Assessment of Cleaning Effect of Irrigation Time Using 5.25% Sodium Hypochlorite and Aspiration with Endovac

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The aim of this study is to determine whether there is a link between the 5.25% sodium hypochlorite irrigation time using Endovac and the endodontic space cleaning quality. The study was done on teeth with a root length of more than 12 mm that did not undergo previous endodontic treatments and had a closed apex. All roots where mechanically prepared and the irrigation protocol was applied acording to the established protocol. The root canal surface was explored by electronic microscopy. A score was given to each image regarding remaining debris and smear layer. The comparative analysis of experimental data shows, that there are no statistically significant differences between the study groups regarding debris and smear layer removal. None of the techniques used in the present study has led to the complete removal of dentinal detritus and root smear layer.

Keywords: Irrigation, EndoVac, Organic Detritus

The purpose of the endodontic treatment is to eliminate any microorganisms that might reside in the endodontic system, using mechanical and chemical procedures and to ensure the health of the periapical tissues. The long-term success of the endodontic treatment depends on the proper cleaning of the endodontic space after mechanical instrumentation, its three-dimensional closure and the provision of crown sealing. Complex root anatomy determines the difficulty of this treatment. The endodontic space has, alongside the root canal, accessory channels, lateral channels, dentinal tubules, apical delta, and is now called an endodontic system [1-4].

Regardless of the method used (manual or rotary) to configure a suitable form for cleaning and obturation, about 25-35% of the endodontic system remains uncleaned [5]. The purpose of the irrigants used in endodontics is to dissolve the pulp debris, to wash the dentinal debris and to disinfect the endodontic space. So far, the ideal irrigation has not been found to meet the criteria mentioned above. The irrigation method currently uses NaOCL (sodium hypochlorite) and EDTA ethylenediaminetetraacetic acid [6-10].

Sodium hypochlorite is the preferred irrigant in endodontic therapy, because it has a high antibacterial effect as well as the ability to dissolve organic residues, but the disadvantage of sodium hypochlorite is represented by its rapid inactivation, therefore the necessity to constantly renew it during irrigation. In other words, effective irrigation requires a large quantity of hypochlorite and a determined length of time to dissolve organic tissues. NaOCl does not have the ability to remove the smear layer that is formed during mechanical instrumentation [11-13]. EDTA on the other hand, has the ability to dissolve the smear layer, open the dentinal tubules to ensure a better penetration of sodium hypochlorite and a better adaptation of the root canal filling [8].

Although this method is widespread in clinical practice, it has a number of drawbacks, mainly because it fails to completely remove the detritus located in the endodontic space, which has an irregular structure. For this reason, improved alternative irrigation methods have been developed [14].

One such method is using negative apical pressure, achieved by using the EndoVac irrigation system created by Schaeffer. The EndoVac system avoids the vapor lock phenomenon, which appears in the apical third of the root canal, thus guaranteeing superior irrigation compared to other irrigation systems. The vapor lock phenomenon appears when a pocket of air remains present after advancing a liquid into an enclosed tube. Often, the root canal acts like a closed tube at the tip of which, an air bubble remains [9].

The EndoVac microcannula is capable, due to its small size (tip diameter 0.32mm), to reach the apical foramen and provide a continuous irrigation flow in this critical area. On the last portion (less than 1 mm), the microcannula has twelve holes, through which the irrigant is being aspirated. Currently, studies show that the irrigant is able to reach 1.5 to 2 mm further than the needle lumen used to irrigate. So, the needles currently available, despite the improved design, do not solve the problem of delivering the irrigant close to the apical foramen. Specialized literature does not show consensus on the time required to irrigate a root canal. Buchanan [15] (2009) and Retamozo [16] (2010) specify time ranges ranging from 2 to 40 min. The goal of this study was to compare any differences that may occur in the elimination of dentinal debris and smear-layer when using the EndoVac irrigation device at different irrigation times.

Experimental part

The chosen work protocol uses the negative apical irrigation technique with EndoVac, (Sybron Endo). The following substances were used for irrigation: physiological saline (saline 0.9%), NaOCl 5.25% and EDTA liq 17%. The apical root diameter was set at 40 to allow a steady flow of irrigant to the apical third.[17] The irrigation times after the mechanical preparation of the channels were set at 5 and 10 min.

