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The Difference of One-Third Apical Root Canal Cleanliness After Instrumentation Between Single File System and Multiple File With Continuous Rotation Motion

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ABSTRACT
Cleanliness of a root canal treatment is measured by the level of cleanliness of the root canal covering the apical third, middle third, and coronal third. The area that is most difficult to clear by the instrument file is the apical third root canal wall because it has a complex root canal shape, there is ramification, is narrower, curved, and often has a root canal branching, the microorganisms that develop in the apical third region. single file and multiple file system rotating instruments have their own advantages and disadvantages depending on the design of the file of a device. The aim of this study was to compare the ability of single file and multiple file system with continuous rotation motion on the cleanliness of apical third root canal after instrumentation .
Twelve freshly extracted mandibular premolar were used for the study. The specimens were randomly devided into two groups. Group I single file system prepared using a One Curve , group II multipleple file system prepared using ProTaper Next with the crown down technique. All research subjects were cut longitudinally, then coating platina. Observation of the level of cleanliness of the root canal was carried out using a Scanning Electron Microscope (SEM) with magnification of 2000 and 5000 times at 1/3 apical. The results of micrographic photographs (SEM) are then given a score of 1-4 based on the dentinal tubules which are not covered by the preparation material.
Mann-Whitney U test results are at p values 0.036 ($p < 0.05$). The lowest Mean Rank value is in the Protaper Next group. In this study, it was concluded that the cleanliness of one-third root canals after preparation using a multiple-*file* instrument was better than one *file* system.

***Keywords**: Single file, Multiple File, SEM, Root Canal Cleanliness*

1. INTRODUCTION

Root canal treatment can be divided into three main stages: biomechanical preparation of the root canal or cleaning and shaping, sterilization, and obturation[1]. The instrumentation aims to form a root canal, to allow optimal irrigation and obturation[2]. The root canal cleanliness after preparation is one measure of the success of a root canal treatment. The root canal cleanliness is characterized by glossy smooth walls[3].

The root canals cleanliness, especially in the apical third, is an important focus to achieve because the smear layer is mostly found in the apical third of the root canal. The difficulty of this apical third area to be cleansed from the smear layer is due to complex, narrower, curved anatomy, and often there is a branching of the root canal[4]. The root canal cleanliness post instrumentation using endodontic files is evaluated by looking at the smear layer. The smear layer is an amorphous and irregular layer of a complex mixture of organic and inorganic particles such as proteins, pulp tissue, blood cells, and root canal walls that are infected by bacteria and fungi[4]. The loss of the smear layer causes better penetration of irrigation solutions into the tubules, sealer cement can flow to fill the empty gaps well, and produce better adhesion between obturation material with root canal wall[6].

Biomechanical preparation is the most time-consuming procedure and is the most difficult factor in root canal treatment[7]. Technology continues to be developed to make root canal preparation techniques more effective and efficient[1]. Instruments used using reciprocal movements are declared safer because it reduces the incidence of broken small file because it can reduce the risk of cyclic fatigue and torsional fractures of the file. However, when performing root canal preparations with complex anatomy, the use of a multiple file system with continuous motion is better used because of the progressive increase in diameter of the instrument to achieve working length with the gradual enlargement of the root canal[8].

Technological advances in endodontics are characterized by the latest innovations to produce new generation endodontic files with a single file system using rotary instruments. The concept of a single file system is to clean the root canal with a single file technique in preparing root canals with a single file number and taper size, even on narrow and curved canals[9]. A single file system reduces working time by around 40% when compared to multiple file systems because it decreases the number of instruments and the number of procedural steps in endodontic treatment[10]. In addition to reducing work time, a single file system decreases the level of patient contamination.

Multiple file system is stated to be more effective in eliminating Enterococcus Faecalis bacteria when root canal preparation is done than a single file system[12]. However, other research states that instrumentation using a single file system compared to using a multiple file system has the same result, which is equally effective in cleaning the root canals[13]. Previously, a single file system used only reciprocal movements, but at present, a single file system with continuous rotation movements has been produced and circulated in the Indonesian market.

