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CLINICAL ARTICLES

Comparison of the First File that Fits at the Apex, Before and After Early Flaring

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The purpose of this study was to compare the first file that fits to the apex (FFFA) in each canal before and after early flaring to analyze if the size of file to fit to the apex would increase after flaring. One hundred mesial canals of lower first and second molars with complete apical formation and patent foramens were selected. The samples were randomly divided into two groups of 50 canals each. A file was fit to the apex in each canal and that size recorded. Radicular flaring was completed using Gates-Glidden drills in group 1 and Rapid Body Shapers in group 2. After flaring a file was again fit to the apex in the same manner as before and its size recorded. The mean diameter of FFFA before flaring (file diameters in mm $\times$ 10^{-2}) was 14.46 ($\pm$4.12) and after 23.3 ($\pm$7.2) for group 1 ($p < 0.001$), whereas in group 2 the mean diameter of FFFA was 17.2 ($\pm$4.96) before and 25.6 ($\pm$6.36) after ($p < 0.001$). A Wilcoxon *t* test indicates a significant difference ($p < 0.001$) between the diameter of FFFA before and after flaring in both groups. The increase in diameter was approximately two file sizes for both groups. From this observation it is concluded that early radicular flaring increases the size file that is snug at the apex, and awareness of that difference gives the clinician a better sense of canal size. Early flaring of the canal provides better apical size information and with this awareness, a better decision can be made concerning the appropriate final diameter needed for complete apical shaping.

Endodontic therapy is traditionally divided into two main objectives: cleaning and shaping and three-dimensional obturation of the canal system. For cleaning and shaping of a root canal most clinicians start by selecting a first file that they believe fits the apex (FFFA) and enlarge in relation to that file diameter. Some authors (1–3) suggest enlarging the canal 1 to 5 file sizes greater than the FFFA, whereas others (4, 5) recommend keeping the apex as small as possible. The later would typically enlarge the root canal without using larger than a #25 file size unless the FFFA is bigger, in which case they recommend to maintain that size at the apex. Despite these differences most authors agree that the starting point for apical shaping is the FFFA. The accuracy of this determination has not been well investigated, and the effect of the coronal region of the canal on this determination has not been fully determined.

Leeb (6) demonstrated that the sensation of file fit does not necessarily occur because of contact at the apex, as is assumed, but may instead be a result of interference in the coronal and middle thirds of the canal. Irregularity of the walls and/or curvatures of the root apply pressure against the file and interfere with the clinician's ability to determine contact and tightness at the apex. This disclosure causes one to doubt the wisdom of sizing apical shaping solely on the tactile sense that contact of a file has occurred in the apex.

Several authors (7–9) suggest that it is advantageous to remove middle and coronal third interference before accomplishing apical instrumentation. This, they report, may be done by using an early flaring of the canal body with either manual or rotary instruments. Rotary flaring, of course, has an important advantage in that it is more rapid than hand and thus reduces treatment time. The flare, smoothness, and uniformity of the canal preparation is also better (10, 11).

One of the more commonly used rotary instruments is a Gates-Glidden (GG) drill; however new nickel-titanium instruments, the Rapid Body Shaper (RBS from Moyco Union Broach), are also available for this use. RBS instruments use a nontapered cutting surface and use a patented guidance tip design. These instruments are designed to reduce canal enlargement and prevent lateral perforations—a complication sometimes related to the use of GG drills. The specialized tip shape prevents ledges and guides the penetration while their parallel cutting edges reduce self-insertion and instrument breakage. Their design and flexibility allow the clinician to safely shape deep into the canal and prepare the body in an expedient way (12).

The literature clearly indicates that shaping the coronal and middle third of canals alters the size of file that fits tightly in the apex. The purpose of this study was to determine if different methods (GG drills or RBS instruments) used for early flaring of a canal would affect the fit at the apex similarly and to measure the

TABLE 1. Distribution of the FFFA before and after flaring

File Size	Group 1				Group 2			
	FFFAb		FFFAa		FFFAb		FFFAa	
	Fr	R_f	Fr	R_f	Fr	R_f	Fr	R_f
8	1	0.02	—	—	—	—	—	—
10	16	0.32	—	—	4	0.08	—	—
15	23	0.46	13	0.26	29	0.58	3	0.06
20	8	0.16	11	0.22	12	0.24	17	0.34
25	2	0.04	15	0.3	2	0.04	10	0.2
30	—	—	5	0.1	2	0.04	13	0.26
35	—	—	4	0.08	1	0.02	5	0.1
40	—	—	1	0.02	—	—	2	0.04
45	—	—	1	0.02	—	—	—	—
Total	50	1.0	50	1.0	50	1.0	50	1.0

FFFAb = First file fits at the apex before flaring; FFFAa = first file fits at the apex after flaring; Fr = frequency; R_f = relative frequency.

tactilely determined fit size before and after radicular flaring. This information is clinically important, because the determination of FFFA is commonly used to identify the extent of apical shaping.