The study was done on teeth with a root length of more than 12 mm that did not undergo previous endodontic treatments and had a closed apex. Teeth with massive fillings, root caries, root fractures, immature apex and a root length less than 11 mm were excluded. After extraction, the teeth were kept in physiological saline.

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All cleaning and irrigation procedures were performed by the same operator. The crown has been cut to create a smooth surface to serve as a benchmark for working length. The crown portion of the root canal was enlarged using Gates-Gliden burs # 1, 2 and 3 (Dentsply). The working length was set with a Kerr steel file #10 (Mani) inserted into the root canal until it was visible at the level of the root apex and then retracted 1 mm. To simulate the apical closed endodontic space, specimens were sealed at the apex with hot glue and then inserted in silicone (Putty Soft Normal Set, Elite HD+, Zhermack).

The glide path was done with Path File # 1, 2 and 3 (Dentsply Maillefer, Balaygues, Switzerland). The root canals were prepared following the Crown-Down technique with Protaper Next files (DentsplySirona Endodontics, Switzerland). A mechanical preparation up to a diameter of 40 was carried out (Protaper Next X4 file). After the use of each rotating instrument, the permeability of the channel and apex was checked with a K-file #10.

Irrigation was performed after each instrument that was inserted into the channel. The irrigation solution was delivered at the crown level with a syringe and a 30 gauge needle. The batches were irrigated with 3 mL of 5.25% sodium hypochlorite solution (Cerkamed, Poland). The excess irrigation solution used during preparation was aspirated from the pulp chamber with Endovac Master Delivery Tip and Macrocanula (SybronEndo, Kerr Italia SRL, Italy).

After the root canal shaping procedure all the teeth were irrigated with 5.25% sodium hypochlorite solution with Endovac Macrocanula inserted up to 5 mm to the apex. The prepared teeth were randomly allocated in two groups, G1 being the group that will undergo a final irrigation of a total of 5 min with NaOCL 5.25% respectively G2 the group that will undergo a final irrigation of a total of 10 min with NaOCL 5.25% The final irrigation protocol in presented in table 1.

After irrigation, two longitudinal grooves were made on each tooth, using a cylindrical diamond bur and were split lengthwise with a chisel. The root halves were kept in artificial saliva (Aristal, France) and were examined under the electronic microscope.

The presence of dentinal detritus was checked, by assigning a qualitative score, after the digital images were examined by two observers, at a magnification from 50x to 709X, at the apical part of the root canal. Designated scores ranged from 1 to 4.

The smear layer was observed by assigning a qualitative score, following the examination of digital images, with a 1000X magnification and 5000X from the apical part of the root canal, by two observers. The designated scores ranged from 1 to 4.

Details of the image classification are shown in the table 2. For each sample, the value used in the study represents the average score awarded by the two examiners.

The data obtained was considered as *ordinal*. The statistical examination was carried out with the Wilcoxon statistical tests. Data analysis was done using SPSS 21 software (IBM Corp, United States).

Null hypothesis:

Remaining dentinal detritus:

-The irrigation time with NaOCl (5 versus 10 min) will have no influence on the amount of the remaining dentinal detritus.

Smear layer:

-The final irrigation time with NaOCl (5 versus 10 min) will have no influence on the amount of the remaining smear layer.

Solution/instrument/time	G1 (**5 min** NaOCL 5.25%)	G2 (**10 min** NaOCL 5.25%)
NaOCL 5.25% Macrocanula 1 min	5mm to apex	5mm to apex
NaOCL 5.25% Microcanula	Up to lenght **4 min**	Up to lenght **9 min**
Saline 3 ml Microcanula 1 min	Up to lenght	Up to lenght
EDTA liq. 17% Microcanula 1 min	Up to lenght	Up to lenght
Saline 3 ml Microcanula 1 min	Up to lenght	Up to lenght
NaOCL 5.25% Microcanula 1 min	Up to lenght	Up to lenght

