IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 3 Ver. VII (Mar. 2016), PP 84-89
www.iosrjournals.org

Comparative Evaluation Of 3 Different Irrigation System: 30 Gauge Blunt Ended Side Vented Needle, Endoactivator & Endovac In Removal Of Ca(Oh)2 From Root Canal System- Sem Study

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Abstract: *To compare & evaluate three different types of irrigation system in removal of calcium hydroxide form the root canal system using 30 gauge blunt ended side vented needle, Endoactivator & Endovac.*
Materials and methodology: *Total sixty freshly extracted human intact maxillary anteriors were collected & decoronated. Access was prepared & working length was determined using #10K file & all canals were prepared till Protaper F4 as MAF & 2.5% NaOCl was used for irrigation & dried with paper points. Metapex was injected until it was extruded through apex & access cavities were sealed with cotton pellet & temporary filling. All samples were stored at 37°C & 100% relative humidity for 7 days & divided into 3 groups (n=20). Group 1: 30 gauge blunt end, side vented needle, group 2: EndoActivator & group 3: EndoVac. SEM evaluation was done & statistical analysis was performed by ANOVA & Post Hoc test.*
Results: *In coronal third, no significant difference was seen in all three groups, whereas group 2 & group 3 were equally effective in removal of calcium hydroxide from middle third. In apical third, group 2 & group 3 performed better than group 1 in removal of calcium hydroxide.*
Conclusion: *Endovac & Endoactivator performed better than needle irrigation in removal of Ca(OH)2 from apical third.*
Key words: *Ca(OH)2 removal, EndoVac, EndoActivator, Needle Irrigation, Sodium hypochlorite*

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I. Introduction

Success of root canal depends on removal of maximum number of microorganisms from root canal space.The presence of microorganisms in the root canal system plays a major role in the pathogenesis of apical periodontitis. The elimination of all microorganisms from the root canal system is accomplished by mechanical instrumentation supported by various irrigating solutions and placement of intracanal medications.[1] $Ca(OH)_2$ has been used in dentistry for almost a century, it was originally introduced to the field of endodontics by Hermann in 1920 as a pulp capping agent. Because of it's excellent results it is used widely for various endodontic therapy.[2] Some of its indications include inter-appointment intracanal medicaments, endodontic sealers, pulp capping agents, apexification, pulpotomy and weeping canals. $Ca(OH)_2$ is preferred because it induces hard tissue formation and exerts antibacterial and tissue healing actions.[3]. It is used as intra-canal medicament because of its proven antimicrobial activity, for its capacity to neutralize bacterial endotoxin and stimulate apical and periapical repair. $Ca(OH)_2$ paste should be removed before the obturation of root canal because the remnants of $Ca(OH)_2$ on the canal walls influence dentine bond strength of sealer and negatively affect the quality of root filling. It is difficult to remove $Ca(OH)_2$ residues from irregularities of the root canal walls.[1] Sodium hypochlorite (NaOCl) irrigation solutions is commonly used for the removal of residual $Ca(OH)_2$.[1] Passive ultrasonic irrigation,[4] rotary instruments[5] and apical patency file[6] have been used to activate the effectiveness of irrigants. Although various irrigants and methods have been proposed for the removal of $Ca(OH)_2$ dressing, there is still no general consensus about which technique is best.

Most older method for delivering irrigants was sharp ended needle but the disadvantages of this system was that it pushes the material beyond the apex so, to overcome this, blunt end, side vented needle is introduced for irrigation. Most commonly used is 30 gauge blunt end, side vented needle placed into the canal until just short of the binding point. The difficulty with this technique is that the depth of needle penetration is dependent on the size and morphology of each canal. Predictable delivery of irrigants to the working length with needle irrigation is not often attained. If too little positive pressure is used, irrigants may not reach close to the working length due to vapor lock effect. If too much positive pressure is used, the practitioner risks forcing irrigants past the terminus of the root canal, which can produce tissue damage, pain, and swelling commonly described as a NaOCl accident.[7]

