

Evaluation of the cleaning efficiency of the isthmus using different rotary instrumentation techniques (In vitro study)

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ABSTRACT

Background: The aims of the study were to evaluate the unclean/clean root canal surface areas with a histopathological cross section view of the root canal and the isthmus and to evaluate the efficiency of instrumentation to the isthmus using different rotary instrumentation techniques.

Materials and Methods: The mesial roots of thirty human mandibular molars were divided into six groups, each group was composed of five roots (10 root canals) which prepared and irrigated as: Group one A: Protaper system to size F2 and hypodermic syringe, Group one B: Protaper system to size F2 and endoactivator system, Group two A: Wave One small then primary file and hypodermic syringe, Group two B: Wave One small then primary file and endoactivator system, Group three A: step back technique to size 25 file as MAF and hypodermic syringe, Group three B: step back technique to size 25 file as MAF and endoactivator system. All the roots were sectioned at 2mm, 6mm, 12mm from the apex and studied by histopathological cross section. The degree of cleaning of each section was measured by the use of Autocade 2004 software system.

Result: The least uncleaned isthmus surface area at coronal, middle and apical section was found by the Protaper system with endoactivator which represented the mean of the percentage of uncleaned surface area of 16.87%, 14.32% and 9.55% respectively. The system that produced least uncleaned canal wall was by Protaper system with endoactivator at coronal, middle, and apical sections of 12.21%, 9.14% and 18.55% respectively. The mean of highest percentage of increased canal diameter which was Protaper system, Wave One system and then step back. The comparison between the groups in the means which showed that the highest percentage of decrease in isthmus area was with the Protaper system, Wave One system and lastly the step back.

Conclusions: The Protaper system with endoactivator was the best system in canal and isthmus cleaning.

Keywords: Isthmus cleaning, canal cleaning, canal diameter, isthmus size. (J Bagh Coll Dentistry 2015; 27(2):43-47).

INTRODUCTION

The root canal system of a tooth is often extremely complex and it is difficult to disinfect completely and quickly. It may be that the best attempts of the operator just to reduce the residual bacterial load to a non-pathogenic number, or change the resident flora sufficiently to allow periapical healing. These microbes and their byproducts can be removed by a combination of mechanical and chemical means.

Mechanical removal relies on the ability of the operator to remove infected pulp and dentine from the surfaces of the root canal by planning the walls; infected material in the lumen of the root canal will be removed.

The isthmus is a narrow connection between two root canals usually containing pulp tissue. It was called a "corridor" by Green in (1973)⁽²⁾ also called "lateral connection" by Pineda in 1973⁽³⁾ and an anastomosis by Vertucci in 1984⁽⁴⁾. In many teeth with a fused root there is a weblike connection between two canals called an isthmus, which can be either complete or incomplete⁽⁵⁾,

which is formed when an individual root projection is unable to close by itself. In clinical practice, this isthmus is important in the surgical and non surgical endodontic procedures. In both cases, it can lead to failure because of poor accessibility to root canal instruments, acts as bacterial reservoir and may reduce the success rate⁽⁶⁾.

MATERIALS AND METHODS

Sampling

Seventy nine human mandibular first molars were collected and only thirty teeth were selected depending on the inclusion criteria.

The inclusion criteria of the mesial roots that were involved in this study are:

1. The length between the orifice and the apex was 12 mm.
2. Presence of the isthmus between the root canals.
3. No crack presented in the root.
4. The apical part of the root presented not fractured.
5. The root apex is closed not open apex.

The crown and distal root were sectioned using prosthetic engine with straight hand piece (W&H, Austria) by thin diamond disk and removed.

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Grouping

Group one: Ten teeth (20 root canals) were prepared by rotary Protaper universal system. This was accomplished by establishing a smooth glide path with ISO No. 10 stainless steel hand files. Preparation of the root canal started by: SX and then S1 instruments, preparing the coronal third of root canal. Then S2 instrument was used to prepare the middle third of root canal 1.0 Ncm. F1 instrument and finally F2 instrument were used to prepare the apical third of root canal⁽⁷⁾.

