Evaluation of the Cleaning Efficiency of 2 Shape, Hyflex EDM and Pro Taper GOLD Systems Using Digital Image Morphometric Analysis (An in Vitro Study)

Safa S. Alobaidy[1], Biland M.S. Shukri[2]

[1]M.Sc. Student, [2]Asist. Prof. (Conservative Dentistry Department, College of Dentistry/Mustansiriyah University, Iraq)

Abstract

Aim of the Study: To measure and compare the cleaning efficiency of **2 Shape, Hyflex EDM and Protaper GOLD** rotary systems in removing debris and compare the percentage of remaining debris at three different levels of root canal by using digital image morphometric analysis.

Material and Method: Total 60 freshly extracted human maxillary first molar with single straight palatal roots were selected were disinfected in a solution of 1% Thymol for 1 day then the palatal roots were sectioned at a length of 12 mm from the apex and randomly divided into three groups of twenty teeth : **Group A:** Was prepared by 2 Shape file system (Full rotary technique). **Group B:** Was prepared by Hyflex EDM file system (Full rotary technique). **Group C:** Was prepared by Protaper GOLD system (Full rotary technique) . All systems were used according to the manufacture instructions and roots prepared to an apical preparation corresponding to size 40 K-file. Sodium hypochlorite (3%) was used as an irrigant for all groups.

Conclusions: 2 Shape system was significantly less effective than Hyflex EDM and Protaper GOLD systems in eliminating debris from root canals at all levels. There were no differences in the cleaning efficiency between Hyflex EDM and Protaper GOLD systems at all levels of root canals.

Keywords: *2Shape, Hyflex EDM, ProTaper GOLD, cleaning efficiency, Digital image morphometric analysis.*

Introduction

The Successful endodontic treatment that depends on sufficient biomechanical preparation of the root canal space. The goals are consists of cleaning of root canal and removing most of debris and shaping of canal[1,2]. The cutting efficiency is one of the basic properties of nickel–titanium (NiTi) endodontic instruments[3]. Instrument design may be a factor that affects the efficacy of remnant debris removal and for smear layer production[4]. The revolution in the manufacturing of root canal instruments leads to a great variety of these endodontic instruments.[5] The cleaning capabilities of different NiTi rotary systems varies because of the different cross-sections and blade designs of each system[6]. That's include variable tapering along of the cutting blades, modifying the instrument's design of cross-section, and the manufacturing process or by the use of new alloys that produce better mechanical properties[7]. Recently introduced 2Shape file system that consist of TS1 (25/.04) and TS2 (25/.06) files at 300 rpm and 1.2 Ncm The 2Shape system (Micro-Mega) in continuous rotation and two finishing files, F35 size (35, .06) and F40 size(40, .04). The 2Shape system has undergone a thermomechanical proprietary process not disclosed by the manufacturer. The files have a special cross-section with a modified triple helix blade. One of the three blades is off-centred and is 0.06 mm shorter than the two others[8]. Hyflex EDM is made by a thermo-mechanically treated alloy (CM-Wire), and it has three different horizontal cross-sections: quadratic in the apical third, trapezoidal in the middle and triangular in the coronal. The file has a 0.10 mm tip diameter and 5% constant taper[9,10]. The ProTaper Gold system was manufactured by (M-wire) treated to gold wire with a triangular cross

section with variable progressive taper. This design of file with progressively tapered that improve cutting efficiency and safety and more durability for ProTaper Gold system.[11,12]

Material and Method

Sixty freshly extracted human maxillary first molar teeth, Immediately after extraction, bone, calculus and soft tissue on the tooth surface were removed manually with cumine scaler. Teeth was disinfected in 3% of (NaOCl) for 30 minutes then wash and maintained wih distilled water at room temperature with 0.1% thymol crystal until use and in saline solution during the experiment.

The palatal root length was standardized for all samples (12 mm) . The length was determined from anatomical apex to bifurcation area by using digital caliper and marked on the root using permanent marker.