To overcome the shortcomings of this irrigation needles EndoActivator(Dentsply) and EndoVac(Sybron-endo) came into existence. EndoActivator system was newly introduced and designed to safely agitate the irrigants to the apical terminus of root canals. Fluid activation in well shaped canals plays an important role in debridement and disinfection of the root canal system. EndoActivator easily and vigorously energizes intracanal irrigants during endodontic treatment. EndoActivator tips are strong, flexible, medical grade polymer tips, uncoated and non-cutting tips. This system creates fluid hydrodynamics, improves debridement and the disruption of the smear layer and biofilm.[8]

The EndoVac is a true apical negative pressure irrigation system. Instead of applying positive pressure, EndoVac uses suction to pull irrigant down the root canal and then up and away into the Hi-Vac suction unit. We call this “negative apical pressure”, because EndoVac applies suction rather than forceful injection to consistently deliver a perfect, bullet proof performance.[9] EndoVac enables irrigation to full working length so that we can finally reach those last few, critical 3-4 mm that are often left untouched. It creates a powerful current force to pump disinfecting irrigants throughout the entire canal system, so pain-inducing bacteria are destroyed more quickly and effectively.[9] The recommended protocol for the use of apical negative pressure irrigation includes two main phases: macro-irrigation and micro-irrigation. This system is composed by a macro-cannula and micro-cannula that make the irrigating solution circulate due to difference of pressure caused by the vaccum inside the root canal system. Measuring 0.32mm in diameter, the micro-cannula can be placed to the working length provided the canal is prepared to a minimum size.[1] On searching the different database there was very little information regarding the retrieval of $Ca(OH)_2$ with different irrigation systems.

So the purpose of this study was to compare the efficacy of three different irrigation system- 30 gauge blunt end side vented needle, EndoVac and EndoActivator in removal of $Ca(OH)_2$ from root canal walls.

II. Materials & Methodology

Study was conducted in the Department of Conservative dentistry and Endodontics, K.M.Shah Dental College, after ethical clearance. Total 60 human permanent, non carious maxillary anterior teeth with single canals and mature apices were selected by direct clinical examination for this study. Type I configuration of root canal was confirmed with digital radiography in mesiodistal and labiolingual planes.Before the test, following extraction all remaining organic residues were removed from external root surfaces with an ultrasonic periodontal scaler. After washing with distilled water, teeth were transferred to 10% formalin solution until use. All the teeth were treated by the same operator.The teeth were decoronated at the level of cemento-enamel junction to obtain a standardized root length of 12mm and allow access to the root canal and provide a stable reference point for all measurements. Canal patency was evaluated using #10 K-Flexofile and any teeth with canal obstructions were discarded.After the root canal orifice was identified, the coronal portion of each canal was preflared using sequential Gates Glidden #3, #2 and #1, irrigated with 2.5%NaOCl and the pulp tissue was extirpated using barbed broaches.The actual length of each tooth was determined with #10 K file, which was introduced into the canal until its tip emerged through the major apical foramen. The working length was established by subtracting 1mm from the length and is recorded as actual length. All the canals were prepared by the same operator using Protaper F4 size as the master apical file. After instrumentation and preparation of the canal, irrigation with 2.5% NaOCl was carried out and dried with paper points. Metapex was injected into the root canal until the material was extruded through the apex and placement was confirmed with radiograph. The access cavities were sealed with cotton pellet and temporary filling. All samples were stored at 37°C and 100% relative humidity for 7 days.

The teeth were randomly assigned into 3 experimentals groups based on irrigant agitation protocols(n=20). Initially, size #40 Hedstrom file was inserted into the root canals to the working length and up and down strokes were performed to disrupt and loosen the medication. The groups were as follows:-

Group 1: 30 gauge blunt end, side vented needle
Group 2: EndoActivator(Dentsply)
Group 3: EndoVac (Sybron-Endo)

In group I (30 gauge blunt end, side vented needle) - 30 gauge blunt end & side vented irrigation needle was inserted as apically as possible without binding, and irrigation was performed with 10ml of 2.5% NaOCl solution.

In group II(EndoActivator) – root canals were irrigated with 5ml of 2.5% NaOCl and #20 with 2% taper EndoActivator tip was placed in a slow speed hand piece and advanced to the working length.