Group two: Ten teeth were prepared by Wave One system; reproducible glide path equivalent to a loose 10 file, then started by the Small (21/06) file, irrigated, recapitulated with a 10 file, then re-irrigated. Then Primary (25/08) file was used for a full working length of 1 mm shorter than the apex⁽⁸⁾, irrigated, recapitulated with a 10 file, then re-irrigated.

Group three: Ten teeth were prepared by step-back technique; started by: Used of size 10 file to full working length which was 11mm, then used of size 15 file to full working length which was 11mm, then used of size 20 file to full working length which was 11mm, then used of size 25 file to full working length (regarded as a master apical file). After that increased one size and subtract 1mm at each time until reached the canal orifice at size 90 k-file⁽⁹⁾.

Each group was subdivided into two subgroups each contained 5 roots (10 root canals); subgroup A was irrigated by normal saline and hypodermic syringe, subgroup B was irrigated by normal saline and endoactivator system by insertion of the tip size 20 for 30 seconds for each root canal. The canals were irrigated between each instrument with 10 ml. normal saline divided according to the number of instrument used in each group.

Histological procedure

After preparation: For each subgroup, the roots were placed in a container and written the name of subgroup on it. The roots of all groups were placed in a formalin solution (10 %) for 3 days for fixation. Then the roots were placed in nitric acid solution (5 %) also for 3 days for decalcification for complete removal of calcium ions from the teeth. After that, the roots were sectioned at 2mm, 6mm, and 12mm from the apex respectively. The block of each root sections was embedded in a solid medium such as paraffin wax. The block of each root and paraffin wax was cut by using microtoms to 4 micron thickness section. The sections were fixed on a slide by using adhesive & stained with H&E stain then washed by tap water. Mounting the cover slide on the slide

by using Canada balsam or dpx. Finally the slide was ready for microscopic evaluation⁽¹⁰⁾.

Microscopic evaluation:

The slides were read by light microscope at 40X magnification power, then a high resolution picture was taken to each section on the slide by DCM 35 digital eye piece camera.

Study one: evaluated the unclean to clean root canal wall percentage. The sections were stained by H&E stain to verify the organic debris at the inner wall of the root canal. Each canal was divided to four part to be seen the whole canal outline under magnification power 40X. Then a microscopic picture of canals was drawn by soft ware AutoCade 2004 system for sections at 12mm, 6mm, 2 mm from the apex for each sub group to show the unclean to clean surface area as percentage by draw first the canal to represent the whole area tracing the outline of the root canal by using poly line by soft ware AutoCade 2004. Then draw the unclean part and measured the unclean part and subtracted the uncleaned part to cleaned part as percentage to all canal area.

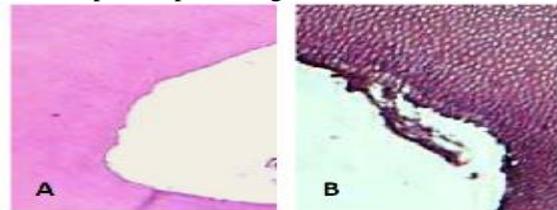


Fig 1: A- clean canal wall. B- unclean canal wall.

Study two: evaluated the unclean to clean surface percentage in the isthmus. This procedure was done in the same way as the previous study, but the isthmus was included in this study. The isthmus was calculated from the imaginary continuous line of the circle of the root canal. The isthmus was divided into two parts and a microscopic picture was taken under magnification power 40X, then isthmus was drawn by soft ware AutoCade 2004 system for sections at 12 mm from the apex (root canal orifice), 6 mm from the apex, 2 mm from the apex for each sub group to show the unclean to clean surface area as a percentage by draw first the isthmus of each canal to represent the whole area by tracing the border of the isthmus then draw the unclean part and subtracted the uncleaned part to cleaned part as percentage to all canal area.

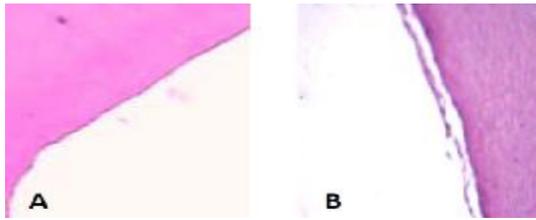


Fig 2: A- clean isthmus wall. B- un clean isthmus wall.

Study three: which measured :

- A- The percentage of increase in canal diameter by using different rotary systems at root canal orifice.
- B- The percentage of decrease of isthmus size at the orifice region.

