Al-Azhar Journal of Dentistry

Volume 7 | Issue 2 Article 4

Restorative Dentistry Issue (Removable Prosthodontics, Fixed Prosthodontics, Endodontics, Dental Biomaterials, Operative Dentistry)

4-1-2020

Comparison of the Cleaning Effectiveness and Incidence of Dentinal Defects after Biomechanical Preparation Using Different Ni Ti Rotary Instruments in Root Canals

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How to Cite This Article

Mohammed, Maiada; Kamel, Wael; and Rokaya, Mohammed (2020) "Comparison of the Cleaning Effectiveness and Incidence of Dentinal Defects after Biomechanical Preparation Using Different Ni Ti Rotary Instruments in Root Canals," *Al-Azhar Journal of Dentistry*: Vol. 7: Iss. 2, Article 4.
DOI: https://doi.org/10.21608/adjg.2020.7722.1095

AL-AZHAR
Dental Journal
For Girls

The Official Publication
of The Faculty of Dental
Medicine For Girls,
Al-Azhar University
Cairo, Egypt.

Print ISSN 2537-0308 • Online ISSN 2537-0316

ADJ-for Girls, Vol. 7, No. 2, April (2020) — PP. 165:170

Comparison of the Cleaning Effectiveness and Incidence of Dentinal Defects after Biomechanical Preparation Using Different Ni Ti Rotary Instruments in Root Canals

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http://adjg.journals.ekb.eg

DOI: 10.21608/adjg.2020.7722.1095

Restorative Dentistry
(Removable Prosthodontics, Fixed Prosthodontics, Endodontics, Dental Biomaterials, Operative Dentistry)

ABSTRACT

Purpose: This study was directed to evaluate the cleaning effectiveness& the dentinal defects incidence after preparation with different Ni-Ti rotary instruments in permanent molar root canals. **Materials and Methods***:* A 60 human permanent lower first molars were used in this study. According to the Ni-Ti rotary system used in canal instrumentation, specimens were divided into 3 main groups (n=20) (One Shape, HyFlex EDM and XP-Endo Shaper). Each system was used as the suggested settings by manufacture. Each group was received Copious irrigation with 2.6% NaOCl was performed after the use of each file and finally with combination of 17% EDTA and 2.6% NaOCl. Then specimens were washed with distilled water. Each main group was divided into two subgroups (A &B) (n=10) according to evaluation methods: Subgroup A: The cleaning effectiveness (Scanning electron microscopic (SEM) evaluation). Subgroup B: The incidence of dentinal defects (Steriomicroscope evaluation). **Results:** Regarding to cleaning effectiveness, highest mean and standard deviation values were recorded for HF system while lowest mean value was recorded for XP system. Regarding to dentinal defects, the highest mean and standard deviation values were recorded for OS system, while the lowest mean value was recorded for XP system. **Conclusions:** The results of the present study showing that: XP-Endo Shaper file gives promising better results in cleaning ability with minimal incidence of dentinal defects found in root dentin.

KEYWORDS

Dentinal defect,
Ni-Ti rotary instruments,
Steriomicroscope.

INTRODUCTION

Success of endodontic therapy depends on proper root canals' biomechanical preparation. Canals prepared with stainless steel instruments were cleaned only superficially and the pulp tissue was

- Paper extracted from Master thesis entitled "Comparison of the Cleaning Effectiveness and Incidence of Dentinal Defects after Biomechanical Preparation Using Different Ni Ti Rotary Instruments in Root Canals".

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not removed completely. Also it have been shown time-consuming and iatrogenic errors were created such as ledging, zipping, canal transportation, apical blockage and formation of cracks in the root dentin[1, 2]. Ni-Ti instruments have been developed to eliminate some of the short comings of these traditional endodontic instruments [3].

Ni-Ti mechanical instrumentation with chemical cleaning reduce remaining microorganisms in the root canal system [4-6]. The number of bacteria in the root canal decreased by combining the use of irrigation solutions and rotary instruments compared to standard instrumentation alone [7]. In the past few years, several rotary systems have been introduced to the market to shape the root canal system. These systems consist of 2 or more files. Recently to reduce the consumption of time, the concept of cleaning and shaping root canal using single-file was introduced [8].

MATERIAL AND METHODS

Teeth selection and preparation:

60 recently extracted human permanent mandibular first molars were used in this study. The crowns were decapitated from the roots at 2 mm above the cemento-enamel junction and the distal root of all samples was separated at the furcation level with a double face diamond disk. Canal Patency establishment with no.10 K-File.

