Influence of file length on the quality of root canal preparation

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ABSTRACT

Introduction: Many factors relative to the characteristics of dental instruments, such as cross-section, tip design and taper, can enhance the action of wearing on root canal walls. Nevertheless, whether file length influences or not preparation quality remains unclear. **Objective:** To assess the influence of file length over quality of root canal preparation. **Methods:** Thirty simulated root canals (IM do Brasil) were divided into two groups and prepared with 21-mm and 25-mm FlexoFile instruments and 25 mm FlexoFile instruments in Groups I and II, respectively. The crown-down technique was employed and the apical third enlarged up to file #35. The simulated root canals were photographed and radiographed prior to and after root canal preparation. Images were analyzed with the aid of Image Toll 3.0 software. Wear distribution and apical deviation were analyzed by superimposing both images. **Results:** No statistically significant difference was found in terms of wear distribution or apical deviation between groups. **Conclusion:** File length had no influence on centralization of root canal preparation and apical deviation of simulated root canals.

Keywords: Endodontics. Root canal preparation. Root canal treatment.

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Introduction

Endodontics is the dental specialty that requires the longest training period for clinicians to acquire the appropriate skills to handle the plethora of instruments and techniques. It differs from other specialties, in that the clinicians cannot directly visualize the effects of its actions beyond root canal opening. Root canal treatment starts from the moment the file is inserted into the root canal opening, consequently blocking the clinician's view, which provides him/her with only two strategies to ascertain instrument pathway: radiography, a two-dimensional representation of a three-dimensional problem; and tactile sensitivity. Therefore, manual dexterity plays a key role, along with mastery of the technique and knowledge of instruments, all of which are critical to overcome anatomical difficulties, such as curvatures and atresia.

Cleaning and shaping of root canals are paramount for the success of endodontic treatment. Straight canals are relatively easier to treat than when curvatures are present. In the case of the latter, a strong tendency towards transportation of the root canal from its long axis is observed. Widening curved root canals using conventional hand stainless steel files often results in unintended anatomical changes, such as transportation, blockage, ledging, and perforations. Wildey et al[1] showed that when instruments are inserted into a curved root canal, the canal remains unchanged until force is applied. Once instrument hardness is greater than that of the dentin, when the instrument returns to its original position after force application and withdrawal, dentin wear will have occurred. Due to lower resistance, dentin may have been removed on either aspect of the curvature, and if not well managed, could result in aberrant canal shaping.

Factors relating to the characteristics of instruments can intensify the action of wearing on root canal walls. As hand files are available in lengths of 21, 25 and 31mm, the use of shorter instruments, which reduce the distance between the handle and the tip, results in improved tactile sensitivity and, therefore, better manual control.[2]

Different approaches have been suggested to minimize problems in root canal preparation, namely: pre-flaring,3 the crown-down concept;[4-7] pre-bended stainless steel instrument;s[8] and the use of instruments with an inactive tip.[7,9-10]

The aforementioned arguments highlight the importance of investigating whether the length of the hand file can influence final quality of curved root canal preparation.

Material and Methods

A total of 30 transparent epoxy resin blocks containing simulated canals (IM do Brasil Ltda., São Paulo, SP, Brazil) with a 40° curvature were selected for this study. The glide path was established with a #15 Flexofile hand file used throughout the entire length of the canal. Samples were photographed with a stand at a focal distance of 32cm. The working length was determined at 1mm short the foramen. Standardized digital radiographs (Kodak RGV 5100) were taken from each simulated root canal and stored for future comparison.

The resin blocks were numbered, covered with a black tape, and had the apical foramen identified. They were then divided into two groups and prepared with the aid of Flexofiles (Dentsply / Maillefer, Ballaigues, Switzerland) measuring 21mm and 25mm for Groups I and II, respectively. Subsequently, the crown-down technique was carried out.[4] The same clinician prepared all blocks and instruments were discarded after being used three times.

Pre-flaring was performed using Pre-Race (FKG, Switzerland) rotatory files #40/0.10 and #35/0.08. The apical portion of the canal was prepared with a #35 file. 10 ml of 1% sodium hypochlorite solution was used to irrigate after each instrument. The canals were dried by aspiration with capillary tips (Ultradent, USA), and the blocks photographed and radiographed with file #35 at the working length.

Pre- and post-operative images were superimposed with the aid of Image Tool 3.0 software. Analysis of superimposed images was performed following assessment criteria for each third of simulated root canals: wear distribution directed towards the outer wall of curvature, directed towards the inner wall of the curvature or at the central portion. Images were then quantitatively assessed for wear in each wall. Data were displayed in tables and statistically analyzed by means of ANOVA with a significance level of 5%.

Radiographic scans were analyzed with the aid of Adobe Photoshop CS5 software. Pre- and post-operative images were superimposed, and the angles formed by lines tangent to surgical diameter corresponding to a #35 file and tangent to file #15 were recorded. Coincidence of both files in the apical third revealed no deviation. When an angle was formed, apical deviation was present and the angle was calculated and displayed in tables. Data were analyzed by means of non-parametric Mann-Whitney U-test at a significance level of 5%.

Results

Assessment of wear distribution

Table 1 shows wear distribution (outer wall, inner wall or at the central portion) expressed in percentages for each third of simulated root canals.

Assessment of apical deviation

Only one sample from Group I showed apical deviation (21.6°), while in Group II, four samples presented apical deviation (8.7°, 25.3°, 11.4° and 7.1°). Mann-Whitney U-test revealed no significant difference between groups (p = 0.1696). Table 2 shows statistical data according to file length.

