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Efficiency of Calcium Hydroxide Removal from Single Rooted Teeth with Single Canal Using EndoActivator and PATS Vario: An Invitro Study

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Abstract: ***Objective: The aim of this in vitro study was to compare the effectiveness of EndoActivator and PATS Vario (ProAgitator tip system with variable frequency) in removal of oil-based Calcium Hydroxide (Metapex) from root canal of single rooted teeth under Stereomicroscope. Materials and Methods: Twenty extracted single rooted teeth with single canal were selected and root canal preparation was done using Herogold rotary file system upto 30/0.04 using NaOCl, EDTA and Normal Saline. In the prepared root canal, Metapex was placed. For removal of Metapex, the specimens were randomly divided into 2 groups; Group 1: EndoActivator and Group 2: PATS Vario. After removal of Metapex specimens were sectioned buccolingually and every third of the root was evaluated under stereomicroscope at 40x magnification to analyse amount of remaining Metapex in each segment. Data were analysed by using Friedmann test and Mann Whitney U test. Results: No statistically significant difference was observed in the efficacy of EndoActivator and PATS Vario for removal of Metapex at cervical (P = 0.47), middle (P = 0.96) and apical (P = 0.79) part of the root canals. Conclusion: It can be concluded that both the techniques were equally effective in removing Metapex from the root canals.***

Keywords: Calcium hydroxide, EndoActivator, Irrigation, PATS Vario, Root canal

1. Introduction

The primary goal of endodontic therapy is to control the activity of microorganisms which plays a major role in the development of pulpal and periapical diseases of tooth. Cleaning and shaping of the root canals using mechanical instrumentation and various irrigating solutions greatly reduces the bacterial count in the infected canal but it is still difficult to achieve total disinfection [1,2]. However, certain bacteria lurk in the apical delta, dentinal tubules, ramifications, and isthmuses because of the intricacy of the root canal system. Intracanal medications can therefore eradicate these undetectable microorganisms [3,4]. Determining whether medication has the ability to eliminate microbes and neutralise their metabolites is crucial for choosing the best intracanal medication [5].

Calcium hydroxide ($Ca(OH)_2$) has been widely used as an intracanal medicament in cases of necrotic teeth, periapical diseases, apexification, resorption, etc.[6]. Its antibacterial activity is due to its high pH (12.5-12.8). The following mechanisms most likely account for the deadly effects of hydroxyl ions from calcium hydroxide on bacterial cells; bacterial cytoplasmic membrane damage, denaturation of proteins and DNA damage[7]. Enterococcus faecalis is one of the bacterial species that are frequently associated with endodontic failure are said to be resistant to total eradication, despite the effectiveness of Ca(OH)2 as an intracanal medication[3,8]. Metapex (Meta Dental Corp. Ltd., Elmburst, NY, USA) is a silicone oil-based Ca(OH)2 paste that contains 38% iodoform. It is advised to use it in these situations since it is more effective than calcium hydroxide alone at disinfecting dentinal tubules infected with E. faecalis [5].

Removal of $Ca(OH)_2$ medicament from the root canal is necessary before obturation as it affects the quality of root canal filling. Remnants of Ca(OH)2 will hamper the diffusion of sealer into the dentinal tubules and decrease the adhesion of sealer with dentine[1]. The most commonly employed method for removal of Ca(OH)2 from root canals is conventional syringe needle irrigation with different combinations of sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) combined with filing motion and activation with master apical file[1,9]. But this method could not completely remove the Ca(OH)2, particularly in the apical third of root canal. The stream action is weak with the use of conventional syringe needle irrigation due to the complex anatomy of the root canal. The effectiveness of the irrigation depends on the the streaming action rather than the volume of irrigation. Several studies have shown that activation of irrigants using sonics and ultrasonics improves the removal of Ca(OH)2[9].

The EndoActivator system (Dentsply Tulsa Dental Specialties, Tulsa, OK, USA) is a sonic irrigation system that consists of a portable handpiece and three types and disposable flexible polymer tips of various sizes. These polymer tips are beneficial as they do not cut the root dentin [10]. Its design allows for the safe activation and the production of vigorous intracanal fluid agitation [11].

Pro-agitator tip system with variable frequency (PATS Vario) is an airsonic device that consists of a handpiece that agitates the irrigant and polymer tips (20.03, 25.03, and 30.03) in different sizes. It has three different frequencies: low (2000

Hz), medium (4000 Hz), and high (6000 Hz). It is used for sealer application, activation of irrigants and for the removal of intracanal agents. This three-dimensional moving device offers safe sonics, effective ultrasonics, decreased tip fracture risk with enhanced irrigant acoustic streaming [12].

