Original Article

Comparison of Irrigation Penetration into the Apical Part of Canals in Hand and Rotary Instrumentations

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ABSTRACT

Introduction: The penetration of irrigating solution to the apical one third of canals and removal of debris are dependent on the final size of the instruments and instrumentation techniques used in the canals. The purpose of this study was to evaluate the effect of final instrument size, on irrigation penetration into the apical part of canals in hand K-file instrumentation versus rotary system of Hero 642.

Methods and Materials: The mesiobuccal canals of 48 first mandibular molar teeth were selected for this study. The teeth were divided into 2 groups of 24 in each and the mesiobuccal canals were instrumented by hand K-file or rotary system of Hero 642 at 2 stages. After each stage, a contrast medium was injected into the canals and radiographs were taken by RVG system. The irrigation penetration was measured in radiographs by Diamax software. The data were analyzed using t – student test.

Results: This study showed that instrumentation up to # 25 file is not enough for irrigation penetration into the apical area. Also by more flaring the canals, more irrigating solution penetrates into the apical part of canals ($P \leq 0.001$), but the difference between hand and rotary systems was not statistically significant ($P > 0.05$).

Discussion: According to this study, instrumentation up to # 30 file results in better irrigation penetration into the apical area. The flaring of the canals is essential for better cleaning and irrigation of apical area.

Key Words: Cleaning, Filing, Flaring, Irrigation penetration, Master Apical File.

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Introduction

Cleaning and shaping the root canals are essential steps in root canal treatment. Unfortunately, the mechanical action of instruments is unable to reach some areas of the root canals due to their anatomical complexities [1].

Davis et al have shown that the morphology of root canals is very complex and that mechanically prepared canals contain areas not accessible by currently used endodontic instruments [2]. Thus a root canal irrigating solution is needed to aid canals debridement [3].

The irrigating penetration into the apical one third of canals and removal of debris are dependent on the final size of the instruments used in the canals [4]. Different results

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have been reported regarding the effectiveness of minimum enlargement size in the apical one third of canals to achieve proper irrigation penetration [5-8].

The apical enlargement size depends on the kinds of instruments and techniques used in canal preparation. One of the commonly used methods of instrumentation is conventional "K" type file with manual step back technique. Recently, a new generation of endodontic instruments, made from nickel, titanium, or nitinol alloy have been introduced which has a new blade design, greater instrument taper, alternative sizing system, and introduction of full rotary motion for cleaning and shaping canals [9].

The aim of this study was to evaluate the effect of final instrument size and canal shaping in hand K- file instrumentation versus rotary system of Hero 642, on irrigation penetration into the apical part of canals.

Methods and Materials

This experimental (in vitro) study was performed on mesiobuccal canals of 48 freshly extracted human first mandibular molars with lengths of 18-22^{mm} and curvature of 20-30 degrees. The teeth with calcification, open apex, excessive curve, aggressive or root caries, root resorption, or treated root canals were excluded from study.

After debridement and disinfecting with 5.25% NaOCl for 20 minutes, wax was placed on the apex of mesiobuccal canals and the teeth were cast. After taking a diagnostic radiograph, access cavity was prepared and coronal pulp was extirpated. Then a #15 K-file (Mani, Japan) was inserted in mesiobuccal canal up to approximate working length. A radiograph was taken and exact working length(WL) was determined.

Then the teeth were divided into 2 test groups of 24 in each and canal preparation was done in 2 stages at each group as follows.

First group (24 teeth):

Stage A:

1. Pre flaring with No 1, 2, 3 Gates Glidden drills by step back technique,
2. instrumentation with # 15, 20, 25 K-files (Mani, Japan) up to WL (MAF= 25),
3. irrigation by 2 ml of 2.6% NaOCl after each filing by a 23 gauge needle (Maybod Yas, Iran),
4. maintaining patency during instrumentation,
5. final irrigation by 2 ml of 2.6% NaOCl,
6. drying canal with paper points,
7. injection of 2 ml of 50% NaI (Kimia, Iran) as a contrast medium into the canal for 2 minutes. This procedure was performed by the same needle used for irrigation during instrumentation (a 23 gauge, Maybod Yas, Iran), so the needle was not locked into the canal,
8. covering the access cavity with wax, and
9. taking a radiograph with RVG system (Planmeca, Finland) in constant parameters (50 KVP, 8 MA, 0.12 S).