Samples grouping:

According to the Ni-Ti rotary system used in canal instrumentation, specimens were randomly divided into 3 main experimental groups: Group 1: Specimens were prepared by OS (Micro mega-France) rotary file, Group 2: Specimens were prepared by HF (EDM), One File 25 (Coltene–Whaledent, Switzerland), Group 3: Specimens were prepared by XP-Shaper (FKG Dentaire, Swiss) single file. Each group was received Copious irrigation with 2.6% NaOCl was performed after the use of each file. And finally with combination of 17% EDTA and 2.6% NaOCl. Then specimens were washed with distilled water. Each main group was further divided into two subgroups (A & B) according to evaluation methods: Subgroup A: The cleaning effectiveness (SEM evaluation) and Subgroup B: The incidence of dentinal defects (Steriomicroscopic evaluation).

Scoring and evaluation:

A. SEM evaluation:

The cleanliness of the root canals and smear layer were evaluated at three levels of root canal (apical, middle and coronal) using environmental SEM (FEI Quanta ESEM). Photomicrographs were taken under magnification (X 4000) and scored then analyzed.

B. Steriomicroscopic evaluation:

The instrumented teeth were sectioned at levels of 9, 6 and 3 mm from the apex by low speed diamond disc, scored according to the origin of defects then analyzed.

Statistical analysis:

Data were presented as mean and standard deviation values. Cleaning effectiveness scores were compared using ANOVA test. Dentine defects scores were compared using Kruskall Wallis test.

RESULTS

I. Cleaning effectiveness:

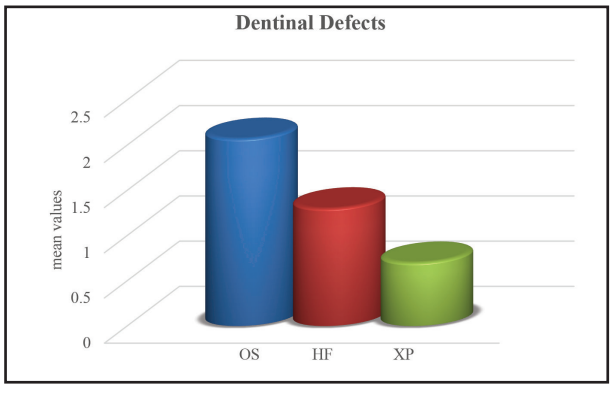
At the apical part, the highest values were recorded for XP system and OS system, and the lowest values were recorded for HF system. At the middle part, the highest values were recorded for HF system, and the lowest values were recorded for OS system and XP system. At the coronal part, the highest values were recorded for HF system, and the lowest values were recorded for XP system. At the total all parts, the highest values were recorded for HF system, and the lowest values were recorded for XP system. ANOVA test revealed that the difference between groups was not significant(Table 1).

Table (1) *Mean scores of cleaning effectiveness using different files in different root segments .*

		Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max	*P* value
					Lower Bound	Upper Bound			
Apical	**OS**	3.20	0.63	0.20	2.75	3.65	2.00	4.00	0.845ns
	HF	3.00	0.67	0.21	2.52	3.48	2.00	4.00	
	XP	3.20	1.23	0.39	2.32	4.08	1.00	5.00	
Middle	**OS**	1.50	0.71	0.22	0.99	2.01	1.00	3.00	0.215ns
	HF	1.90	0.99	0.31	1.19	2.61	1.00	4.00	
	XP	1.50	0.71	0.15	0.95	1.65	1.00	2.00	
Coronal	**OS**	1.50	0.53	0.17	1.12	1.88	1.00	2.00	0.122ns
	HF	2.20	1.40	0.44	1.20	3.20	1.00	4.00	
	XP	1.40	0.52	0.16	1.03	1.77	1.00	2.00	

II. Dentinal Defects:

At level 3mm, the highest mean and standard deviation values were recorded for OS system, while the lowest mean value was recorded for XP system. At level 6mm, the highest mean and standard deviation values were recorded for OS system, while the lowest mean value was recorded for XP system. At level 9mm, the highest mean and standard deviation values were recorded for OS system, while the lowest mean value was recorded for XP system. At all levels, the highest mean and standard deviation values were recorded for OS system, while the lowest mean value was recorded for XP system. Kruskall Wallis test revealed that the difference between groups was significant (fig.1).



Figure(1) Column chart showing mean values of dentinal defects in different files

DISCUSSION

The purpose of root canal preparation is to shape root canal irregularities and clean the root canal system from debris and microorganisms, to facilitate the placement of a permanent root canal filling materials. During root canal instrumentation there are many complications such as perforations, ledge formation, transportation of canal, and formation of cracks in the root dentin. The effective ability to clean the root canal system depends on using both instrumentation and irrigation [9].