The crown of the tooth was grasped with metal vice and a double-faced diamond disc mounted on a straight handpiece and water as coolant. The sectioning of the palatal root was perpendicular to the long axis of the root to facilitate straight line access during root canal procedure, and to establish a flat coronal surface that served as a stable reference position to facilitate length measurement of the canal, instrumentation, and penetration of irrigation needle.

The Pulp tissue was extirpated by using barbed broach followed by irrigation with 5ml distilled water. The k-file #15 was inserted in the canal until it appear from apical foramen to check the patency of the canals[13]. The correct WL was established by subtracting 1mm from root length**.**

Only roots with initial file size 20 K-file were included in the study. each sample was embedded in silicone rubber base impression material (putty consistency) that placed inside a mold To facilitate handling of the sample during instrumentation procedure.

The specimens Will be randomly divided into three groups (n=20) according to the type of instrumentation systems used. The canal was irrigated with 2 ml of 3% freshly prepared NaOCl, and the final irrigation was done with 3mL of normal saline after root canal instrumentation

In this study The gradation of root canal preparation used were performed according to the manufacturer's instructions of the file system by electrical motor endomate used for each group. First, the silicon stopper was set on the instrument at full of W.L for all types of files and all root canals were instrumented to master apical file to size 40. For standardization all samples were fixed by a small bench vice during instrumentation.

2Shape:

Teeth (n = 20) were prepared with 2Shape system. All canals were prepared by:

1. TS1 (25/.04), at speed 350 rpm and 1.2 Ncm torque until a resistance can be felt.
2. TS2 (25/.06), at speed 350 rpm and 1.2 Ncm torque until a resistance can be felt
3. F40 (40/.04), at speed 350 rpm and 1.2 Ncm torque until a resistance can be felt

Each file use movement in three waves (3 up-and-down movements) with upward circumferential filing movement.

Each new instrument was used to prepare only two canals **(Staffoli., et al, 2018).** Remove the file from the root canal, clean the flutes and irrigate the root canal until reach to file size (40/0.04).

Hyflex EDM: Teeth (n = 20) were prepared with Hyflex EDM was used until reach to finishing file size (40/0.04). Each file was discarded after being used in two canals[14].

ProTper GOLD: Teeth (n = 20) were prepared with ProTaper GOLD files.. The instrumentation was started with shaping files (S1 & S2) were use with a brushing action on the withdrawal stroke: S1 (18/.02) was used to 3/4 of W.L then, to full WL (speed: 300 Rpm and torque: 3.0 Ncm). S2 (20/.04) (shaping file # 2) was used to 3/4 of W.L then, to full WL (speed: 300 Rpm and torque: 1.0 Ncm).

while the finishing files were used with non-brushing motions (pecking motions) until reaching the full WL: F1 (20/.07), (speed: 300 Rpm and torque 1.5 Ncm). F2 (25/.08), (speed: 300 Rpm and torque 2.0 Ncm). F3 (30/.09), (speed: 300 Rpm and torque 2.0). F4 (40/.06) (speed: 300 Rpm and torque 2.0 Ncm).the canal was completed in crown down manner by gentle in and out motion **.** The canal was instrumented to MAF # F4/.06. One set of instruments was used for the preparation of two canals[15]**.**

Finally after final irrigation the canal was dried with absorbent paper points and the access opening was sealed with moist cotton pellet and temporary filling to block the entry of debris during sectioning and prevent contamination of the root canal space[16,17].

After removed the teeth from the impression material and before sectioning, a permanent blue marker was used to draw guiding line longitudinally on the tooth surface parallel to the long axis of the roots **.**A metal saw was used to make longitudinal groove along root, a short blast of air was used to remove any remaining dust then the root was splinted by placing a surgical chisel on the grooves and with small mallet applied with slight pressure **.**the longitudinal section root with most visible part <180 degree was selected for the study (because >180 degree possibly interfere with visualization during photography[18-21]. (Fig. 1).

