Research Article

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Determination of the Diameter of the Prepared Apex to Improve the Irrigants Efficacy: An In Vitro Study

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ABSTRACT

Aims: The purpose of this study was to determine the minimum instrumentation size required for the effective penetration of irrigants and elimination of debris and smear layer from the apical third of the root canals.

Methods and Material: The mesiobuccal canals of 19 freshly extracted human mandibular first molar teeth were instrumented using the crown-down technique. The teeth were divided into four test groups according to the size of their Master Apical File (#20, #25, #30), and two control groups. After final irrigation, the removal of debris and smear layer from the apical third of root canals was determined under a scanning electron microscope. The data was analyzed using Kruskal-Wallis and Mann- Whitney tests.

Results: Based on the results, it appears that the minimum instrumentation size needed for penetration of irrigants to the apical third of the root canal is a #30 file

Conclusion: Adequate apical enlargement is a prerequiste for improved irrigant efficacy in the root canal system.

Keywords: NaOCl, Apical diameter, irrigant penetration, Smear layer.

INTRODUCTION

Bacteria and their by-products have been shown to potray a siginificant role in pulpal and periapical diseases. Disinfection and complete obturation of the root canal system, and prevention of reinfection are long considered the basis for successful endodontic therapy(1). Mechanical instrumentation and irrigation are sound endodontic principles and essential components of successful Endodontics.Consequently different irrigants are used during cleaning and shaping root canals for the removal of smear layer and necrotic tissues.(2,3)

Root canal preparation is accomplished using a combination of mechanical instrumentation and chemical irrigation (4). Sodium hypochlorite (NaOCl) has been the most commonly used endodontic irrigant for the past four decades. Sodium hypochlorite in conjunction with Ethylenediaminetetraacetic acid (EDTA) is able to remove remaining pulp tissue, smear layer, and predentine (5,6). The penetration of irrigants to the apical third of canals and removal of debris are dependent on the final size of the instruments used in the canals. Studies by Ørstavik et al. (7) and Matsumiya and Kitamura (6) suggested that the size of apical instrumentation may be important for the

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Fig 1: test samples divided into groups.

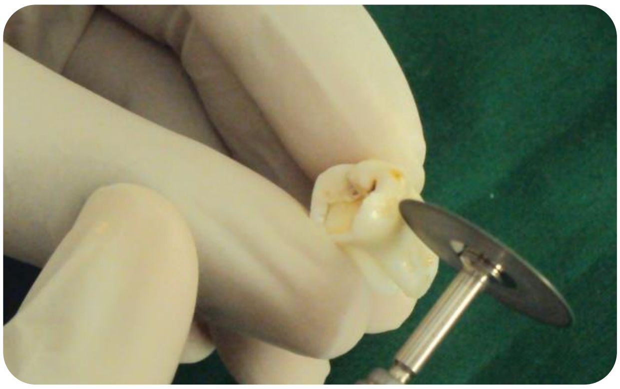

Fig 2: tooth being split in buccolingual direction.

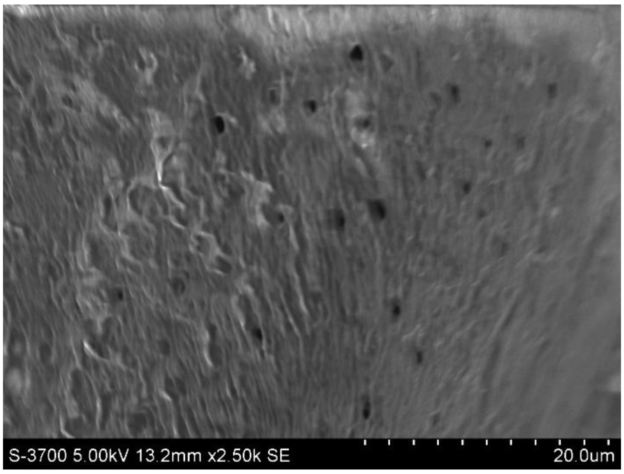

Fig 3: Positive control group.

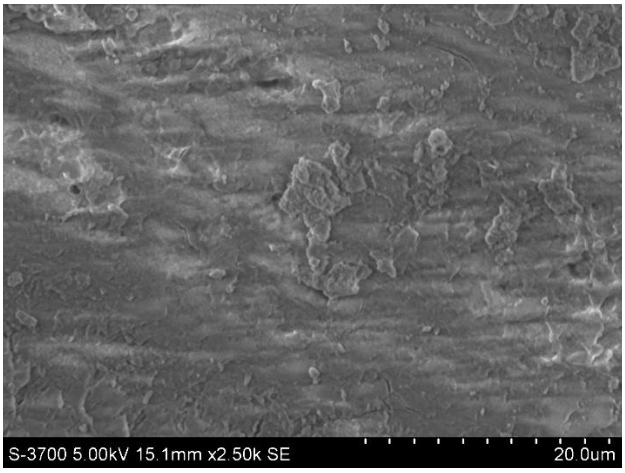

Fig 4: Negative control group.