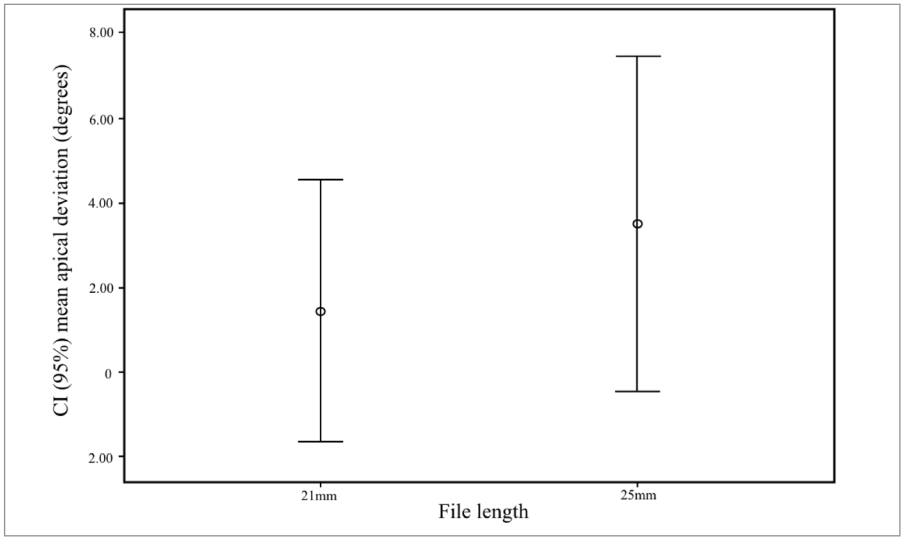
Table 1. Shows wear distribution (outer wall, inner wall or at the central portion) expressed in percentages for each third of simulated root canals.

	Cervical				Middle				Apical				
	E	C	I	SD	E	C	I	SD	E	C	I	SD	
Group I	26.6	46.6	26.6	±2.40	-	46.6	53.3	±1.55	40	60	-	±2.38	p≥0.05
Group II	46.6	53.3	-	±1.77	-	26.6	73.3	±1.49	80	20	-	±1.79	

E – wear directed towards the outer wall; C – wear at the central portion; I – wear directed to the inner wall; SD – standard deviation. * no significant difference.

Table 2. Statistical analysis of apical deviation according to file length

File	n	Mean	Median	Standard deviation	Standard error	*p-value*
21 mm	15	1.44	0.00	5.58	1.44	0.1696
25 mm	15	3.50	0.00	7.13	1.84	



Graph 1. 95% Confidence interval for the mean apical deviation according to file length.

Discussion

Despite acceptance and popularization of reciprocating and rotatory instrumentation in Endodontics, the use of manual techniques remains a reality for both the general dental practitioner and endodontists, particularly those working for public health services. A well-recognized problem with the use of stainless steel files is that they often do not provide the necessary tapered shape required.[11] Clinicians should choose appropriate tools and techniques in order to achieve wear patterns as close to symmetrical as possible, since uniformity and three-dimensional extension of the anatomical root canal are primary objectives of preparation.[12]

The use of stainless steel instruments in curved root canals demands clinicians have considerable technical ability. In molars, for example, the need to extend apical preparation to diameters larger than file #25 is mandatory. Marroquín et al[13] demonstrated that apical constriction of maxillary molars buccal roots and mandibular molars mesial root have an anatomic diameter corresponding to files #20 and #25. Therefore, the use of more flexible files allows more centralized widening, especially in the apical third. Flexofiles feature a triangular cross-section, which is associated with higher cutting efficiency and improved flexibility compared to quadrangular cross-section files.[14-16]

The crown-down technique allows a gradual advance of instrument and greater control over it. Preflaring, carried out by removing dentin debris from the canal opening and which prepares the cervical third, causes subsequent instruments to initiate their action from the middle third. This, in turn, restricts file cutting action to a few millimeters of its active portion, thereby causing less stress and providing greater manual control on the part of the clinician. Likewise, working with instruments with length close to that of the working length allows the clinician to exert greater control over the tip. The greater the distance between the handle and the tip, the lesser the manual control, which may result in aberrant canal shaping, thus compromising the outcome.

The results from the present study did not reveal significant difference ($p \geq 0.05$) when root canal preparation was performed with 21-mm or 25-mm files. However, important considerations could be drawn from data analysis. Due to the use of Pre-Race instruments for pre-flaring, no difference was observed in the cervical third. In the middle third, 21-mm file showed a more centralized preparation than that carried out by the 25-mm file (46.67% and 26.66%, respectively), as shown in Table I. Regarding the apical third, the use of 21-mm files also revealed better results (60% centralized).

Despite lack of statistical significance in terms of apical deviation between groups, a low incidence of apical deviation was observed in Group I. This finding corroborated studies comparing Flexofiles with other instruments, which revealed greater flexibility and lower incidence of apical deviation.[15-19] Results achieved in Group II suggest a higher rate of apical deviation with significant angular degrees (7.1°, 8.7°, 11.4°, 25.3°). This finding was related to two aspects of canal preparation: file length and kinematics. Regarding the former, the shorter the distance between the handle of the instrument and its tip, the better clinician's control. Instruments with a length close to the working length provide more tactile sensitivity, which may also affect kinematics.

It is likely that in Group II, in which preparation of the middle third showed a higher rate of wear on the inner wall of the curvature (73.33%), lack of control over the instrument tip was a decisive factor, which resulted in rectification of original canal pathway with consequent apical transportation.

Conclusions

Based on the results achieved in this study, it seems reasonable to conclude:

1. There was no significant difference between groups in terms of canal widening for any of the thirds analyzed, however, wear was more frequently oriented towards the inner walls of the curvature when 25-mm files were used.

2. Although no significant difference was found between the two groups, apical deviation was more frequently seen when 25-mm files were used.

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