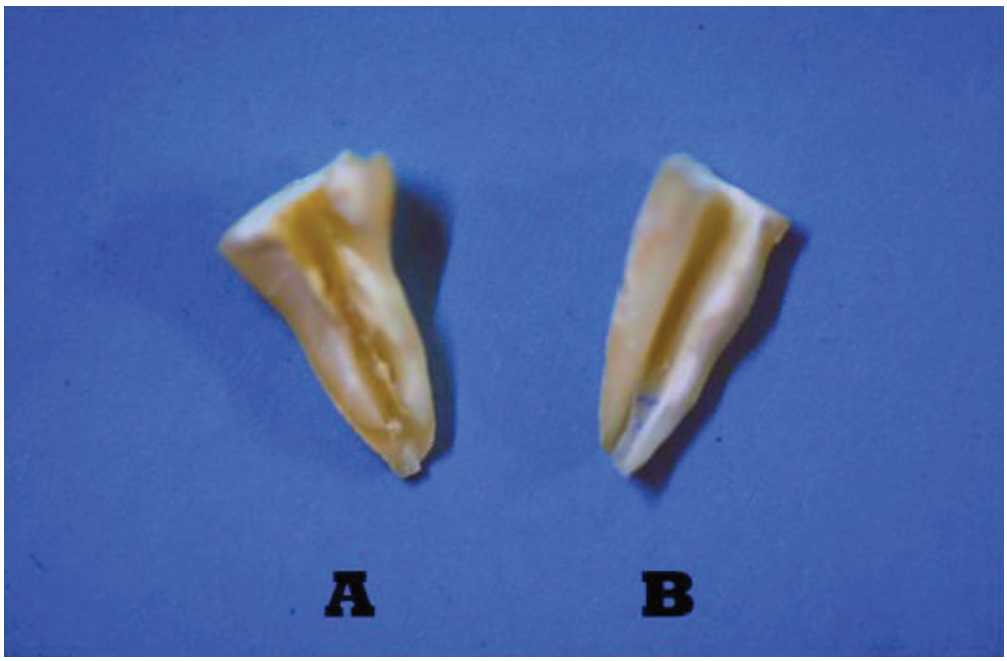

Figure 1: Split root

All images of split roots were taken by using a Nikon D5300 professional digital camera with macro lens(105) at 1:1 setting with electronic macro flash,The images was saved at computer with maximum resolution of 6000×4000 pixels**.** The camera position selected according to the optimum focusing without blurred vision. Sectioned root was placed over a gridding paper under lens for measurement. [16]

All Images were saved and opened into Adobe Photoshop CC 2018 and magnified 100 times with the digital zoom tool. The root canal area was divided into three equal thirds (Apical, Middle and Coronal) by superimposed lines above canals after discarded 2mm coronally avoidance any remnant of temporary filling at 1, 4, 7 and 10 mm from the measured working length (1 mm shorter from the apical foramen).

by using special software tool (magnetic lasso tool) that allow traced The remaining debris in canal and the total number of pixels occupied by the debris was reported by using the histogram function in the software program.

Percentage of remaining debris will be calculated for the 1-4 mm (apical), 4-7 mm (middle) and 7-10 mm (coronal) areas for each canal

Percentage of Dentine Debris at each third =

$$\frac{\text{The Pixels of Dentine Debris at each third}}{\text{Total Pixels of entire canal area of third}} \times 100$$

