Comparative Evaluation of Demineralization of Radicular Dentin with 17% EDTA, 7% Maleic Acid and 10% Citric Acid at Different Time Intervals

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Abstract

Introduction

Various acids and chelating agents are used to remove the smear layer, biofilm and infected radicular dentinal surface adjacent to root canals during the root canal therapy. Hence the present study was undertaken to estimate and compare the phosphorus release by 17% EDTA, 7% maleic acid and 10% citric acid when used as final irrigants, from radicular dentin at different time intervals.

Materials and Methods

Access cavities were prepared on 65 no. extracted single rooted teeth and canals were instrumented by step back technique up to # 60-size K file. The teeth treated with experimental solutions and phosphorus release was evaluated at every 1 min, 5 min, 10 min and 15 mins., using automated random access biochemistry Analyzer. Results were analyzed using descriptive, intergroup and intragroup analysis were done by Tukey HSD test, Bonferroni test and Anova test.

Results

Throughout the experiment, maleic acid showed maximum phosphorus liberation, highest at 15 mins. Interval (54.400mg/dl) followed by citric acid (53.480mg/dl) and then EDTA (51.514mg/dl). Citric acid was more effective than EDTA after 10 mins. All solutions showed increase in phosphorus liberation as time period increased with minimum at 1 min. and maximum phosphorus liberation was at 15 mins. Interval.

Conclusion

The present study concluded that 7% Maleic acid is a best solution to remove smear layer, biofilm and infected radicular dentin by showing maximum phosphorous release followed by 10% Citric acid and 17% EDTA at 1min, 5 mins,10mins, and 15 mins.

Introduction

Thorough debridement and disinfection are the main essential parts of root canal therapy to control microbes causing pathology. According to Grossman, chemomechanical preparation is most important step in root canal therapy. Organic contents, infected dentinal debris, smear layer and dead pulp tissue which are nidus for bacterial growth are cleared off from the root canal through mechanical instrumentation, chemical irrigation and irrigants. The chemomechanical preparation of root canal represents one of the most important phases of therapy. Smear layer of 1-2 µm. thickness, composed of organic, inorganic material is produced in the root canal

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Objectives of the study were:
1) To determine the demineralizing effect of 17% EDTA, 7% maleic acid, 10% citric acid by evaluating the phosphorous liberation at 1 minute, 5 minutes, 10 minutes, 15 minutes, using saline as a control.

2) To compare the demineralizing effect of experimental irrigating solutions by comparing the amount of phosphorous released at different time intervals.

Methodology

A total 65 number of extracted single rooted human caries free, intact anterior teeth and premolars during instrumentation [1]. This smear layer contains bacteria and creates a source for bacterial growth and ingress. Smear layer also creates a barrier for antimicrobial agents (intracanal medicaments) from gaining entry to the core of the contaminated dentinal tubules, prevents adhesion of gutta-percha and sealer to the root canal walls [2]. Hence smear layer removal is critical for successful root canal therapy. Haapasalo et al. suggested that removal of the smear layer condensated in the dentinal tubules (smear plugs) allows both intracanal medicaments to infiltrate the dentinal tubules for better disinfection and a better adherence and penetration of sealer into the dentinal tubules preventing apical/coronal microleakage [3, 4]. Mc Comb and Smith confirmed that the smear layer is loosely adhered to the root canal wall while other recent studies have showed that the smear layer is adhered strongly to dentine making it difficult to remove [5]. Because of complex chemical composition of smear layer, it is obvious that only irrigants which contain both organic and inorganic solvents can effectively and totally remove smear layers [6].

Irrigation of the root canal is responsible for cleaning and flushing out of the dentinal debris that adheres to the root canal wall after instrumentation. Since no single irrigant can remove both inorganic and organic material simultaneously, a combination of irrigants is required to remove both the matters by flushing action as well as their chemical effect [7]. EDTA has been used as an effective chelating agent in endodontics. But it has shown to etch radicular dentin if it remains longer than 15 mins in the canal [8]. Removal of smear layer by maleic acid and citric acid from the surface of the root canal wall also has been viewed as success. Hence the present study was undertaken to compare the effect of 17% EDTA, 7% maleic acid and 10% Citric acid by estimating phosphorus release from radicular dentin at different time intervals.

throughout the instrumentation, irrigation was accomplished by using 2ml of 3% NaOCl solution using 27 gauge needle and 2ml syringe. After instrumentation, teeth were decoronated using a carbondum disc and longitudinally using carborundum disc and the length of the roots were standardized for 17mm length. The width of all the roots were kept to the same dimension. 2 coats of nail varnish were applied on the outer surface of all teeth. The pre and post treatment pH of all the solutions were recorded using a pH meter. After this the teeth were treated with 2ml of experimental solutions of 7% maleic acid, 17% EDTA and 10% citric acid by spreading the irrigants uniformly over the canal walls and leave the solutions for 1, 5, 10 minutes and 15 minutes. The amount of phosphorus released was measured with the help of “Automated Random Access Biochemistry Analyzer” (Figure 1).

Data were tabulated and statistical analysis was done using Tukey test and Mann Whitney test, Bonferroni
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tests were done for intergroup and intragroup comparison.