2. MATERIAL AND METHODS

Ethical clearance was obtained from the Research Ethics Commission of the Faculty of Dentistry, Gadjah Mada University, Yogyakarta. The study subjects consisted of 12 extracted mandibular premolars for orthodontic treatment with the criteria of a straight root, having a single root canal and apex closing and perfect root formation, with an initial diameter of K-file # 15. The research subjects were cleaned of debris and the remaining tissue and then stored in a closed container containing a solution of formalin buffer.

Tooth deconstruction was carried out and the roots were 12 mm long. The tooth roots were randomly divided into 2 treatment groups, each group consisting of 6 specimens. Specimens were fixed in red night blocks measuring 5 x 5 x 4 cm. In group I, the root canals were prepared with a crown down technique with a rotating speed of 300 rpm and a torque of 2.5 Ncm using a rotating instrument file system (One Curve, Micro Mega) with a diameter and taper of 25 / .06 Ncm according to a working length of 1 minute whereas in group II using a multiple file system rotating instrument (Protaper Universal, Dentsply, Switzerland), files X1 (17 / 0.4) and X2 (25 / .06) with a rotational speed of 300 rpm and torque of 2.5 Ncm for 1 minute.

Every file used always uses 15% EDTA gel lubrication and 1 ml of root canals are irrigated with 1 ml of NaOCl solution, 1 ml of sterile distilled water, 1 ml of EDTA 17% solution then dried with paper points. Two grooves on the buccal and lingual sides of the tooth were made using a diamond disc, the specimen being cut longitudinally. Specimens were dehydrated using 70% ethanol for 15 minutes.

The specimen was then fixed using carbon paint and then vacuum under a pressure of 5 Pa. The tooth specimen was then coated with platinum (platinum coating) using a fine coat ion sputter machine for 2 minutes with a current of 2A. After the coating is complete, the specimen is placed in the specimen holder and then inserted into the column for scanning. Each specimen was seen with the standard magnification of 2000 times and 5000 times. The picture taking (micrographic photo) is done at 1/3 apical and the results are stored digitally using SemAfore computer software. Scoring is assessed based on criteria:

a. Score 1 = No smear layer, all dentinal tubules open more than 75%

b. Score 2 = There is a smear layer in a certain area, dentinal tubules open less than 75%
c. Score 3 = There is a smear layer, tubules can be seen in certain areas and partially covered; less than 50% of the dentinal tubules are seen.
d. Score 4 = Homogeneous smear layer covering the dentin surface, dentinal tubules are not visible[14].

Data from observations of smear layer cleaning were analyzed using Mann Whitney U to determine the significance level of differences in root canal hygiene between groups. Data analysis was performed using SPSS 25.0 software with a significance level of 5%.

3. RESEARCH RESULT

The Mann Whitney U test showed that there was a significant difference in the cleanliness of the apical third of the root canal after instrumentation between a single file and multiple file systems with continuous rotation motion, from the significance value of 0,000 (p<0,05). The mean rank on the multiple file system statistical results is at 4.42 while the single file system is at 8.58. This shows the lowest average score is on a multiple file system. The results of the Mann Whitney U test summary can be seen in Table 1. The scoring results in each group between three observers were summarized and their median values were calculated.

Table 1. Summary of the non-parametric test results of Mann Whitney U

System	n	Mean Rank	p
Single file	6	8,58	0,036 *
Multiple *files*	6	4,42	

Sig. : significance (p <0,05)

Based on Table 1, it can be concluded that there was a significant difference in the group instrumentation between single file system and multiple file system on continuous rotation motion with a value of 0.036 (p <0.05). The observation results on a scanning electron microscope with 2000 times (Figure 1.a) and 5000 times magnification (Figure 1.c) in group instrumentation with multiple file systems with score of 1. The observation results on a scanning electron microscope with 2000 times (Figure 1.b) and 5000 times magnification (Figure 1.d) in group instrumentation with a single file system with score of 2.