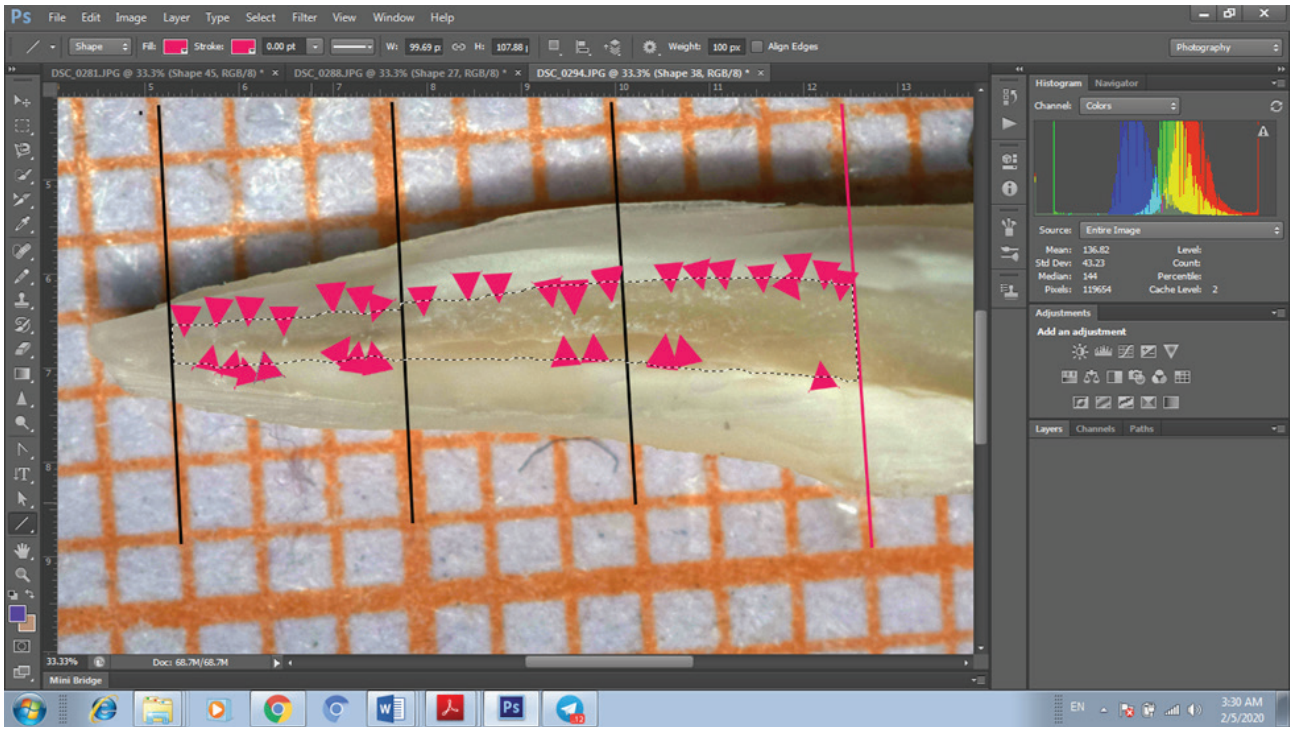

Figure 2: Digital image analysis magnified at (X 33.33) of one root section that instrumented by 2SHAPE system with using Adobe Photoshop CC 2018. pink arrows referred to some of dentin debris.

