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Effect of Different Apical Diameters on Apical Seal of Human Dentition - An In Vitro Study

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Abstract

The aim of this study is to compare the apical leakage after the preparation following different apical diameters. This is an in vitro study.

Materials and Methods: 40 extracted maxillary incisors were randomly allocated into three groups of 10 teeth each (n . 10) according to the apical preparation size: Group 1: finishing file F1 corresponding to size 20 reached the working length (ProTaper Universal system Dentsply®); Group 2: prepared up to size 25 corresponding to finishing file F2; Group 3: prepared up to size 40 corresponding to finishing file F3. Five teeth were assigned to positive and negative control groups. After the filling of the root canals, the teeth were isolated and immersed in a dye solution, then cut longitudinally, photographed, and the dye penetration were calculated using a stereomicroscope.

Results: Comparison of the three different apical preparation sizes showed no statistically significant differences regarding the apical microleakage.

Conclusion: The most important value of the dye penetration was observed in the group with the largest apical diameter.

Keywords: Apical leakage, Dentition, ANOVA, Dye Penetration, Apical limit, Root Canal

Introduction

The root canal filling achieves three significant objectives. They are Elimination of residual bacteria from the root canal system, Prevention of the entry of fluid from the periapical tissues and Prevention of coronal microleakage. It has been shown that 63% of the endodontic treatment failures are related to apical percolation due to an insufficient sealing. It thus appears that the shaping and disinfection of the apical third takes a paramount importance in the success of the endodontic treatment. Two major questions, which need attention, are which apical limit should be chosen and which apical diameter size should be chosen. For the apical limit, the current recommendations require ideally that instrumentation and obturation should not exceed the root canal space. The

shaping of the last apical millimeters should respect mechanical and biological objectives: conicity, respect of the apical diameter and the original position of the foramen are important for the adjustment of the master cone in the apical third. As for the apical preparation diameter, of the one main mechanical imperatives in the apical third preparation is to preserve the apical foramen in its initial position and in its narrowest diameter in order to avoid any complication such as tearing, zipping, or transportation of the foramen.

However, we should not forget that bacteria penetrate deeply in the dentinal tubules, especially when the teeth are infected, and that some authors support the necessity of an apical enlargement in order to reduce as much as we can the bacterial growth in the apical third. All things considered the diameter preparation of the foramen is a very controversial topic in endodontics. The Objective of the study is to evaluate and compare effectiveness of three different apical preparations - i) up to size 20 corresponding to finishing file F1. ii) up to size 25 corresponding to finishing file F2. Iii) up to size 30 corresponding to finishing file F3. The Aim of the study is to compare the apical leakage after the preparation following different apical diameter.

Methodology

Forty extracted human permanent single rooted teeth were collected from the Department of Oral and Maxillofacial surgery, Peoples College of Dental Sciences and Research Centre, Bhopal. The INCLUSION CRITERIA considered was 40 intact human permanent mandibular premolars with closed apex and single canal. The EXCLUSION CRITERIA under consideration were following - i) Teeth with open apex. ii) Teeth with caries, cervical abrasion, or fractures. iii) Teeth with old endodontic manipulation. iv) Teeth with internal or external resorption. V) Teeth with dilacerations.

Materials used were 40 extracted permanent mandibular premolar, 5 % Sodium hypochlorite solution, 17% EDTA gel, 17% EDTA solution, Distilled water, Normal saline and Disposable syringes.

40 intact, human single rooted teeth keeping exclusion and inclusion criteria in mind were used in this following study. All selected teeth were debrided and cleansed with manual scaling and washed under running tap water. Radiographs were taken to rule out more than one canal. All the teeth were stored under normal temperature in normal saline and decoronated using a wheel diamond disk keeping 15mm standardized root length. Patency achieved by 10k file and Shaping and Cleaning done till F1, F2, F3 with using pro-taper gold file system, using Crown-Down technique. Sodium hypochlorite was used between each file size. After completion of instrumentation. Subsequently teeth were divided into five groups.