MATERIALS AND METHODS

Fifty mesial roots of mandibular first and second molars were selected for this study. Each root was examined to ensure that apical formation was complete and the foramina were patent. These 50 roots yielded 100 canals for use in this evaluation. The teeth were stored in physiological saline after extraction. The crown and root surfaces were cleaned with a scalpel, and the distal root of each tooth was sectioned away at the furcation with a #169L fissure bur. The resulting specimens could be examined radiographically using a mesio-distal view, as well as the usual facial-lingual view.

A preoperative radiograph (Kodak Ultra-speed, Super Poly-soft, size #2 DF-58 periapical, Eastman Kodak Company, Rochester, NY) was taken from clinical and proximal aspects. Caries and restorations were removed, and a typical endodontic access made. The pulp chamber and canal contents were removed with small files (#8 and #10). Canals were irrigated with 2 ml of sodium hypochlorite (5.5%, Clorox, Clorox de Mexico S.A de C.V. Tlanepantla, Mexico). Patency was demonstrated by passing a #6 file through the foramen until it was just visible, and working length was established by subtracting 1 mm from this full canal length.

A metalographic microscope (4XAZ, Zeigen, Mexico City, Mexico), with retractable 40× semiplane objective and P10X plane ocular with a micrometric scale having a measurement range of 0 to 1.6 mm and discretion to 0.01 mm, was used to verify file dimensions. Flex-R files (Moyco, Union Broach Co., Long Island City, NY) were used for apical measurements.

Apical fit was considered to have occurred when the largest file reached the apex and passage beyond that depth was not a possibility. In both groups the largest file that could fulfill these criteria and reach the working length was determined. In all instances a larger file was tried to ensure that it could not reach the same depth (i.e. working length). Once satisfied that the largest file had been chosen radiographs were taken from the proximal and clinical views. These radiographs verified that the file had reached the working length and fit the canal correctly. The size of this file was recorded as FFFA before flaring (FFFAb). After verifying fit early flaring was performed for each group.

Group 1

In this group GG drills (Moyco, Union Broach Co.) were used to flare the body of each canal. Flaring began with a GG #6. This drill was used to enlarge the orifice and transported it toward the mesial-facial or mesial-lingual corner of the pulp chamber. The canal was irrigated with 2 ml of sodium hypochlorite, and the flaring continued with a GG #5 extending the shaping 2 mm further apically and again transporting the shaping toward the mesial-facial and mesial-lingual corners. The entry into the canals was always from the distal toward the mesial and removal applied pressure toward the mesial respective corners. This methodology maintained transporting forces away from the furcation and furcal concavity. Irrigation was repeated after each GG and patency tested with a small file. GG #4, GG #3, and GG #2 were used to complete the flaring, each penetrating 2 mm deeper than the preceding drill. No transporting motions were used with these three sizes; however canal patency was checked and irrigation continued.

Group 2

Early flaring was conducted with RBS reamers (Moyco, Union Broach Co.). These instruments are available in four sizes: #1 (red, 0.61 mm), #2 (blue, 0.66 mm), #3 (green, 0.76 mm), and #4 (black, 0.86 mm). A gear reduction handpiece was used and a rotational speed of ~325 rpm maintained. To facilitate the penetration of RBS reamers the orifice of the canal was opened 3 mm deep with a size #40 Flex-R file. Irrigation removed debris from the canal before RBS use. Flaring began with a RBS #1. Penetration was as deep as this drill would progress without coming closer than 3 mm from the working length. RBS #2 penetrated 1 mm less than RBS #1. RBS #3 penetrated 2 mm less than RBS #2, and RBS #4 penetrated 2 mm less than RBS #3. At the end of this procedure, the canal was irrigated and patency was confirmed with a small hand file.

After early flaring was completed a new evaluation for the FFFA was completed. This was accomplished in the same manner as previously described. Radiographs were made using the clinical

TABLE 2. Increment frequency of increase in file size per group

Increment	Frequency	
	Group 1	Group 2
None	4	2
1	20	22
2	15	18
3	6	6
4	4	2
5	1	—

Note: each increment = one file size.

and proximal views as before. This file size was recorded as FFFA after flaring (FFFAa).