Stage B:

1. Removing the wax,
2. irrigating the canal by 10 ml of normal saline to remove contrast medium,
3. filing with # 30 K-file up to WL (MAF=30),
4. flaring by # 35, 40, 45 K- files and No 3, 4 Gates Glidden drills,
5. recapitulating to MAF, maintaining patency, and irrigation by 2 ml of 2.6% NaOCl after each file,
6. final irrigation by 2 ml of 2.6% NaOCl,
7. drying the canal with paper points,
8. injection 2 ml of 50% NaI for 2 minutes,
9. covering the access cavity with wax, and
10. taking a radiograph with RVG in a similar manner to stage A,

Second group (24 teeth):

Stage A:

1. Pre flaring with No I, 2, 3 Gates Glidden drills by step back technique,
2. instrumentation with rotary system of Hero 642 (MicroMega, Switzerland) in this arrangement: 20/0.06 → 20/0.04 → 20/0.02 → 25/0.04 → 25/0.02 to WL (MAF=25/0.02) accompanying by irrigation with 2 ml of 2.6% NaOCl after each file, and
3. final irrigation and following process same as group 1.

Stage B:

1. Removing the wax,
2. irrigating the canal by 10 ml of normal saline to remove contrast medium,
3. instrumentation with Hero 642 No 30/0.02 → 30/0.04 (MAF), and
4. final irrigation and following process same as group 1.

For similarity of radiographs in stages A and B in both groups, an acrylic mold was made from tube and sensor of RVG in a stable situation and all radiographs were taken at that position.

The radiographs of both stages of two test groups were analyzed by Diamax software[1]. Three dentists measured the full length of canal (orifice to radiographic apex) and penetration depth of contrast medium by this software in pixels. The average of data collected by the three observers was calculated and the percent of the penetration depth of contrast medium was measured for each specimen by the following ratio:

$$\frac{\text{Mean penetration depth of contrast medium}}{\text{Mean full length of canal}} \times 100$$

The data analysis was done by t- student test.

Results

The results of this study are shown in table 1. This study demonstrated that by larger instrumentation in apical area and more flaring of the canals, more irrigating solution penetrates to the apical part of canals ($P \leq 0.001$), but the difference between hand and rotary systems was not statistically significant at each stage ($P > 0.05$).

Table 1. Penetration of contrast medium into the canals in different stages in two groups.

	hand file Mean ± SD (%)	Hero 642 Mean ± SD (%)	T	P-value
Stage A MAF = 25	92.22 ± 7.49	88.31 ± 13.96	1.20	0.233
Stage B MAF = 30	99.89 ± 0.49	99.98 ± 7.37	0.86	0.391

[1] Diamax is a software for processing the pictures taken by the digital imaging system. This software enable clinician to manipulate the picture displayed on the monitor and save it.

Discussion

Yared and Dagher reported that a # 25 file was as efficient as a # 40 file for reducing residual microorganisms [10]. Coldero et al also concluded that no excessive apical enlargement is necessary for intracanal bacterial reduction [6].

In contrast to these findings, several investigations emphasize on instrumentation up to files larger than # 30 to reduce the bacterial counts and enhance the antibacterial effects of irrigation [4, 11, 12]. Some authors have recommended to enlarge the canals up to more than # 40 files at the apical one third of canals to achieve better cleaning [7, 13, 14].

Khabiri et al showed that the instrumentation up to size 30 is enough for irrigation penetration into the apical part of canals [15]. Khademi et al also reported that apical instrumentation up to # 30 file with 0.06 coronal taper is effective for the removal of debris and smear layer from the apical portion of root canals [16]. But Senia et al showed minimum penetration of NaOCl to the apical part of canals enlarged up to # 30 files [17]. Albrecht et al evaluated various tapers of Profile GT files and observed more cleaning by larger instrumentation than # 20 preparation [18].

This study showed that when master apical file was # 25, the irrigation did not penetrate enough into the apical area, but with MAF=30 irrigation reached to this area in both hand and rotary groups. This finding is in agreement with Khabiri et al and Khademi et al [15, 16]. The difference between Senia et al study and ours maybe is due to more tapering in canals with MAF=30 in our study. Also by more flaring the canals, more irrigation penetrated into the apical area. The difference between hand and rotary instrumentations with similar MAF was not statistically significant which is in contrast with Sharma and Shivanna [9]. They compared the amount of smear layer after hand and rotary instrumentations and found that hand instrumentation left more smear layer than Light speed, Profile, and Hero 642 in middle and apical one thirds of canals [9]. This difference could be due to the evaluation method

which in their study was the amount of smear layer but in our study it was the depth of irrigation penetration.

It seems that, regardless of the type of instrumentation (hand or rotary), apical filing up to # 30 file is necessary for proper penetration of irrigation into the apical area. Two sizes flaring in apical area associated with coronal flaring by NO 1, 2, 3, 4 G.G in hand instrumentation, and 0.04 tapering in rotary instrumentation is enough for this purpose.

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