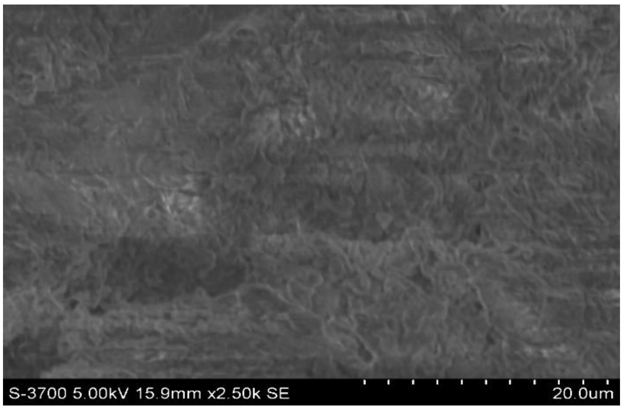

Fig 5: Test sample 1 (apical enlargement to #ISO 20 6% TAPER)

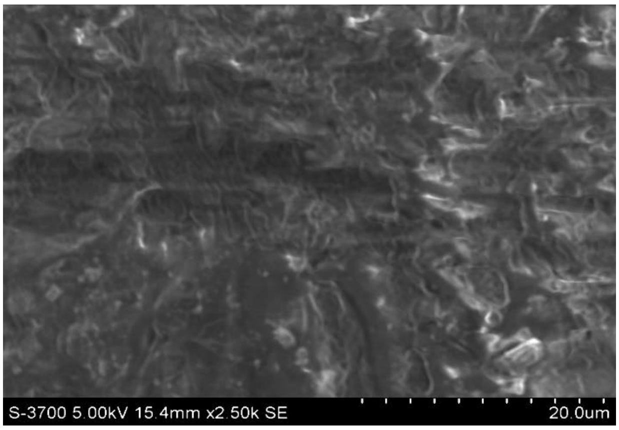

Fig 6: Test sample 2 (apical enlargement to #ISO 25 6% TAPER)

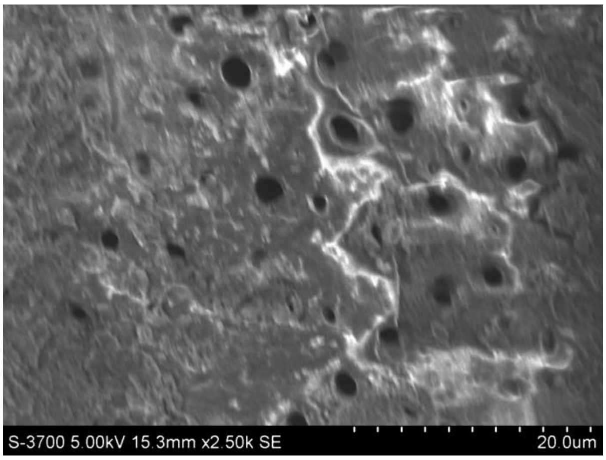

Fig 7: Test sample 3 (apical enlargement to #ISO 30 6% TAPER)

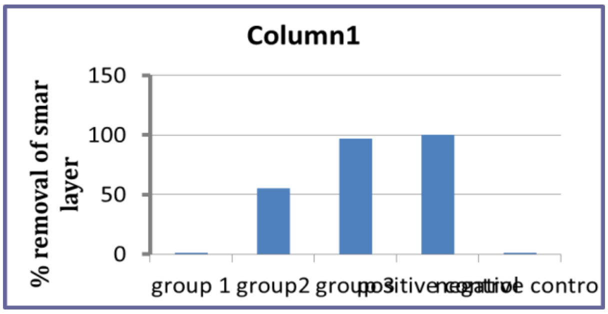

Fig 8: % removal of smear layer.

effective removal of canal bacteria. These studies found that with larger instrumentation fewer bacteria remained in the canal and the healing was more rapid. Different results have been reported regarding the effectiveness of minimum enlargement size in the apical third of canals to achieve proper penetration of irrigants (2,8). The purpose of this study was to determine the minimum canal enlargement in the apical part of instrumented canals for the removal of debris and the smear layer.

MATERIALS AND METHOD

15 freshly extracted human mandibular molar teeth with two separate mesial canals were selected for this study. Straight line access established using a diamond fissure bur in a highspeed handpiece.The working length of mesiobuccal canals was visually determined by a K-File #10 (Maileffer, Switzerland) 0.5 mm short of the apical foramen. Then, the root end of each tooth was covered with melted wax to disable the operator from seeing root canal instrumentation during cleaning and shaping.