There are limited studies comparing the EndoActivator with PATS Vario in removing calcium hydroxide from the root canals. The aim of this in vitro study was to compare the effectiveness of EndoActivator and PATS Vario in removal of oil-based Calcium hydroxide (Metapex) from single-rooted teeth. The null hypothesis of the study was that there is no significant difference between the different techniques in the removal of intracanal calcium hydroxide.

2. Materials and Methods

Twenty freshly extracted, non-carious, intact, single rooted teeth having single canal were selected for the study. The samples were stored in 3% sodium hypochlorite solution for 2 days to remove adhered organic tissues and were cleaned off from debris and residual tissues with the help of an ultrasonic scaler.

The specimens were decoronated using a low-speed handpiece with a double-sided diamond disk and root canal length was standardized to 15 mm. The apical patency was established using #10 K-file. Working length was taken by introducing # 10 K file firstly and then with #15 K file until the tip was seen at the apex. 1 mm minus of the length of the root was determined as working length. Cleaning and shaping done was with Herogold file system (Micromega) upto 30/0.04. NaOCl, EDTA and Normal Saline were used as an irrigant. Root canals were dried with 30/0.04 paper points. Metapex was carried using Lentulo spiral and placed into the canal until the medicament was seen at the apex of the working length and confirmed with radiograph. A cotton pellet was kept inside the access cavity and temporary filling was placed. All specimens were kept for 7 days at 37°C with a relative humidity of 100%. After 1-week, temporary fillings were removed, #15 K-file was introduced into canals to loosen $Ca(OH)_2$ to create a space for irrigation.

For removal of Metapex, the specimens were randomly divided into 2 groups; Group 1: EndoActivator (n=10) and Group 2: PATS Vario (n=10)

Group 1: EndoActivator : The sonic tip no #25/02 was placed 2 mm shorter than working length. The canals are filled with 3% NaOCl, and after 60 seconds of up-down activation, the solution was irrigated with regular saline and then 3 mL of 17% EDTA for 1 minute. This cycle was performed for 2 times and canals were dried with paper points.

Group 2: PATS Vario : The PATS Vario system was used for airsonic activation, and a polymer tip sized #20/03 was affixed to the nozzle along with 3% NaOCl and activated for 60s, followed by irrigation with normal saline and then 3 mL of 17% EDTA for 1 min. This cycle was performed for 2 times and canals were dried with paper points.

After completion of removal of Metapex, each root's buccal and lingual aspects had two longitudinal grooves cut with a diamond disc, which were subsequently divided in half with a chisel. Segments were individually evaluated under stereomicroscope at 40x magnification at cervical, middle and apical third. To determine the remnants of Metapex on three segments (cervical, middle, and apical) of root canal walls, following scoring system as described previously by Khademi et al. [13], was used.
0 = the surface was not covered with calcium hydroxide.
1 = 1/3 of the surface was covered with calcium hydroxide
2 = 2/3 of the surface was covered with calcium hydroxide.
3 = the surface was covered with calcium hydroxide completely.

3. Results

Data were submitted to statistician and statistical analysis was done using Friedman test and Mann-Whitney U-test with the help of Microsoft Excel. The p-value of less than 0.05 was considered significant statistically. PATS Vario performed better than EndoActivator in removing Metapex. However, there was no significant difference seen between the cervical, middle and apical third in EndoActivator and PATS Vario groups as shown in Table 1. No statistically significant difference was observed in the efficacy of EndoActivator and PATS Vario for removal of Metapex at cervical (P = 0.47), middle (P = 0.96) and apical (P = 0.79) part of the root canals.(Table 2, Figure 1)

Table 1: Intracanal Metapex removal of two different techniques at Cervical, Middle and Apical levels

Techniques	Cervical third		Middle third		Apical third		p-value
	Mean	SD	Mean	SD	Mean	SD	
Endo activator	1.4	0.52	1.2	0.42	1.9	0.57	0.12
PATS Vario	1.2	0.42	1.2	0.42	1.8	0.42	0.06

