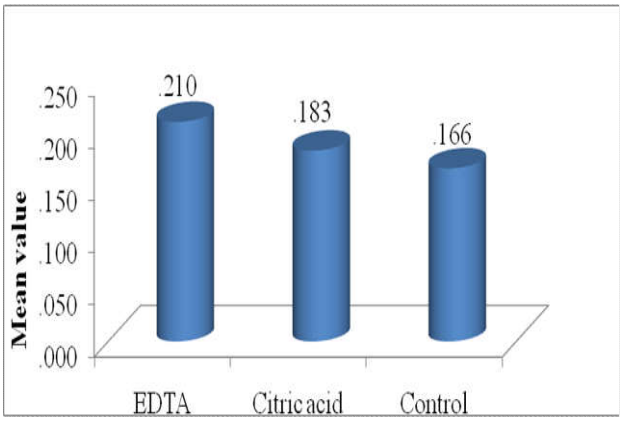
Group C: root-end cavities with no demineralizing agent (Control Group).

All the groups were retro filled with MTA Plus and allowed to set. The samples were then stored in 100% humidity for 24-hours and coated with nail varnish except the resected root end. After drying, they were immersed in methylene blue dye for 24-hours. The teeth were sectioned into two halves longitudinally and examined under stereomicroscope. Digital images were viewed in the computer monitor using Motic Plus 2.0 software

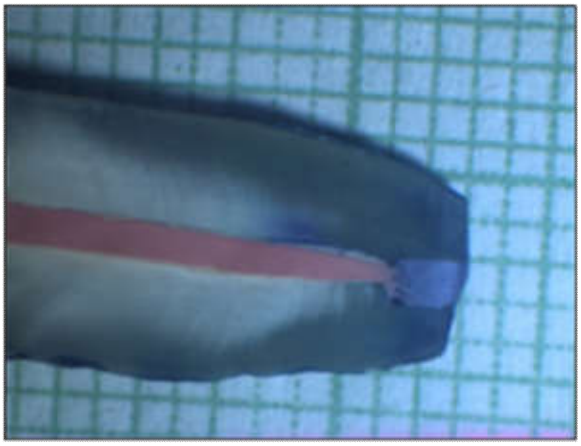
RESULTS

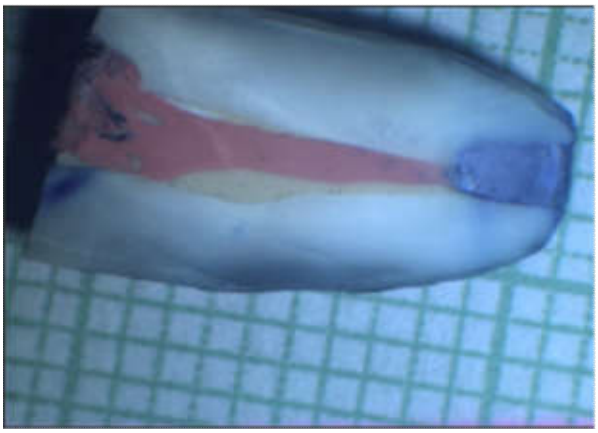
Control group with no demineralizing agent showed least mean microleakage (0.166±0.040mm) and group demineralised with 17% EDTA showed highest mean microleakage (0.210±0.16mm)

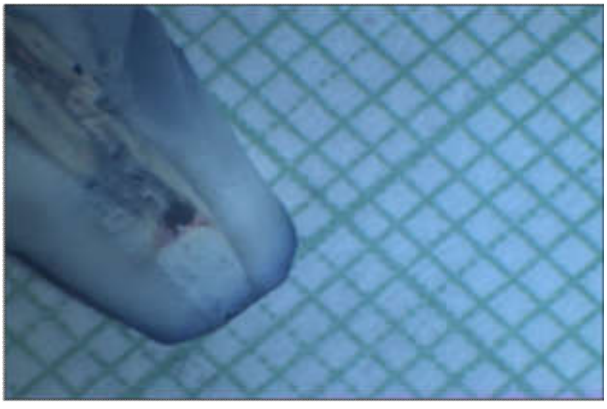
Table 1. Graph for Comparison of mean Microleakage



Multiple Comparisons			
Dependent Variable Microleakage			
Tukey Hsd			
Group(I)	**Group (J)**	**Mean Difference(I-J)**	**P**
Citric acid	Control group	0.17	0.296
Control group	EDTA	0.45	0.001vhs
Citric acid	EDTA	0.27	0.05 sig







Figures 1, 2, 3. Motic plus 2.0 stereomicroscopic images of group 1,2,3

DISCUSSION

In periradicular surgery, root-end cavity preparation followed by appropriate retrograde filling is necessary to prevent microleakage of irritants into the root canal system (Winik *et al*., 2006). A well-adapted apical root end filling material in a properly prepared cavity is a vital factor in the success of surgical endodontic procedure (Karlovic *et al*., 2005).