The teeth were divided into three experimental groups with five teeth in each, and two control groups with two teeth in each. The mesiobuccal canals were instrumented by crown-down technique using hand files (Maileffer) and rotary files (Protaper, Dentsply). Each canal in the three experimental groups was enlarged at the working length to a #20 file in group 1; #25 file in group 2 and #30 file in group 3. Each canal in the two control groups was enlarged at the working length to a #40 hand NiTi file. Root canals in all groups were irrigated with 2ml of 5.25% NaOCl using a 27-gauge needle after each instrument. In the three experimental groups and the positive control group each canal received a final irrigation of 5 ml of 17% EDTA for 5 min followed by 5 ml of 5.25% NaOCl for 5 min. Final irrigation in the negative control group was only with 5 ml of 5.25% NaOCl for 5 min. Root canals in all groups were irrigated with 5 ml of distilled water to remove any effects of irrigants. Two grooves without entrance into the canals were created on the buccal and lingual surfaces of the mesial root; each root was split longitudinally in a buccolingual direction. One-half of each root was randomly selected and placed in a 2% glutaraldehyde solution for 24 hrs.

The fixed specimens were rinsed three times with a sodium cacodylate buffered solution (0.1 M, pH _ 7.2), incubated in osmium tetroxide for 1 hr, dehydrated with ascending concentration of ethyl alcohol (30-100%) and placed in a dessicator for at least 24 hrs. Each specimen was then mounted on an aluminum stub, coated with 25_m of gold palladium and examined under a scanning electron microscope (SEM). Photomicrographs of the apical third of each canal with a magnification of 2500x were taken for final evaluation. In a blind manner, three investigators scored the presence or absence of smear layer on the surface of the root canal or in the dentinal tubules from the coded photomicrographs.

A score of 1 through 8 was used for the evaluation of photomicrographs (9):

Score 1: The surface is devoid of debris and smear layer.

Score 2: The surface is devoid of smear layer, but little debris is observed.
Score 3: The surface has been cleaned, but both smear layer and debris are dispersedly observed.
Score 4: The surface has been cleaned, but the level of smear layer and debris is also noticeable.
Score 5: The clean surface is a bit greater than unclean surface.
Score 6: Almost half of smear layer and debris have been removed.
Score 7: The greater part of smear layer and debris are left.
Score 8: The surface is completely covered with smear layer and debris.

After scoring the photomicrographs, the information was recorded and analyzed using Kruskal-Wallis and Mann-Whitney tests.

RESULTS

All of the specimens in the positive control group were devoid of smear layer and had significant erosion at the orifices of the dentinal tubules. Each specimen in this group received a score of 1. All the specimens in the negative control group were covered with smear layer and debris. Each specimen in this group received a score of 8.

All of the specimens in the experimental group 1 (instrumented at the working length to a #20 file) were covered with smear layer and debris. Each specimen in this group received a score of 8. The mean score for specimens in the experimental group 2 (instrumented at the working length to a #25 file) was 3.4. This score translates to removal of 76% of debris and smear layer in this group. All of the specimens in experimental group 3 (instrumented at the working length to a #30 file) scored 1, indicating that 100% of debris and smear layer was removed in this group.

STATISTICAL ANALYSIS

Statistical analysis of data using Mann-Whitney test showed that the difference was statistically significant ($p < 0.05$) between groups 1 and 2, as well as between groups 2 and 3. The results of the Mann-Whitney test also shows that statistically there is no difference between:

1. Group 3 and positive control group [$p < 0.01$]
2. Group 1 and negative control group [$p < 0.01$]

DISCUSSION

The extent of apical enlargement, has been a matter of ongoing debate and a never ending discussion. A common recommendation is to enlarge the root canal to at least three sizes beyond the initial file to bind. Studies have shown, however, that initial binding files often do not correspond to the actual size of the foramen, because the instruments are actually binding more coronally.(10)

Previously studies by Baugh & Wallace; Rollison etal; and Bystrom et al have shown that instrumentation to files larger than #30 reduces the bacterial counts, enhances the antibacterial effects of intracanal irrigants and prevents late bacterial growth after cleaning and shaping of root canals (11,12,13). Wu and Wesselink have recommended enlarging the canals to sizes over #40 files to remove more debris from the canals and achieve better cleaning in the apical thirds of the root canals. However, instrumentation to these sizes increasing the risk of perforation, ledge, and transportation, especially in narrow and curved root canals is evidently seen. (14)

In contrast to the above findings, Yared and Dagher reported that a #25 file was as efficient as a #40 file for reducing residual microorganisms(15). Based on their findings, Coldero et al concluded that no excessive apical enlargement is necessary for intracanal bacterial reduction (16). Albrecht et al. instrumented the canals with various tapers of Profile GT files and observed a significantly greater percentage of remaining debris in the apical areas of the canals enlarged to the size #20 preparations compared to larger instruments(10).

The minimum instrumentation for proper penetration of irrigants to the apical third of the canal is a #30 file, as it appears unnecessary to remove dentine in the apical part of the root canal when a suitable coronal taper is achieved. The results of our study are also consistent with the findings of Mirzabagherian who used orographin as a contrast media to trace penetration of irrigants into the apical third of instrumented canals (17).

CONCLUSION

The findings of the above study show that apical instrumentation to a #30 size file with an adequate coronal taper is effective for the removal of debris and smear layer from the apical portion of root canals.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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