The image observed on the scanning electron microscope with a magnification of 2000 times (Figure 2) shows a picture of the dentinal tubules and the smear layer with each score. In (Figure 2.a), there were more than 75 open tubules and no smear layer.

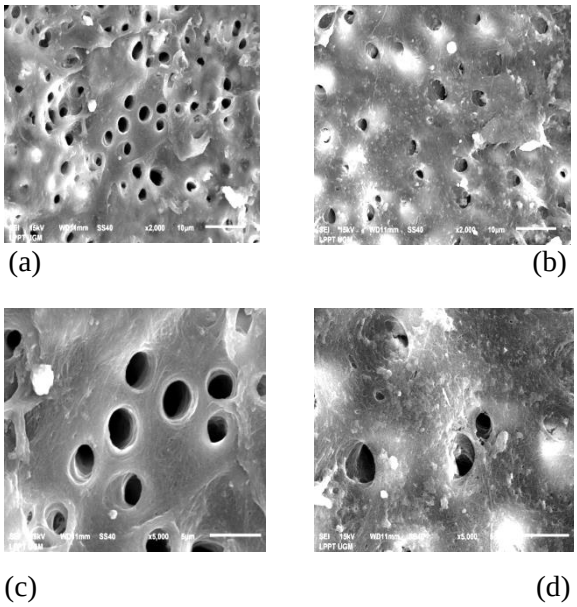

Figure 1. Images of scanning electron microscope magnification 2000 and 5000 times (a) Specimen post preparation using a multiple file system with magnification 2000 times (b) Specimen post preparation using a single file system with magnification 2000 times (c) Specimen post preparation using a multiple file system with a magnification of 5000 times (d) Specimen after preparation using a single file system with a magnification of 5000 times.

In (Figure 2.b) there were smear layer in a certain area, dentinal tubules open less than 75%. In (figure 24.c) There is a smear layer, tubules can be seen in certain areas and partially covered; less than 50% of the dentinal tubules are seen. In (Figure 2.d) there were homogeneous smear layer covering the dentin surface, dentinal tubules are not visible.

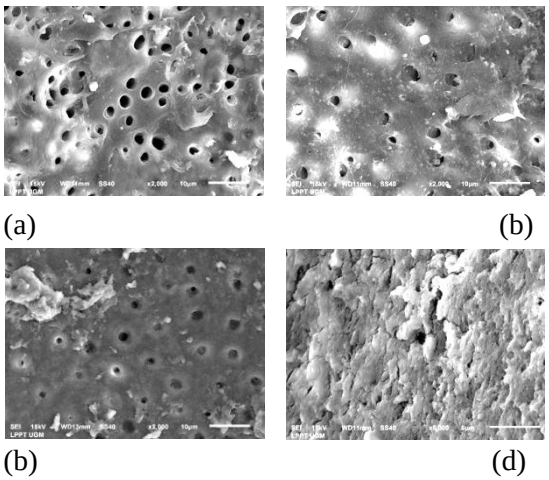

Figure 2. Overview of scanning electron microscope 2000 times magnification Group (a) score 1 (b) score 2 (c) score 3 (d) score 4.

4. DISCUSSION

Based on the results of the Mann Whitney U statistical test, there was a significant difference in the cleanliness of the apical third of the root canal after preparation using a rotary instrument with a single file system and a multiple file system ($p < 0.036$). The mean rank on the results of multiple file system statistics is at 4.42 while that on a single file system is at 8.58. This shows the lowest average score is on a multiple file system.

