

## Irrigation Solution Pattern in Root Canal Treatment (Irrigation Solution Pattern in Root Canal between Negative Pressure System by Endovac and Sonic Activation by Eddy System)

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### Abstract

Irrigation is crucial for long term success in root canal treatment. Studies have shown that irrigant delivery in positive pressure irrigation producing a vapour lock effect. Aims: To Analyze the difference of irrigant patterns between negative pressure irrigation system and sonic activation to root canal cleaning efficacy.

Twenty seven human mandibular premolar were instrumented using ProTaper Next with 2,5% NaOCl irrigation. Divided in three groups randomly. Group I: positive pressure irrigation systems as control. Group II: negative pressure irrigation systems. Group III: sonic activation systems. Teeth were sectioned longitudinally halves then cut in the apical third part and examined under microscope for working length evaluation. Irrigant pattern examined with spectrophotometry.

Using Anova followed by Shapiro wilk for normality test and Post Hoc test for individual comparison. There is no significant difference between negative pressure and sonic activation for reaching the working length. There is significant difference between negative pressure and sonic activation for lateral penetration to the canal wall.

Activation using Eddy® has a better streaming in terms of lateral penetration to the canal wall and no difference in terms of capability of reaching the working length compare with endoVac.

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### Introduction

The effectiveness of root canal irrigation is influenced by dispersion pattern of irrigation solution throughout the root canal wall and lateral dispersal capability to the lateral penetration wall.

Negative pressure irrigation technique using EndoVac system causes the flow of irrigation fluids to flow constantly and reach the root canal up to the length of work.<sup>1,2</sup> Eddy® system produces sonic vibrations so it increases penetration and irrigation solution pattern in root canal through cavitation and acoustic streaming effect.<sup>1,2,3,4</sup>

This study will analyze the difference of irrigation solution pattern in negative pressure irrigation system using EndoVac and sonic activation using Eddy® system.

### Materials and methods

The procedures of this study followed were in accordance with the ethical standards of the responsible committee on human experimentation. This study used the first mandibular premolar teeth extracted with few criteria namely, average length of  $20 \pm 2$  mm, 1 (one) root canal, and apex tip perfectly sealed and no root tooth defect. The sample preparation in this study begins with soaking the sample in normal saline solution. The sample was divided into 3 groups, each group consisting of 9 teeth. Premolar teeth are prepared by access opening using high speed endo access bur. The working length of all samples is measured using files number 8 and 10. After that, glide path was done using file no 8, 10, 15 in sequence, then continued with root canal preparation with Protaper Next until X3 irrigated according to irrigation system used in each - group. Teeth are inserted into the ring nut of the protrain device, then divided into 3 groups:

Group I : Irrigation using conventional syringe, irrigation fluid of 2.5% NaOcl solution +

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methylene blue delivered through 10 ml syringe with 30 gauge size placed 2mm from working length for 20 seconds. This process is carried out for 3 times, producing an irrigation fluid with a total volume of 6 ml with total irrigation time for 60 seconds.

Group II : Irrigation using endoVac irrigation system 2.5% NaOc + methylene blue solution delivered through master delivery tip placed on orifice continuously produce irrigation fluid for 20 seconds. This stage is repeated three times. Producing 6 ml of irrigation fluid with total irrigation time for 60 seconds. The microcanula (# 32 / .02) is used 2 mm from the working length in sequence.

Group III : Irrigation using Eddy® Irrigation System with NaOcl 2.5% + methylene blue solution delivered through vibration of water scaller and tip placed 2 mm from working length. This stage is repeated three times. So as to produce irrigation fluid as much as 6 ml. With a total irrigation time of 60 seconds. The root canal is then dried using a paper point

Samples that have been prepared and irrigated are marked on the buccal and lingual portions of the teeth using disc bur to a depth of approximately 1/3 of the tooth and then vertically separated in buccal-lingual direction using chisel so that it splits into 2 parts. Teeth that have been split into two parts then cut in the apical third by using the bur disk. The cut sample was then observed using a light microscope with 100X magnification, followed by a spectrophotometric test.

## Results

In this study, the achievement of irrigation solution at working length was analyzed using light microscope (figure 1 and figure 2) and the spread of the irrigation solution laterally through the spectrophotometric test (table 1 and figure 2). The results of data and overview of research of irrigation solution exchange found the following results:

To find out differences of solution penetration in working length between control group, endovac, and eddy was done using post hoc test statistic test. From the test post hoc test results obtained in Table 1.