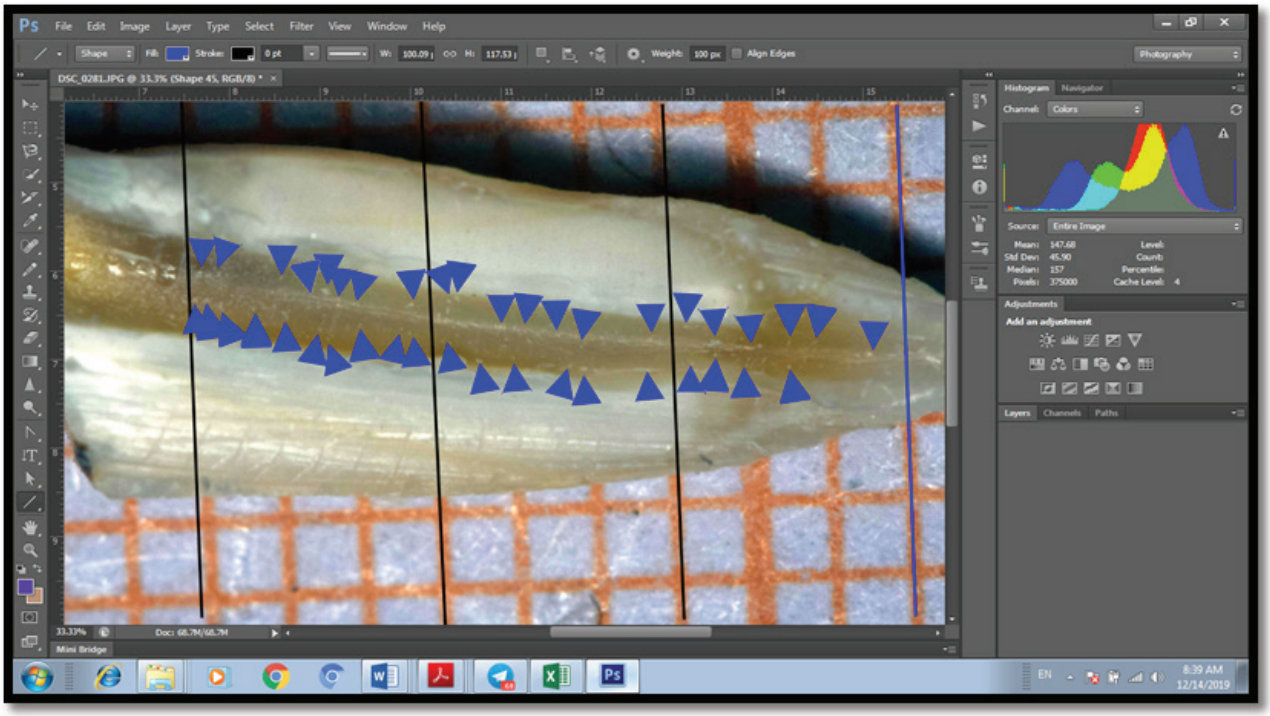

Figure 3: Digital image analysis magnified at (X 33.33) of one root section that instrumented by Hyfex EDM system with using Adobe Photoshop CC 2018. blue arrows referred to some of dentin debris.