High resolution picture was taken by digital camera for each root before and after preparation at level of root canal orifice and the magnification used was 100X. The root was placed in a plastic mold which made from silicon and its dimension was 2 cm length, 3 cm width and 2 cm elevation as a holder to maintain the same position of the root before and after preparation.

The ruler was placed beside the mold to obtain the correct dimension measurement. The camera was placed at fixed position on the table and at the same distance from each root which was 20 cm during picture capturing, to prevent any variation in dimension between roots during measurement and comparison between dimensions.

Then AutoCad 2004 software system was used to draw each canal and isthmus by using poly line to draw the outline of canals and isthmus before and after instrumentation to measure the difference in canal diameter before and after instrumentation, and the length of isthmus before and after instrumentation for each group. Then a formula was used to show the percentage of increasing in canal diameter which was $(\text{canal diameter after instrumentation} - \text{canal diameter before instrumentation}) \times 100 / \text{canal diameter before instrumentation}$. The percentage of decreasing in isthmus size after instrumentation was measured by formula which was $(\text{isthmus size after instrumentation} - \text{isthmus size before instrumentation}) \times 100 / \text{isthmus size before instrumentation}$.

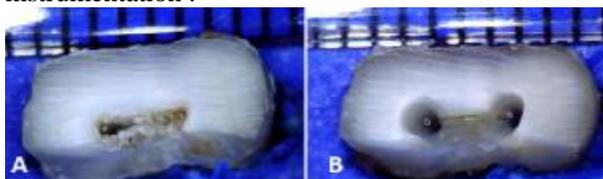


Fig 3: A-Mesial root before instrumentation B-After instrumentation by Protaper files.

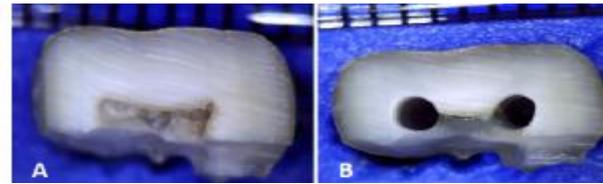


Fig 4: A- Mesial root before instrumentation B- After instrumentation by Wave One files.

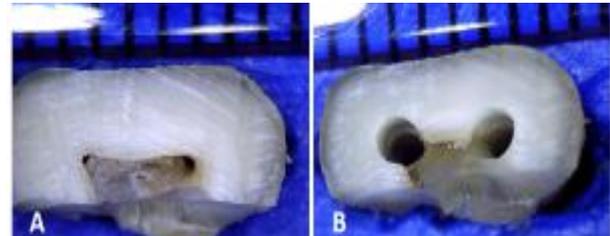


Fig 5 :A- Mesial root before instrumentation B- After instrumentation by step back technique.

RESULTS

The comparison among the six groups in the percentage of unclean root canals surface area after instrumentation

The least uncleaned root canal surface area according to preparation techniques was Protaper system, and according to the irrigation systems was EndoActivator system.

Table 1: The means of percentage of unclean root canals surface area at 12mm,6mm,2mm from the apex .

Sections	Groups					
	1 A	1B	2A	2B	3A	3B
12mm from apex	15.85	12.21	22.13	15.05	38.06	35.94
6 mm from apex	14.77	9.14	17.17	13.7	28.04	25.19
3 mm from apex	22.02	18.55	24.22	19.05	23.4	20.51

The comparison among the six groups in the percentage of unclean isthmus surface area after instrumentation.

The least uncleaned isthmus area according to preparation techniques was Protaper system, and according to the irrigation systems was EndoActivator system.

Table 2: The means of percentage of the unclean isthmus area at 12mm,6mm,2mm from the apex.

Sections	Groups					
	1 A	1B	2A	2B	3A	3B
12mm from apex	30.38	16.72	32.44	20.52	32.82	25.72
6 mm from apex	21.72	14.36	18.3	15.5	23.93	22.8
3 mm from apex	13.25	9.55	14.35	12.13	18.33	17.75

The comparison among the Protaper, Wave One and step back systems:

1-In the percentage of increase root canals diameter after instrumentation at the orifice area.

Table 3: The means of the percentage of increase in canal diameter at the canal orifice area.