(I) Group	(J) Group	Mean	Difference (I-J)	Std. Error	Sig.
Control	EndoVac	-.79111*	.03916	.000	
	EDDY®	-.86778*	.03916	.000	
EndoVac	control	.79111*	.03916	.000	
	EDDY®	-.07667	.03916	.062	
	control	.86778*	.03916	.000	
EDDY®	EndoVac	.07667	.03916	.062	

Table 1. Post Hoc Test Result

\*Significant difference ( $p<0.05$ )

Table 1 shows that the control group on EndoVac has a mean value of - 79111, and is statistically different from the p value of 0.000 where the value ( $p<0.05$ ). The control group compared to Eddy® has an mean value of -86778, and is different from the p value of 0.000 where the value ( $p<0.05$ ). The EndoVac group compared to controls has a mean value of 79111, and is different from the p value of 0.000 where the value ( $p<0.05$ ). The EndoVac group compared to Eddy® has a mean value of -.07667 and it's not different from the p value of 0.062 where the value ( $p<0.05$ ). The Eddy® compared to control group has a mean value of .86778 and is statistically different by the p value of 0,000 where the value ( $p<0.05$ ). Eddy's group compared to EndoVac has an average of .07667 and is not different from p value of 0.062 where the value ( $p<0.05$ ). Spectrophotometric test was performed to determine the ability of lateral movement of tooth root canal wall. Spectrophotometric analysis result are shown in figure 1.

In figure 1 it can be seen that each treatment group has 9 teeth samples. For spectrophotometric results in the control group had a mean value of 0.0034955 and standard deviation 0.00022231. Spectrophotometric result using EndoVac has a mean value of 0.3788156 and standard deviation 0.07286012. While the results of spectrophotometry using EDDY® has a mean value of 0.7874300 and standard deviation 0.34115262.

To know the difference of spectrophotometric analysis, the result between control group, endovac, and eddy was analyzed using post hoc test statistic test. The post hoc test result shown in table 2.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
Control	Endovac	-.37532001*	.04895770	.000
	EDDY®	-.78393446*	.04895770	.000
EndoVac	control	.37532001*	.04895770	.000
	EDDY®	-.40861444*	.04895770	.000
	control	.78393446*	.04895770	.000
EDDY®	Endovac	.40861444*	.04895770	.000

**Table 2.** Post hoc test result of irrigation solution lateral movement

From table 2 the result of post hoc test showed that the control group compared to endovac had an average of 375320001, and it was statistically different with p value of 0.000 where the value ( $p<0.05$ ). The control group compared to eddy group has a mean value of -78393446, and statistically different from the p value of 0.000 where the value ( $p<0.05$ ). The endovac group compared to control group has a mean value of 37532001, and statistically different from the p value of 0.000 where the value ( $p<0.05$ ). The EndoVac group compared to Eddy group has a mean value of -.40861444 and statistically different from the p value of 0.000 where the value ( $p<0.05$ ). The Eddy group compared to control group has a mean value of 78393446 and statistically different from the p value of 0.000 where the value ( $p<0.05$ ). Eddy's group of EndoVac has a mean value of .40861444 and is statistically different by the p value of 0.000 where the value ( $p<0.05$ ).

## Discussion

The complex anatomy of root canal system does not allow instrumentation to mechanically cleanse the entire root canal system, adequate irrigation processes are needed in eliminating bacteria, necrotic tissue, and others contained in a root canal system. Anatomically the roots are covered by a bone socket (close end channel), resulting in air gas bubbles trapped inside a root canal known as the "vapor lock effect".<sup>5</sup> "Vapor lock effect" results in irrigation fluid inhibition to reach working length so that it can lead to debris, bacteria, toxins, etc., especially in the 1/3 apical region decreasing the effectiveness of root canal irrigation.<sup>5,6,7</sup> To overcome the occurrence of "vapor lock effect"

instrumentation is required in the form of activation of irrigation fluid in the root canal so that the circulation of irrigation fluid can run effectively.<sup>7,8,9</sup>

The working length is the distance from the apical constriction to the reference point, which must be done the process of shaping, cleaning, and obturation. The reference point is the area on the occlusal or incisal surface, where a measurement estimate is performed. Apical constriction is the region of the most narrow root canal, and is the most narrow diameter blood supply area, which then widens and connects with a vast system of vascularization. From a biological perspective the apical constriction is the most rational point in which root canal preparation ends.<sup>8,9</sup>

The results of this study indicate that the negative pressure EndoVac irrigation technique and the sonic Eddy® activation irrigation system did not differ significantly. Both of these irrigation techniques can deliver irrigation fluid to the working length compared to the control group, but the sonic vibrations generated from the Eddy® system result in a stronger lateral penetration movement, characterized by a deep blue color on the root canal wall when compared to the group control and endovac groups.<sup>10</sup>

The advantages of using EndoVac, among others, can eliminate vapor lock, the risk of irrigation solution extrusion can be reduced, and can clean more debris on ishtmus.<sup>1,3</sup> the disadvantage in the EndoVac system that requires a minimum root canal preparation of ISO#35 to insert the microcanula into the root canal up to the working length, has similar results to a common syringe needle when eliminating the bacteria on 1/3 apical.