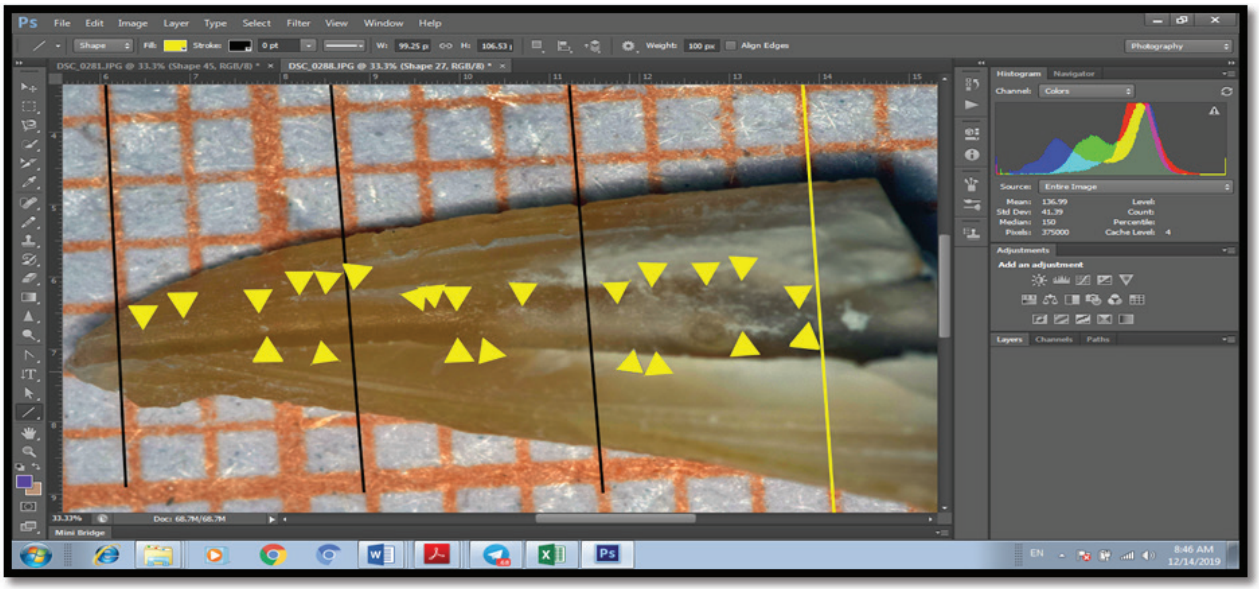

Figure 4: Digital image analysis magnified at (X 33.33) of one root section that instrumented Protaper GOLD system with using Adobe Photoshop CC 2018. yellow arrows referred to some of dentin

Results

data were tested for normality using the Shapiro-Wilk test .Kruskal-Wallis test showed a significant difference ($P \leq 0.05$) between groups for the remnant of dentin debris at all levels (Apical, Middle, and Coronal).

The median values of the remnant of dentin debris for different groups and different levels . At the apical level, group A showed the highest remnant (2.79%) followed by a group B(0.40%) while the lowest remnant was found at group C (0.35%).

At the middle level, the highest remnant was found at the group A(1.32%) followed by group C(0.42%), and the lowest remnant was found at group B (0.39%). At the coronal level, the highest remnant was found in group A(0.95%) followed by group B(0.5553%), and the lowest remnant was found at group C (0.35%). (**Figure** 5).

For all groups and thirds, the highest remnant was found at the apical level of group A and the lowest remnant was found at middle of group B and coronal thirds of group C.(**Figure** 6)

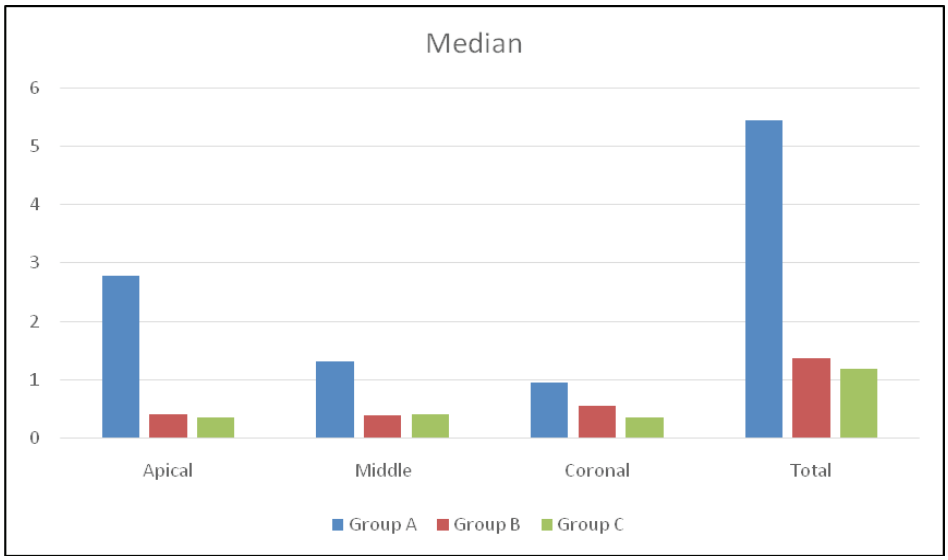

Figure 5: Median of percentages of remnant of dentin debris at different levels and groups.