Table 1
THE IRRIGATION PROTOCOL FOR THE STUDY GROUPS USING SODIUM HYPOCHLORITE

Noted	Dentinal Detritus	Smear layer
1	little or no dentinal detritus which covers up to 25% of the specimen's surface.	Smear layer which covers up to 25% of the specimen's surface, visible and patent dentinal tubules
2	little to moderate dentinal detritus which covers between 25% and 50% of the specimen's surface.	Smear layer which covers between 25% and 50% of the specimen's surface, most of the dentinal tubules are visibile and patent
3	moderate to heavy dentinal detritus which covers between 50% and 75% of the specimen's surface.	Smear layer which covers between 50% and 75% of the specimen's surface, few or no dental tubules are visible and patent
4	heavy amounts of dentinal detritus which covers over 75% of the specimen's surface.	Smear layer which covers over 75% of the specimen's surface, no tubule orifices visible and patent

Table 2
IMAGE CLASSIFICATION CRITERIA FOR DENTINAL DETRITUS AND SMEAR LAYER

Results and discussions

Remaining dentinal detritus

Comparing the examination results obtained for the remaining dentinal detritus samples, no significant differences were observed. Wilcoxon Signed Ranks Test has a Z value of -1.342, Asymp. Sig. (2-tailed) p=0.180.

The data obtained in our study shows, that any of the NaOCl irrigation protocols used, were able to remove the debris inside the root canal to an extent of over 50%. It can be noticed that more than 60% of the cases show detritus on less than 25% of the surface.

Smear Layer

Comparing the examination results obtained for the smear layer no significant differences were found. Wilcoxon Signed Ranks Test has a Z value of -1.672, Asymp. Sig. (2-tailed) p=0.095.

As a consequence of the obtained results, we assume that the null hypotheses No. 1 and 2, which claim that there are no differences between the experimental groups, are confirmed and consequently the technique of irrigating the root canal using Endovac has no influence on the amount of remaining dentinal detritus and the amount of smear layer.

Irrigation of the endodontic system, by conventional methods, includes the risk of extrusion in the periapical region, of sodium hypochlorite, which can lead to necrosis of the tissues. We chose to use a concentration of 5.25% sodium hypochlorite in the present study, because other studies [18- 20] show that high concentration is more effective in neutralizing microorganisms at endodontic level.

In articles related to endodontic irrigation, the intervals, temperatures and concentrations of the irrigant are very different. To achieve adequate disinfection of the endodontic system, different studies have been conducted using various concentrations of sodium hypochlorite (1.3%, 2.5%, 5.25%) [18, 19, 21-24]. Other studies compared different temperatures (between 25 degrees Celsius and 75 degrees) and different irrigation ranges (from 1 min to 40 min) [15, 16, 24- 27].

Until now, there has been no consensus on the minimum and optimal irrigation time required to obtain proper disinfection of the endodontic system. Retamozo et al.[16] (2010) shows in his study that, 40 min of irrigation are required to remove the Enterococcus Faecalis. Its results are consistent with those obtained by Siqueira et al.[23] (2000). On the other hand, these long irrigation intervals are not feasible in clinical practice. In another study by Turker et al.[24] (2015) it was shown that the root canal disinfection was equally effective at the irrigation intervals of 1 min and 5 min. Kamran et al.[26] (2014), showed that a minimum of 5 min of irrigation was required to remove C. Albicans, while Ruff et al.[28] (2006) sustained that 1 minute of NaOCl irrigation at 6% concentration, was effective in eliminating C. Albicans.

EndoVac's ability to remove the smear layer has been investigated in several studies. However, the EndoVac system has proven to be more effective in removing smear layer and dentinal detritus than manual dynamic irrigation [29-35].

An interesting feature obtained from the study is that, of the dentinal resorption appearance. This aspect may occur due to the prolonged contact of EDTA with intracanalicular dentine due to the small diameter of the channel which makes it difficult to be washed.

SEM allows an increased view of the root canal walls, an assessment of the persistence of the dentinal detritus and the removal of the smear-layer. However, the evaluation method is subjective, because it is based on the qualitative comparison of the presence of open dentinal tubules according to Lottani et al. [36] (2009).

Conclusions

The EndoVac system has been shown to be effective in removing dentinal root canal debris and we have not found significant differences between the irrigation range of 5 minutes and that of 10 min.

However, none of the techniques used in the present study have led to the complete removal of dentinal detritus and root smear layer.

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