While Eddy is a sonic system of irrigation fluid activation at a frequency of 5000-6000 Hz with the help of water scaller, which can produce cavitation effects and acoustic streaming. Tip of Eddy system made from polyamide, with size 20.04, and 28mm tip length. The cavitation effect produced by the Eddy irrigation system results from the rapid movement from the tip. The tip inside the irrigation fluid at the time of activation will form small bubbles of gas that rupture, thus releasing energy that strengthens the effectiveness of irrigation fluid. Acoustic streaming improves the cleaning effect on root canal walls. The complex root canal system,

necrotic tissue, and dentine powder attached to the root canal wall can be effectively cleaned inside a complex root canal.<sup>1,3,5</sup>

In this study will be proved whether there is a significant difference between the irrigation solution pattern using syringe 30G side vented, endovac system, and Eddy which is placed 2 mm of working length. This study used premolar teeth as a sample, with a straight root. Working length measurement using apex locator, shaping procedure and irrigation using protrain tool.

In the control group the irrigation solution is unable to achieve the working length, because there is a vapor lock effect so that the cleaning process in the apical region is ineffective, indicated by the blue (methylene blue) staining that does not moisten the root canal wall.

In the EndoVac and Eddy group which is placed 2mm from the working length and 2.5% NaOCl irrigation fluid mixed with 5% methylene blue obtained results can reach the length of work, this is indicated by blue dye that wetted on 1/3 apical. The EndoVac and Eddy irrigation systems are capable of eliminating the vapor lock effect so that the irrigation solution can flow towards the length of work, this is because in the endovac system there is a microcanula that can be placed close to the working length so that the shear stress decreases and the irrigation solution can flow along the length of work. While in the Eddy system, when the tip is activated in the root canal there is a cavitation and acoustic streaming effect resulting in high turbulence in the irrigation solution, so that the shear stress inside the root canal becomes low and the irrigation solution can flow to the working length of.<sup>1,2,3,4</sup>

Based on statistical calculation with Shapiro Wilk for spectrophotometric test in the control group had  $p = 0.430$  ( $p>0,05$ ). Spectrophotometric result in EndoVac group has  $p$  value = 0.210 ( $p>0,05$ ). Spectrophotometric results in Eddy group had  $p = 0.0063$  ( $p>0,05$ ). This shows that each group has a normal data distribution. Then to know the difference of spectrophotometric result between control group, endovac, and Eddy was done using post hoc test statistic test. From the post hoc test results obtained control group compared to endovac has a mean value of - 375320001, and is statistically different from the  $p$  value of 0.000 where the value ( $p<0,05$ ). The control group compared to eddy has a mean value of -78393446, and statistically different from the  $p$  value of 0.000

where the value ( $p<0,05$ ). The EndoVac group compared to control group has a mean value of 37532001, and statistically different from the  $p$  value of 0.000 where the value ( $p <0,05$ ). The EndoVac group compared to eddy has a mean value of -40861444 and statistically different from the  $p$  value of 0.000 where the value ( $p<0,05$ ). The Eddy group compared to control group has a mean value of 78393446 and statistically different from the  $p$  value of 0.000 where the value ( $p<0,05$ ). Eddy's group compared to endovac has a mean value of .40861444 and statistically different by the  $p$  value of 0.000 where the value ( $p<0,05$ ).

Spectrophotometric assays in the control, EndoVac, and Eddy groups produced different blue colors, in the control group and the blue and light-colored EndoVac controls and were not concentrated when compared with the Eddy group. This can be caused by several factors, the EndoVac through a negative pressure irrigation system has a low turbulence flow inside the root canal, resulting in the interaction between the irrigation fluid and the root canal wall resulting in a low osmotic pressure. In contrast, the sonic irrigation activation irrigation system produces high osmotic pressure, because it has cavitation and acoustic streaming effects, so that the interaction between the fluid and the root canal wall proceeds adequately (effective lateral penetration runs).<sup>1,2,3,11,12</sup> Vapor-lock effect or the presence of air gas bubbles trapped during the irrigation process can be eliminated through sonic vibration.<sup>3</sup> Vibration from sonic activation can reach all parts of the root canal to lateral canals and accessories channels. In addition, the vibration of irrigation fluid activation from sonic vibration results in penetration of irrigation fluid with high viscosity towards apical.<sup>11,12</sup>

## Conclusions

Based on the results of this study it can be concluded that negative pressure EndoVac irrigation techniques and sonic pressure activation Eddy® system does not differ significantly in delivering irrigation solution to the length of work compared with the control group, but the sonic vibration generated from the Eddy® system produces a higher lateral penetration motion than EndoVac negative pressure irrigation technique.

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## Declaration of Interest

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