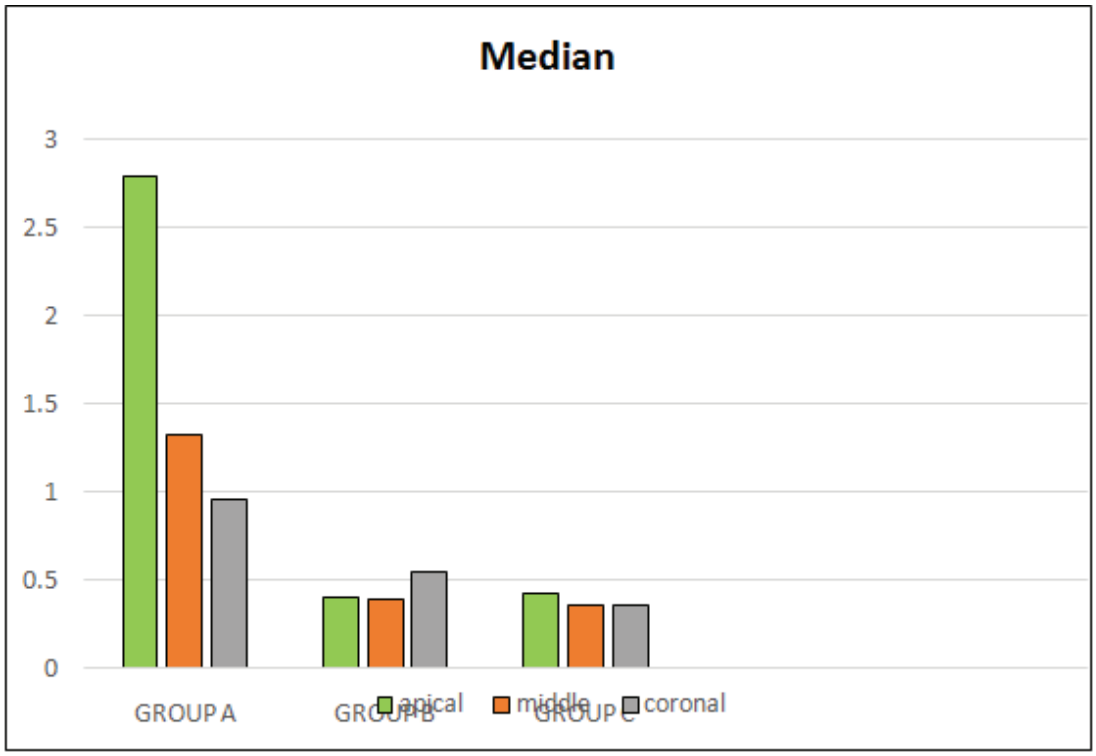

Figure 6: Median of percentages of remnant of dentin debris at different levels and groups.

Mannwhitney with bonferroni correction test showed a significant difference at apical and middle levels between group A and group C and also found significant difference at apical and middle levels between group A and group B.

Discussion

The most important objective of root canal therapy is to decrease the number of microorganisms and pathologic debris in root canal systems to prevent or treated apical periodontitis. Grossman (1976) described mechanical cleaning as the most important part of root canal therapy.

The result shows significant difference between (2Shape at all levels with no significant difference between Hyflex EDM and ProTaper Gold). The cause of a significant difference between groups and levels may be related to two reasons: the first one the instruments design and second one metallurgical properties (alloy processing) . Endodontic instruments vary in their debris removal efficacy and their smear layer production**.**

In this study the 2Shape file produced the highest amount of debries among the tested file system. Also the 2 Shape file has a significant difference between levels (apical - middle) and (apical-coronal) most of remnant diagnosed apically.

Manufacture done by applied the thermal treatment which as the **(T.wire)** 2Shape files are exposed to multiple thermal cycles to transition the crystalline phase of nickel-titanium. The Hyflex EDM file system shows second least amount of debris. Hyflex EDM is the first endodontic instrument that is manufactured an electrical discharge machining (EDM) process creates a 'rough spark-machined' That creates a hard and rough surface of the file, resulting in superior fracture resistance and improved cutting efficiency**.**

Conclusions

Within the limitation of this in vitro study, None of the experimental instrumentation systems used were able to achieve completely clean canal from debris; 2 Shape system was significantly less effective than Hyflex EDM and Protaper GOLD systems in eliminating debris from root canals at all levels and There were no differences in the cleaning efficiency between Hyflex EDM and Protaper GOLD systems at all levels of root canals.

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Conflict of Interest: None to declare.

Ethical Clearance: All experimental protocols were approved under the College of Dentistry, and all experiments were carried out in accordance with approved guidelines.

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