EndoActivator tip was applied into the canals for 30s with circumferential motion and a final irrigation of 5 ml of 2.5% NaOCl was used. The tips were used at full working length with a gentle up and down motion.
In group III (EndoVac) – the apical negative pressure irrigation was used. The macro-cannula tip was used to deliver irrigant up and down the canal for 1 minute. This was followed by micro-cannula irrigation.
Each cycle of micro-cannula irrigation consists of tip being placed at full working length for 20 seconds. This was repeated 9 times during a period of 3minutes. A total of 10ml of 2.5% NaOCl is used.

SEM evaluation

Longitudinal grooves were prepared on the buccal and lingual surfaces of each root with a diamond disk at slow speed. The teeth were split along their long axis in a buccolingual direction. Canals were gently cleaned of all extraneous debris remnants. The samples were dehydrated and coated with gold-pallidium particles, and a magnification of 75x was used to evaluate the cleanliness of the canal walls at the apical, middle and coronal thirds of root canal. The images of canal surfaces were selected from apical, middle and coronal thirds for SEM evaluation.
A scoring system described by Kuga et al was used to evaluate the quantity of remnants on the canal walls. The scores used were as follows:

0. Absence of residues.
1. Small amt. of residues(upto 20% of surface covered)
2. Moderate amt. of residues(20-60% of surface covered)
3. Large amt. of residues (more than 60% of surface covered)

The results hence obtained were subjected to statistical analysis.

III. Observations & Results

All the three groups effectively removed the calcium hydroxide from the coronal third whereas group 2 & group 3 were more effective in removing calcium hydroxide from the middle third than group 1. Removal of calcium hydroxide from the apical third was seen more in group 2 & group 3 as compared to group 1.
One way Anova was done for all the three groups in coronal, middle & apical third.

TABLE 1: Anova table (CORONAL THIRD)

		Sum of Squares	Df	Mean Square	F	**p-value***
Coronal	Between Groups	4.133	2	2.067	3.548	**.035**
	Within Groups	33.200	57	.582		
	Total	37.333	59			

TABLE 2: Anova table (MIDDLE THIRD)

		Sum of Squares	Df	Mean Square	F	**p-value****
Middle	Between Groups	16.933	2	8.467	13.406	**<0.001**
	Within Groups	36.000	57	.632		
	Total	52.933	59			

TABLE 3: Anova table (APICAL THIRD)

		Sum of Squares	Df	Mean Square	F	**p-value**
Apical	Between Groups	14.233	2	7.117	7.846	**.001**
	Within Groups	51.700	57	.907		
	Total	65.933	59			

F= F-ratio
*p<0.01; significant
**p<0.001, highly significant

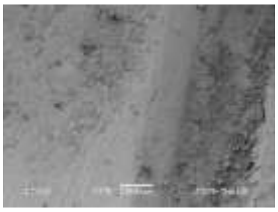
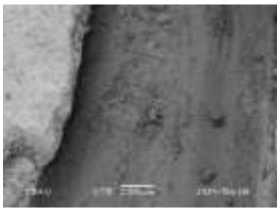
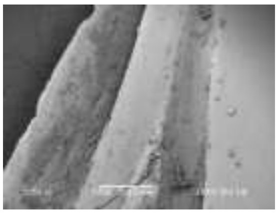
The tables above shows that there is significant difference between any of the two groups, so overall group comparisons of p value was done using Post-hoc HSD test as shown in Table 4.