Canal preparation Techniques	Mean
Protaper	81.05
Wave one	58.13
Step back	53.80

2-In the percentage of decrease isthmus size after instrumentation at the orifice area.

Table 4: The means of the percentage of decrease in isthmus size at the canal orifice area.

Canal preparation Techniques	Mean
Protaper	33.43
Wave one	29.41
Step back	16.24

DISCUSSION

The comparison among the six groups in the percentage of unclean root canals surface area after instrumentation at 12 mm, 6 mm and 2 mm sections from apex.

The least un-clean surface area of root canal at 12 mm, 6 mm sections from apex according to preparation techniques was the Protaper system, then WaveOne system and lastly stepback system, and according to irrigation techniques was EndoActivator then hypodermic syringe. but at 2mm section the least un-clean surface area of root canal according to preparation techniques was the Protaper system, then stepback system and lastly WaveOne system

This may be due to the use of multiple instruments (5 files) during the Protaper preparation and brushing action against canal wall, while only 2 files were used during Wave

One preparation. The result was best by using endoactivator system than without it. This may be due to the acoustic streaming due to sonic activation to irrigation fluid.

The result of this study at 12mm,6mm,2mm agrees with the finding of Burklein et.al 2012⁽¹¹⁾, which showed that the Protaper system removes more smear layer and cleans better than Wave One. The finding of Rodig et.al 2010⁽¹²⁾ agrees with the present study as it shows more smear layer removal at coronal region is effective when endoactivator system was used.

Also the result of the study at 6mm,2mm agree with the finding of Luciana et.al 2011⁽¹³⁾ showed that sonic irrigation is better in smear layer removal middle third of the canal than conventional irrigation which agree with this study. Uma et.al in 2010⁽¹⁴⁾ got comparable result with this study when they found that endoactivator better cleaned the middle third of the canal from debris.

Also the result of the study at 2mm agree with the finding of Luiz et.al 2011⁽¹⁵⁾ showed that none of hand or rotary instrument was totally effective in cleaning apical root canals space.

The comparison among the six groups in the percentage of unclean isthmus surface area after instrumentation at 12 mm, 6 mm, and 2 mm sections from apex.

The least un-clean surface area of root canal at 12 mm, 6mm and 2 mm sections from apex according to preparation techniques was the Protaper system, then WaveOne system and lastly stepback system, and according to irrigation techniques was EndoActivator then hypodermic syringe.

This may be due to the use of multiple instruments (5 files) during the Protaper preparation and brushing action against canal wall, while only 2 files were used during Wave One preparation. The result was best by using endoactivator system than without it. This may be due to the acoustic streaming due to sonic activation to irrigation fluid. The result of Protaper system with hypodermic syringe at 12mm from apex was 30.44% of unclean isthmus area more debris removal and accumulation in isthmus which is removed by using endoactivator, the debris were dislodged and removed resulting in better cleaning.

This result of least un-clean surface area of root canal at 12 mm, 6mm and 2 mm sections from apex agrees with Gencoglu and Gundogar 2008⁽¹⁶⁾ who showed ultrasonic instrument is useful to clean isthmus of mesial root of mandibular molars which supports the use of

endoactivator system. This study disagrees with Mathew 2012⁽¹⁷⁾ who presented Wave One is the worst in isthmus cleaning. The present findings agree with of Susin et.al 2010⁽¹⁸⁾ that no irrigation techniques produce completely removed debris from isthmus regions.

Also the result of least un-clean surface area of root canal at 6mm and 2 mm sections from apex agrees with Unni et.al 2011⁽¹⁹⁾ which supported the present study's findings that rotary system with endoactivator never reached 100% cleaning.

As conclusions; the best cleaning result for root canal walls 12 mm, 6 mm and 2 mm from the apex were the Protaper system, then Wave One system and lastly the step back technique. The Endoactivator irrigation system presented better results than the manual hypodermic syringe when used with all the instrumentation systems. The best cleaning result for isthmus walls cleaning 12 mm, 6 mm and 2 mm from the apex were the Protaper system, then Wave One system and lastly the step back technique. Maximum coronal orifice widening was presented in the Protaper system, followed by Wave One system, then step back system. The system that performed maximum decreasing in the isthmus area after instrumentation was the Protaper system, followed by Wave One system, then step back system.

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