The root end bevel given in this study was a short bevel, ie. root end resection performed perpendicular to the long axis of the root. This has the advantages of conservation of the root length, shorter cavosurface margin and less exposure of dentinal tubules. Mechanically manipulated dentin surfaces are always covered with the smear layer, a loosely bonded amorphous layer of organic and inorganic debris (Sousa, 2005). It can be disintegrated or dissolved by soluble products from bacterial metabolism, such as acids or saliva, causing formation of a gap between the filling material and the root canal walls (Kubo, 2005). It has been reported that the application of demineralizing acids or chelating agents remove smear layer, expose the underlying radicular collagen fibrils, funneling dentin tubules, modifying dentin permeability and restoring the biocompatibility of the root end (Crigger, 1983). In this study, the smear layer of root-end cavities was removed in 2 groups using 17% EDTA and 10% citric acid. Ethylene diamine tetra acetic acid (EDTA) is most commonly used for the smear layer removal. However, it has been reported that 17% EDTA is not efficient in removal of smear layer especially in the apical third of the root canal system. It has also been reported to be cytotoxic (Chhaparwal *et al*., 2017). In the present study, the irrigation time was set to 1 min because irrigation with 17% EDTA for more than 1 min has shown to cause excessive peritubular and intertubular dentinal erosion (Calt, 2002). Gagliani *et al* reported that the extension of leakage on marginal interface of apical retrofils assessed with 0.5% fuchsin after application of 17% EDTA buffered solution on the sectioned surface, was never greater than 2.4 mm (Gagliani, 1998). However, in the present study, the application of 17% EDTA (Group 2) on root-end cavities and resected apical surface yielded greater leakage of the methylene blue dye. These findings confirm the hypothesis that the demineralizing agents remove smear layer and possibly produce changes in dentin surface permeability and can facilitate bacterial penetration.

Citric acid is another commonly used demineralising agent, an organic acid with sufficient tissue compatibility (Scelza, 2003). Souza *et al* showed that 1% citric acid at pH 1.0 proved to be the most effective solution for root dentin Ca^{2+} extraction (Sousa, 2005). However, Peters *et al* observed that the use of 1% citric acid did not affect retrograde sealing (Peters *et al*., 1992). Craig and Harrison reported that Citric acid used to demineralise root ends resulted in more rapid and complete healing than the non-demineralized. They proposed that demineralization using citric acid enhances cementogenesis by removing the smear layer and exposing the collagen fibrils. Exposure of collagen promotes early adherence of fibrin, fibronectin and reparative cells to the resected root surfaces. They concluded that demineralization enhances cementogenesis which is the key for dentoalveolar healing, by removing smear layer barrier and exposing collagen component of resected cementum and dentin (Craig, 1993). In the present study, citric acid demineralization showed lesser mean microleakage compared to that of EDTA 17%. This depicts that the demineralising action of citric acid 10% is optimum for better adhesion of root end filling material and effective apical seal than that of EDTA 17%. Wu *et al* used a fluid transport model, did not remove the smear layer from the root sections before obturation with MTA. They reported that further hydration of MTA powder by moisture, resulted in an increase in compressive strength and decrease in microleakage (Wu *et al*., 1998). A study by Kubo *et al*, evaluated the effect of demineralising agents, phosphoric acid, EDTA 17% and 24% and concluded that least mean microleakage was observed when no demineralising agent was used[13]. A similar finding was observed in the present study, wherein the group (control group) with no demineralising agent showed least mean microleakage. Dye penetration is often used for leakage studies because dyes are relatively easy to be stored, applied and to have their penetration assessed quantitatively (Tanomaru Filho, 2005). Moreover, if a filling material does not allow penetration of small molecules such as dyes, it is likely that it has potential to prevent leakage of larger molecules, such as bacteria and their byproducts (Youngson, 1998). One of the pre-requisites for the success of surgical endodontics relies on selection of root end filing material having beneficial properties such as biocompatibility, good strength, optimum sealing ability, optimum periodontal healing, radiopacity, easy manipulation and should not get affected by the presence of moisture. MTA Plus was used in the present study as it has a final setting time significantly shorter than ProRoot MTA (55 min vs. 165 min) (Siboni, 2017). According to Gandolfi *et al*, MTA Plus showed improved reactivity and prolonged capability to release calcium ions compared to ProRoot MTA (Gandolfi *et al*., 2014). MTA Plus was chosen for this study considering its availability, lower setting time compared to that of ProRoot MTA.

Conclusion

Within the limitations of this study, it can be concluded that citric acid (10% for 1 min) is a better demineralizing agent than EDTA (17% for 1 min), however, use of demineralising agents is not recommended for predictable and successful outcome in periradicular surgeries. Removal of smear layer increases dentin permeability, facilitating bacterial penetration, hence it can be concluded that application of demineralising agents during apical surgery is not recommended.

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