	Groups	P value
Coronal third	1 vs 2	0.105
	1 vs 3	0.041
	2 vs 3	0.910
Middle third	1 vs 2	0.20
	1 vs 3	<0.001
Apical third	1 vs 3	0.001
	2 vs 3	0.018

Thus if the groups are overall compared with each other, it can be concluded that group 3 shows the maximum efficiency in removing calcium hydroxide from the apical & middle third, followed by group 2 and the least effective is the group 1 where 30 gauge side vented needle was used.
SEM Images:-

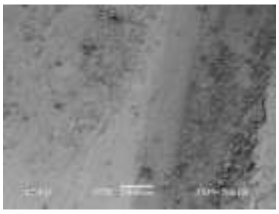
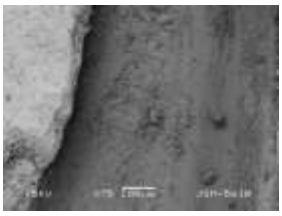
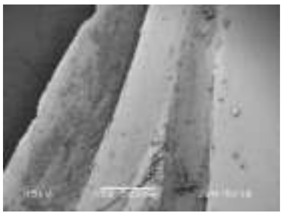
Group 1- 30 gauge side vented needle

Coronal area Middle area Apical area

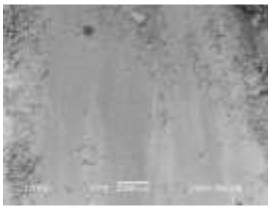
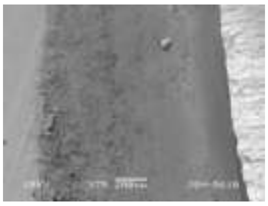
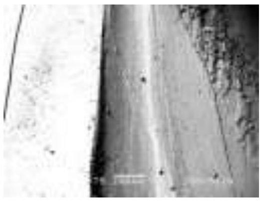
Group2- Endoactivator

Coronal area Middle area Apical area

Group3 – EndoVac

Coronal area Middle area Apical area

IV. Discussion

Disinfection of root canal using antimicrobial and tissue-dissolving irrigants as well as intracanal medicaments are considered to be the most important part of chemo-mechanical debridement (Haapasalo et al. 2005). The main aim of chemomechanical preparation is the elimination of the etiological factors which are responsible for the infection in the root canal & this elimination or reduction in the number of endodontic microorganisms can be achieved by using various strategies like biomechanical preparation, irrigation, intracanal medicaments & obturation.[10] Use of calcium hydroxide is seen in several clinical conditions & is kept for different time intervals from 7 days-24 months. For intracanal medicament time period is 7 days whereas for apexification it is kept 6 months to 24 months.[11] It has been demonstrated in various studies that $Ca(OH)_2$ when used as an intracanal medicament reduces the pathogenic species which are associated with pulpal necrosis. The antibacterial efficacy of calcium hydroxide depends on the type of vehicle used. Now, $Ca(OH)_2$ which is placed in the root canal has to be removed before obturation as it may influence the dentin bond strength. Antibacterial effects of intracanal medicaments as well as pathogenicity of the microorganisms can be evaluated by inoculating microorganisms on agar plates. Previously, various studies reported that remaining $Ca(OH)_2$ on root canal wall could interfere with penetration of sealer into dentinal tubules which reduces bond strength of a resin-based sealer and interfere with the sealing ability of a silicon-based sealer.[12,13,14]

In present study total 60 intact human maxillary anteriors were taken and stored in 10% formalin until use. Human teeth are considered as a prospective source of blood borne pathogens according to the Occupational Safety and Health Administration (OSHA). To address this concern American Dental Association (ADA) and Centre for Disease Control (CDC) call for thorough removal of any organism capable of transmitting disease from an extracted human teeth.[15] Numerous types of solutions used for storage are noted in the literature range from water and saline to solutions prepared to prevent bacterial growth such as chloramines-T, sodium azide in saline, sodium azide in water, thymol, aqueous chloramine and 3% sodium hypochlorite. For prevention of dehydration of the tooth it is important to use the solution in between the procedure. 10% formalin was used for the disinfection of the teeth because it has no adverse effect on the tooth structure and microleakage.[15]

Very few studies have evaluated the Efficacy of irrigation in root canals with different tapers(Lee et al. 2004b, van der Sluis et al. 2005b, Huang et al. 2008) & different master apical file sizes (Khademi et al. 2006, Hsieh et al. 2007, Huang et al. 2008). Lee et al. and van der Sluis et al in 2004 & 2005 conducted a study with continuous flow of 2% NaOCl with the help of PUI & according to their results it was concluded that greater the taper, more debris can be removed which indicate that root canal enlargement is important to certain limit which will help in proper irrigation. In addition to the above statement, Huang et al. in 2008 also stated that a larger apical size will allow better apical flushing of the irrigating solution. Even in 2006 Khademi et al concluded that apical instrumentation till size 30 with 0.06 taper was effective in penetration of irrigants till the apical area. Therefore, in the current study, all the canals are prepared by using Protaper F4 size as the master apical file.[10]