The present study conducted for evaluating the cleaning effectiveness and incidence of dentinal defect formation after preparation with three Ni-Ti rotary systems which are single-file systems used in continuous rotation; HF, OS and XP, in mesio-buccal canals of the extracted human mandibular first molars using (SEM) to evaluate cleaning effectiveness and stereomicroscope to rule out the dentinal defects.

I. Comparison of different systems in each root segment regarding to its Cleaning effectiveness:

Regarding to the apical segment, the possible reasons for this difference in the cleaning ability between these systems can be attributed to that electrical discharge machining (EDM) manufacturing

process created a hard and rough surface that might improve the cutting efficiency of HF files. HF files are produced by control memory treatment just like HyFlex CM file which results in the high flexibility of HF. Whereas OS made from conventional Ni-Ti wire and XP made from max-wire [10].

In the middle segment, the relatively good smear layer removal capacity of OS than HF could be attributed to an increased chip space due to progressively changes from an asymmetrical design of three cutting edge at apical portion to two cutting edges at middle portion, allowing more debris to transport in a coronal direction. Larger cross-sections of HF than OS, HF has trapezoidal cross-section in middle part while OS has transitional zone, may not provide enough space for debris to be displaced and the debris impedes the instrument for cutting more dentin [11].Also OS has a variable helix angle that provides excellent upward debris removal and limits the screwing effect [12].Somewhat better cleaning ability of XP than HF may be due to its smaller core diameter compared with other instruments [13].

In the coronal segment, the possible reasons for low debris removal capacity of HF than OS can be attributed to their cross sectional design; HF has triangular cross section at the coronal portion while OS has S-shaped cross section at the coronal portion with 2 cutting edges ,which decrease its chip space than OS [14].

The overall cleaning efficacy is best with XP followed by OS, whereas the lowest cleaning efficacy was recorded in HF. The best cleaning ability of XP than any other systems may be attributed to its irregular movement and its smaller mass, which allows upward removal of debris during root canal preparation [13]. The best cleaning of XP could be explained also by the instrumentation technique, and rotational high speed (800 rpm). Also the specific design of XP. Namely, the shape like snake and super elasticity of XP allowed it to expand in the canal (from taper 0.1 to 0.4 taper) and reach inaccessible parts (canals, lateral canals, apex ramifications). Debris that are created are easily and efficiently removed, the larger chip space compared to other instruments with a larger core diameter . The reason of the relatively higher cleaning effectiveness of OS than HF may be due to its asymmetric cross-sectional geometry, this design provides an optimal cutting action resulting in a better cleaning and shaping of the curved root canal systems[15,16].

II. Comparison of different systems regarding to dentinal defects formation:

The lowest incidence of dentinal defects observed in root dentin after instrumentation with XP as compared to HF and OS may be due to the manufacturing process. XP is prefabricated with the Ni-Ti Max-Wire. The metallurgical alloy gives the instrument high flexibility, super elasticity and more resistance to fatigue. The greater flexibility of these files may prevent the formation of dentin microcracks [17-19]. Previous studies suggested that instruments manufactured from controlled memory Ni-Ti wire have more flexibility than conventional Ni-Ti wire. Hence, HF manufactured from this wire would have contributed to less number of cracks than OS which made from conventional Ni-Ti wire [20,21]. The present result may be also attribute to that XP has less taper compared with HF and OS. Some authors confirmed that when taper of the instrument is increased, it tends to remove more root dentin, compromising the root which is more likely to get dentinal defects[22]. In contrast, HF having more taper (0.08) than OS (0.6) results in less crack. This may be due to the manufacturing process [23].

Regarding to each system, the highest mean value was recorded at 3mm, then at 6mm, whereas the lowest value was recorded at 9mm. The snake-shaped design of XP file gives the file an extra flexible structure which providing less stress to dentin walls and minimizes the risk of microcracks formation in dentin. For HF the variable taper and variable cross-section over entire length of working part may explain the reduced dentinal defects at 6mm and 9mm teeth sections than at 3mm teeth sections.

Regarding OS these results could be influenced by their asymmetrical cross-section over entire length, constant taper, variable pitch and noncutting safety tip [24].

CONCLUSION

According to the results of the present study, it could be concluded that: XP-Endo Shaper file gives promising better results in cleaning ability with minimal incidence of dentinal defects found in root dentin.

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