The Cleanliness of the root canal is influenced by the preparation instruments and irrigation materials used during the instrumentation process. According to Zand et al., physical forms of the NiTi rotary instrument influences the instrument's ability to clean the root canals[15]. This ability was associated with the effectiveness of cutting canal walls and the removal of debris and smear layers from the root canals. These physical forms include geometry design, angles formed by the edge of the cutting blade and rake angle which will affect the effectiveness of cutting. The number of cutting blades that affect the cutting ability of the instrument, the angle formed by the cutting blade edge with the instrument's long axis (helix angle) and the number of spiral per unit length of the instrument (pitch) which affects the release of the instrumentation results, flute design and the grooves between the blades cut to permit the removal of debris and smear layer out from root canal[16].

In this study using a multiple file system instrument with a rectangular cutting blade design with 4 sides of the cutting blade, 4 flutes with a helix angle of 18.5 °, whereas in single file system the design of the geometry combines the cross-section of the triangular cutting blade (3 sides of the cutting blade) and S cross-section (2 sides of the cutting bar). The triangular cutting blade is in the D0 section while the cutting blade S is in the middle towards the corona[17].

The rectangular cross-section of the multiple file system used in this study results in greater cutting power when compared to the single file system, the Asymmetric Rotary (AR) unique movement of the multiple file system can increase the efficiency of root canal formation.[18] The cutting blade the multiple file system when rotating away from the axis enlarges the space making it easier to removed debris[19].

The multiple file instrument in this study had a higher number of cutting blades in the apical third of the working length compared to the single file system instrument used so that the cutting effectiveness of the multiple file instrument in this study was better when compared to the one file instrument in this study. The number of cutting blades will affect the speed of an instrumentation device during root canal preparation[18]. In the study of Santosh et al., mentioned that the cutting power of an instrument with a single file continuous motion system is lower when compared to a multiple file system with continuous rotation motion[19].

Besides, the helix angle and number of threads per unit length of the instrument (pitch), the design of the flute and the presence groove also influence the removal of debris from the instrumentation results[15]. According to Wan et al., The cutting power of the instrument will decrease significantly when the angle of the helix angle increases. The force required by the instrument works more when the helix angle increases. Instruments with smaller helix angles will increase the cutting power of the instrument[21].

The instrument with the multiple file system in this study, besides having 4 sides of the cutting blade also has 4 flutes with several of threads consistent with a helix angle of 18'5 °, while the one file system instrument in this study has 3 flutes on each side of the cutting blade and varying pitch[22]. These conditions allow specimens prepared using a multiple file system in this study to have a residual debris residue in the apical third less than the specimens prepared using a single file system in this study. This is by the opinion of Wan et al., which states that the design of the flute and the number of flutes on each instrument is one of the factors that play a role in cutting efficiency[23]. Besides, Ghobashy et al. which states the ability of instrument preparation with a multiple file system using Protaper Next is better than a single file system using *Oneshape*[24].

After instrumentation root canal cleanliness using endodontic files was evaluated by observing the presence of a smear layer[5]. According to Prati et al, the basic assessment of root canal cleanliness was seen from the number of dentinal tubules that opened after instrumentation[14]. The scoring was increasing when dentinal tubules more covered by the smear layer

Less maximal cleaning can be caused by the lack of file instruments that cut through the dentin matrix[24]. In this study, the possibility of smear layers remaining in the apical third of the root canal during instrumentation using a multiple file system is less than that of a single file system, so that the irrigation solution used in this study was able to eliminate the smear layer which was evaluated using SEM.

5. CONCLUSION

Based on the results of research on the differences in cleanliness of the apical one-third root canal after preparation between single file and multiple file system with continuous rotation motion, the conclusion is that the apical third of the root canal after preparation using a multiple file system is cleaner than the one-file system.

6. SUGGESTION

Based on the results of the study the authors suggest the use of instruments with a multiple file system. However, if you want to use a single file system that is suitable for the instruments in this

study, the preparation time should be extended and irrigated as much as possible.

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