Figure 1: Showing test solution vials random auto-analyzer

Graph 1: Showing mean radicular demineralisation of different irrigants solutions at different time intervals

Results

Descriptive statistics shows maximum liberation of phosphorus by 7% maleic acid at all time intervals i.e. At 1min, 5mins,10 mins and 15 mins with statistically very highly significant difference with all the other irrigants except with EDTA at 1 min (p<0.001) (Graph 1). Throughout the experiment maleic acid showed maximum phosphorus liberation followed by EDTA and then citric acid. Only at 15 mins citric acid showed more phosphorus liberation than EDTA. Saline showed no phosphorus liberation throughout the study.

Intergroup comparison was done using Tukey’s HSD test and showed no statistically significant difference between maleic acid and EDTA at 1 min. But at other time intervals, there is significant difference between all the irrigants (Table 1). Multiple comparisons by Bonferroni test indicated statistically significant difference between different time intervals too, within each group with mean difference lowest at 15 mins followed by 10 mins and then at 5mins and 1 min. Saline which is used as control showed no phosphorous liberation at all time intervals.

Discussion

The most important phase in root canal therapy is to eliminate microorganisms and diseased tissue present in the root canal along with infected dentinal tubules and prevent re infection of root canal system postoperatively. During instrumentation of the canal smear layer is created...
which contain bacteria and may help in the aggregation of microorganisms into the root canal walls. Hence, it is necessary to remove this smear layer to prevent infection of root canals and allow easy penetration of intracanal medicament into the dentinal tubules. For completely disinfecting the root canal system, along with the dentinal tubules, the irrigating solutions must be able to infiltrate entire anatomy of the root canal system. The process of radicular superficial layer demineralization is important in endodontics by reducing the microhardness to remove smear layer, biofilm and infected dentin. Sodium hypochlorite has been advocated as an effective antimicrobial agent which can dissolve organic pulpal tissue, but is ineffective in removing the smear layer. To remove inorganic materials such as chelating agents have been used as irrigants. 7% EDTA is widely used chelating agent in endodontics. According to Lora Mishra et al. 17% EDTA is effective in removing the calcium from root canal dentin but causes decrease in the microhardness of root dentin. The 10% citric acid solutions with a pH of 1.8 are also effective in removal of smear layer [10]. According to previous authors decalcifying effect of 15% EDTA and 15% citric acid showed similar decalcifying effect on radicular dentin. They had conducted the study on root canal dentin and evaluated the amount of calcium extracted from dentin samples using atomic absorption spectrophotometry [11]. Ballal et al. confirmed that using final irrigation with 7% maleic acid for 1 min was more efficient than using 17% EDTA in the removal of smear layer from the apical third of the root canal system [8]. Hence in the present study, three decalcifying agents, i.e 10% citric acid, 17% EDTA and 7% Maleic acid were used. Previous studies have shown that 3-5 mins of irrigation with chelating agents and acids are sufficient to bring decalcification of radicular dentin. The maximum decalcifying effect was seen at 15minutes [8]. Hence time duration to check decalcification were chosen in present study were 5 mins, 10mins and 15 mins.

During root canal therapy the use of chelating agents has been evaluated with different methods. During this study the liberated phosphorous released was evaluated by using “Automated Random Access Biochemistry Analyzer”, a machine that can be used to evaluate different variables in the same sample at the same time. 1200 tests can be performed in a given period of time. The auto analyser has a computer attached to it in, displaying the results within 25 minutes. With all these advantages of auto analyser it was chosen in our study to give quick results.

Results of the present study showed maximum demineralization of radicular dentin by 7% Maleic acid with statistically very highly significant result by more liberation of phosphorous compared to 10% Citric acid and 17% EDTA. This could be because of very low pH (1.8) of maleic acid. Similar results were found by Ballal et al. which is in agreement with the present study [12]. 10% Citric acid showed better results than 17% EDTA, but phosphorous liberation was lesser than 10 percent maleic acid. This could be because of the pH of citric acid (2.2) which is more than the pH of maleic acid. Moreover, maleic acid showed faster action compared to EDTA and citric acid.

According to Roli Bhatnagar et al. citric acid is better demineralizing agent than EDTA, which is in agreement with the present study [13]. As the pH decreases the demineralization effect increases. Hence in the present study maleic acid was better than citric acid and EDTA with more demineralization effect at all time intervals. Citric acid showed better results than EDTA at 10and 15 mins, but at 1and 5 mins it showed lesser demineralization than EDTA. This could be because of 17% EDTA may lose its potency on dentin because of buffering capacity of dentin, where as citric acid may have maintained its pH throughout the 15 mins duration. According to Nathalia Amaral et al. Citric acid was better demineralizing agent as compared to EDTA [14]. Hence from the results of the present study it can be concluded that 7% maleic acid is the best demineralizing agent among the experimental irrigants with maintaining its effect up to 15 mins.17% EDTA showed lesser demineralizing effect than maleic acid throughout the study duration but better than 10% citric acid in first 5 mins. Citric acid gains it potency after 5 mins and showed better effect than EDTA. Future studies are required using scanning electron microscopy to prove these results and to study the post irrigation effect of these irrigants on ultrastructure of radicular dentin. Effect of these irrigants on eradication of endodontic biofilms also could be studied.

From the results of the present study ,it can be concluded that, 7% Maleic acid can be used as a demineralizing agent alternate to 10% Citric acid and 17% EDTA, during the instrumentation of root can system.

7% maleic acid can be recommended as demineralizing agent alternate to 17% EDTA and 10% citric acid, during the instrumentation of the root canal therapy.
References