***p* < .05 (Significant), Friedmann Test**

Table 2: Intergroup comparison at three levels by using Mann Whitney U test

	p-value
Cervical third	0.47
Middle third	0.96
Apical third	0.79

***p* <.05 (Significant), Mann Whitney U test**

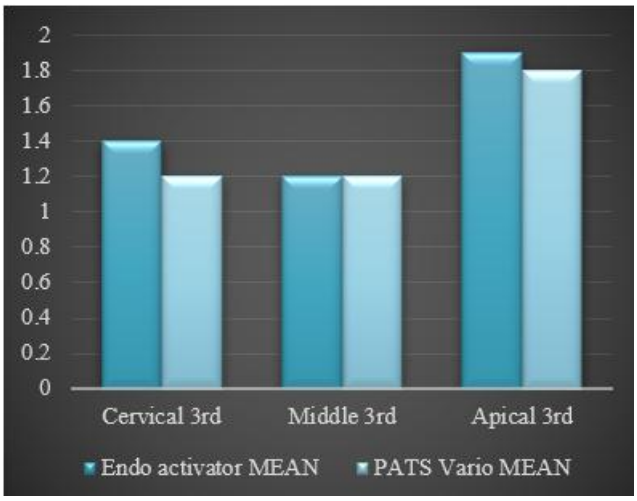

Figure 1: Mean values after removal of Metapex at three levels

4. Discussion

Calcium hydroxide is the most commonly used interappointment intracanal medicament in endodontic therapy because of its effective antimicrobial properties. Complete removal of the medication before to obturation is of importance, as it could adversely impact the sealing ability [9]. It has been reported that $Ca(OH)_2$ residues can pass through the dentinal tubules, weakening the resin-based sealer's binding and interfering with the silicon-based sealer while it is being sealed [14].

EndoActivator, a sonic device with a polymer tip, does not cause damage to the root canal walls compared with ultrasonic devices that use metal files. Alturaiki et al. [10] carried out a study to evaluate the efficacy of several irrigation methods in root canal therapy, including EndoActivator, ProUltra Piezo flow Ultrasonic, EndoVac, and traditional needle and syringe. They discovered that the elimination of $Ca(OH)_2$ from every area of the root canal was superior in the group using EndoActivator.

When used in conjunction with irrigation, the EndoActivator effectively removes $Ca(OH)_2$ from root canals. This may be due to the device's principal purpose, which has been shown to generate vigorous intracanal fluid agitation through acoustic streaming and cavitations [10]. It enhances irrigant flow, circulation, and penetration into the inaccessible sites of the root canal system [15]. According to some research, using the ultrasonic approach to remove $Ca(OH)_2$ may alter the root canal system's morphology when comparing the efficacy of sonic and ultrasonic activation[16].

A new irrigating system Pro-Agitator Tip System (PATS) Vario (Innovations Endo Ltd, India) was introduced in 2021. This system with variable frequency is a new innovation in the field of intracanal agent removal. PATS Vario is basically an air sonic device with less risk of fracturing the tip; its three-dimensional movement enhances acoustic streaming [12]. It is a new system and studies comparing it for evaluating its efficiency in removal of oil-based Calcium hydroxide are not available.

In the present study, NaOCl 3% and 17% EDTA were used for irrigation during the root canal mechanical preparation and the subsequent removal of the intracanal medication. Margelos et al. [17] proved that using NaOCL or 15% EDTA alone cannot remove calcium hydroxide from the canal. According to some research in the literature, 10% citric acid combined with EDTA is more effective at removing $Ca(OH)_2$[18], [19]. Applying EDTA for longer than 60 seconds causes penetration in the dentinal tubules deeper than 50 µm, which results in demineralisation of the dentin. To lessen this problem, regulating the amount of time exposed to the decalcifying solution, using an appropriate irrigant concentration and sequence, and using less aggressive instruments are crucial steps [1].

Intra-canal evaluations employ a variety of methods, such as colour permeability analysis in stereomicroscopy measurements or scanning electronic microscopy (SEM). In addition, stereomicroscopy is currently in use and is a reliable technique for assessing how effectively intra-canal materials are removed or filled. Conversely, the stereomicroscopy approach used in this study has several benefits, including the ability to analyse the root canal in its entirety without causing sample damage, ease of replication and analysis, and current application in related research [20].

Based on the results of this study, there was no significant difference found among the groups, PATS Vario showed better results than EndoActivator under stereomicroscope. The findings are consistent with other research that demonstrated $Ca(OH)_2$ residue on root canal walls regardless of the removal method and file system employed.

The limitation of the current study is that instead of employing a scanning electron microscope (SEM), which may have provided the study with much more detailed precision, a stereo microscope was used with a rather modest sample size. Therefore, more research using SEM and a larger sample size should be conducted.

5. Conclusion

Within the limitations of the present study, both the methods were equally effective in removal of oil-based calcium hydroxide intracanal medicament from the root canal. Effectiveness of Metapex removal using EndoActivator and PATS Vario was not statistically different.

Conflict of Interest
"No potential conflict of interest relevant to this article was reported".

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