Fig.1: Materials and Instruments Used



Stereomicroscope



40 Extracted permanent mandibular premolar



De-coronation using diamond disc



Incubator



Standardization of root length up to 15 mm



Group name	No. of				
	Samp	Description			
	les				
Group 1	n = 10	Canals were prepared up to size 20 corresponding to finishing file F1 of the ProTaper system (Dentsply)			
Group 2	n = 10	Canals were prepared up to size 25 corresponding to F2.			
Group 3	n = 10	Canals were prepared up to size 30 corresponding to F3.			
Group 4	n = 5	The positive control group contained 5 roots that were not filled and covered with nail polish except for their apical 3mm			
Group 5	n = 5	The negative control group included 5 roots that were not filled, and the entire root surface was coated with nail polish, and canal orifices were sealed with cyanoacrylate glue.			

Two layers of nail polish were applied to the root surface, except for the apical 3mm that remained exposed to the dye solution. The 5 teeth used as negative controls had the entire root surface sealed. Specimens were then immersed in 1% methylene blue for 48 hours. After removal from the dye solution, the specimens were rinsed and dried.

The samples were split longitudinally in a mesio-distal direction into two halves, and each sample was then scored under stereomicroscope (2X) using Scoring criteria as mentioned under:

Data obtained were statistically analyzed. The Student's ttest was used to assess the results statistically and to compare differences in the depth of dye penetration between the three groups.

Result

The groups were compared for the dye penetration with the help of one-way ANOVA and found that there was a statistically significant difference between the dye penetration in different groups with F value = 32.09 and p = 0.04. (Table 1, Graph 1).

File System	Ν	Mean	SD	F value	P Value
F1	10	2.89	0.53	32.09	0.04
F2	10	4.34	0.74		
F3	10	5.18	0.64		
Positive Control	05	8.08	0.53		

Table 1: Comparison of Dye penetration among study groups



Graph 1: Dye penetration among the 3 study groups as compared to control group



Fig. 2: Preparation of Different Group Samples







Fig.3: Dye Penetration in Different Group Samples immersed in Methylene Blue Solution.

The dye penetration among the different apical diameter size was compared with the positive control group, using the unpaired t-test analysis. It was found that the mean





penetration for F1, F2 and F3 were significantly lower than the positive control group (p<0.05) (Graph 2).

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Discussion

The root canal anatomy is a complex array of many variations. The challenge is to fill the complexities at large. The major objective of endodontic obturation is to completely obliterate and seal the root canal system while maintaining accurate apical control of the filling material.

There had been a debate for a decade on quality of obturation and sealing ability using different techniques such as Single Cone, lateral condensation technique, and recently used injectable obturating techniques.

Apical constriction is a natural barrier which represents the smallest apical diameter and is located 0.5–1.5mm inside the apical foramen [15]. This structure could coincide with the dentinocemental junction or remarkably close to it. So, they are considered as a single anatomohistological entity elected as the apical limit of preparation.

In fact, it would be appropriate to stop the shaping at the level where pulp tissue ends and leave the cement cone to permit a cemental reparation after the endodontic treatment. therefore, the apical constriction (or CDJ) seems to be reduction with or without apical enlargement preparation and concluded that it was not necessary to remove dentine in the apical part of the root canal when a suitable coronal taper is achieved to allow efficient irrigation of the root canal system. The ideal apical limit to be used as a matrix to support the closing material and avoid any overfilling.

The study by Yared and Dagher evaluates the influence of apical enlargement on the sealing ability of vertical compaction and reports that the size 25 file group showed significantly less apical leakage than the size 40 file group [17].

The study of Gomes-Filho et al. showed that greater dye leakage occurred after disruption and enlargement of the apical foramen [8]. Mente et al. evaluated the influence of the apical enlargement on sealing ability and observed a positive correlation between large apex diameter and greater leakage [13]. The results of our study are in accordance with all these studies since the most important values of the colorant

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infiltration have been observed in the group of larger apical diameter (F3).



Fig. 4: Result of Dye Penetration in Different control Groups after immersing in Methyl Blue Solution.

Conclusion

Within the limitations of this study, there was significant difference in the apical leakage between different apical three preparation diameters. the However, the most important infiltration was observed in the group prepared with the largest apical diameter. There is still no real consensus to the exact size of the apical preparation. Moreover, it is necessary to construct a sufficient tapering along the root canal allowing the efficiency of the chemomechanical cleaning of the apical third and to a deep penetration of irrigation, guaranty the while preserving as much as possible the integrity of the noble anatomical structures of this apical area.

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