Mean values and standard deviations were calculated using a paired *t* test. Comparison of the FFFAb and FFFAa was performed by the Wilcoxon *t* test.

RESULTS

From the FFFAb, only four canals (8.0%) in group 1 and two canals (4.0%) in group 2 kept the same size after flaring. Group distribution of the file diameters is summarized in Table 1 and diameter increments of files are shown in Table 2. The file diameters were expressed in mm $\times 10^{-2}$. Mean diameter of FFFAb and FFFAa flaring was 14.46 ($\pm$4.12) and 23.3 ($\pm$7.2) for group 1 ($p < 0.001$) and for group 2 was 17.2 ($\pm$4.96) and was 25.6 ($\pm$6.36) ($p < 0.001$). A Wilcoxon *t* test of intragroup values indicated a significant difference ($p < 0.001$) of file size before flaring and the file size after for both early flaring groups. It was observed there was no difference in FFFAa between groups 1 and 2. No lateral perforations, ledges, or instrument failures were experienced during this study.

DISCUSSION

Clinicians typically begin shaping by placing a file to the apex and determine the apical diameter, FFFA. From this procedure they make judgments that determine the extent of apical shaping and how much the canal space must be enlarged. This study indicates that their judgment can be in error. The FFFA can be significantly larger after flaring the canal than it is before. This information suggests that canal interference and curvature are a factor in the clinician's ability to sense apical diameter with a file. The results clearly indicate that the FFFA size is significantly different after flaring (i.e. almost two file sizes greater in each canal studied).

This study was conducted in the mesial roots of mandibular molars where the canals are considered very small in diameter; small enough that the apical enlargement is commonly carried to only a #25 or #30 file size (1–5). The results obtained in this study indicate that the FFFA, after flaring removes canal interference and curvature influence, is a #25 or larger. In fact, in nearly 60% of the canals examined, the fit size was greater than a #25 file (Table 1). If one considers that canals tend to be less than round, it is appropriate to enlarge at least a couple of file sizes in an effort to clean and shape the entire space. Data from this study suggest that mesial canals of mandibular molars should be enlarged more than previously accepted. The increase in file size after flaring can be explained by realizing that, within a canal, irregularities and curvature produced contacts with the file and interfere with its progression toward the apex. Early flaring, regardless of the method used, removes these contacts opens the space and reduces file contact; thus, a file progresses more easily toward the apex after flaring. This was previously suggested by Leeb (6). After flaring a file comes to a stop only when the diameter of the canal begins to apply pressure against the instrument. Early flaring allows the operator to sense the canal size near the apex, not curvature and irregularities. This better sense of apical diameter provides information that should result in better control of biomechanical preparation. Early flaring offers several clinical advantages (6–9, 13, 14), and it can be accomplished either by manual or by mechanical means. Mechanical (i.e. rotary flaring) reduces treatment time, but is accompanied by a risk of complications. Over enthusiastic use, inappropriate size, and excessive depths can result in lateral perforations, ledges, and instrument breakage (10, 11, 15).

It is important to note that the technique used with the GG flaring was crown-down and progressed from large to small through the canal, sequence #6, #5, #4, #3, and #2. The large sizes, #6 and #5, were used to move the orifice and canal wall outwardly to a depth of ~4 mm. This nuance altered the insertion axis for the smaller drills (#4, #3, and #2) and allowed the smaller drills to shape 2-mm increments of the canal each. This method provides deeper access with the smaller drills and limits the possibility of instrument failure. In group 2 more important than technique are the RBS reamers. RBS are nickel-titanium instruments with a nontapered design. They can achieve deep penetration into the apical third, maintain the original canal shape (including curvature), and their small size limits the risk of common procedural errors associated with the usage of other larger diameter rotary instruments (i.e. perforations).

Data reveal no relationship between the FFFA size and the use of either GG drills or the RBS system to provide early flaring. This observation is explained by the fact that both systems shape the coronal two-thirds of the canal and remove contacts that when present provide resistance and change the operator's ability to pass a file to the apex. Both systems removed canal interference and allowed the file to contact mostly in the apex and give the clinician a different sense of resistance plus an ability to place a larger file to the apex.

Apical shaping is easier when early flaring is used because only the apical one-third remains unshaped. From the data presented, one can speculate that early flaring would be advantageous for all teeth, and the authors recommend early flaring no matter the tooth type, because interfering contacts can exist in any canal.

A further study is indicated to determine the actual apical canal diameter and relate it to the tactile sensation used in this study.

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J. Dromedary