Due to its restricted capability in dissolving the inorganic materials, NaOCl irrigation was considered to be inadequate for removal of Ca(OH)2 from root canals.[16] Margelos *et al.* reported that by using 15% EDTA solution or NaOCl as irrigants does not remove Ca(OH)2 efficiently from canal wall; whereas, combination of two irrigants with hand instrumentation improves the removal efficiency.[17] However, other studies have reported that concentrated NaOCl had greater antimicrobial action on gram negative bacteria. Therefore, in the current study, we purposed to evaluate the efficacy of different irrigant agitation protocols using with NaOCl on removal of Ca(OH)2 from root canals.[16]

In the present study, results showed that syringe irrigation for Ca(OH)2 removal was less effective from the apical area. The results of the present study are in accordance with previous studies. 30-gauge needle was used to deliver the irrigating solution. Needle irrigation is effective in removing the residues from the coronal area but not from the apical area because irrigating solution can progress only 1 mm further from the tip of the needle.[18] Boutsioukis C et al & Shen Y et al in 2010 used computational fluid dynamics model which stated that design of the tip of the needle it affected the flow pattern, speed and the apical pressure which was generated by the irrigant. The study showed that needles having side or beveled openings did not have any difference in cleanliness of the apical area when it was compared with conventional needles with apical opening. Modified needle tips reduced the pressure generated at the apical foramen therefore, adequate delivery of the irrigant to the WL with needle irrigation may not be obtained. This could be another reason for less removal of Ca(OH)2 from the apical part of the root canal in Group 1.[19,20,21]

The results of the present study showed that removal of calcium hydroxide was better at the coronal area when compared to apical area in all the three experimental groups. This may be related to the volume of the irrigation which may help in influencing the clean canals that is if large amount of irrigating solutions are used it will lead to cleaner canal walls compared to that of smaller amount(Yamada 1983). In current study, the volume of irrigant was the same for all three test groups. Several irrigation units, like Ultrasonic Piezon Master, can supply a continuous flow of irrigating solution which helps in production of high volume irrigation till 20 mL min−1. Lee et al also stated that this may be because of high velocity and volume of irrigating solutions at the coronal area. In all experimental groups, a significant statistical difference was observed in cleanliness between the coronal versus apical third.[20,21]

Results obtained in the study showed that EndoVac and Endo Activator were more effective at the apical area when it was compared with group. This may be because of the design and working properties of this systems like scrubbing or vibration of calcium hydroxide which will aid in the removal of the medicament.

There are various studies which have stated that Endoactivator & needle irrigation have performed equally similar in removal of calcium hydroxide from coronal & middle thirds of the root canal system. According to Uroz-Torres et al in 2010 stated that EndoActivator System did not enhance the removal of smear layer as compared with conventional Max-I-Probe irrigation with NaOCl and EDTA. Akveld NAE in 2007 when compared passive ultrasonic irrigation it was seen that PUI performed better than that of Endoactivator. Li. D, Jhiang S. conducted a study which compared four irrigation techniques in removing calcium hydroxide & it was seen that greater amount of calcium hydroxide was removed using PIPS and ultrasonic at apical area when it was compared with EndoActivator and needle irrigation.[16]

V. Conclusion

Within the limitations of the study it can be concluded that all irrigation devices were effective in removing calcium hydroxide from the coronal area of the root canal system. However, in the present study none of the techniques removed the calcium hydroxide completely from the apical area from the root canal system. Endoactivator and EndoVac performed better in removing Ca(OH) 2 from apical third when compared with 30 gauge blunt ended side vented needle. The Endoactivator & EndoVac showed similar efficiency in the coronal and apical thirds of the specimens.

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