Influence of cervical preflaring on apical file size determination

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Abstract

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Aim To investigate the influence of cervical preflaring with different instruments (Gates-Glidden drills, Quantec Flare series instruments and LA Axxess burs) on the first file that binds at working length (WL) in maxillary central incisors.

Methodology Forty human maxillary central incisors with complete root formation were used. After standard access cavities, a size 06 K-file was inserted into each canal until the apical foramen was reached. The WL was set 1 mm short of the apical foramen. Group 1 received the initial apical instrument without previous preflaring of the cervical and middle thirds of the root canal. Group 2 had the cervical and middle portion of the root canals enlarged with Gates-Glidden drills sizes 90, 110 and 130. Group 3 had the cervical and middle thirds of the root canals enlarged with nickel-titanium Quantec Flare series instruments. Titanium-nitrite treated, stainless steel LA Axxess burs were used for preflaring the cervical and middle portions of root canals from group 4. Each canal was sized using manual K-files, starting with size 08 files with passive movements until the WL was reached. File sizes were increased until a binding sensation was felt at the WL, and the instrument size was recorded for each tooth. The apical region was then observed under a stereoscopic magnifier, images were recorded digitally and the differences between root canal and maximum file diameters were evaluated for each sample.

Results Significant differences were found between experimental groups regarding anatomical diameter at the WL and the first file to bind in the canal ($P < 0.01$, 95% confidence interval). The major discrepancy was found when no preflaring was performed (0.151 mm average). The LA Axxess burs produced the smallest differences between anatomical diameter and first file to bind (0.016 mm average). Gates-Glidden drills and Flare instruments were ranked in an intermediary position, with no statistically significant differences between them (0.093 mm average).

Conclusions The instrument binding technique for determining anatomical diameter at WL is not precise. Preflaring of the cervical and middle thirds of the root canal improved anatomical diameter determination; the instrument used for preflaring played a major role in determining the anatomical diameter at the WL. Canals preflared with LA Axxess burs created a more accurate relationship between file size and anatomical diameter.

Keywords: apical file size determination, coronal flaring, instrument type.

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Introduction

Current standards in root canal treatment are based on cleaning and shaping the root canal prior to filling (West & Roane 1998). Some authors suggest that the amount of apical enlargement to be achieved during shaping of the canal should be based on the estimation of initial apical diameter and by three file sizes greater

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than the first file that fits at the apex (Grossman *et al.* 1988, Ingle *et al.* 1994, Torabinejad 1994, Walton & Rivera 1996, Weine 1996).

The detection of the apical constriction and the determination of the first file that binds at WL are based on the tactile sense of the clinician. This premise is based on the false belief that the root canal is narrower in the apical portion and that the file would pass without interference until this narrow point.

Philippas (1961) reported that continuous and progressive dentine formation in the pulp space narrows the root canal diameter, mainly at the cervical third. Wu *et al.* (2002) reported that anatomical diameter determination based solely on the clinician's ability to detect the apical narrowing by tactile sense is an empirical and inaccurate method. As a result, enlargement of the root canal at working length (WL) with three instruments with increasing file diameters does not guarantee total removal of infected dentine from root canal walls. Tan & Messer (2002) reported that traditional methods of anatomical diameter determination of the apical portion of canals have underestimated the real diameter of this region. The authors also reported that the enlargement of the cervical and middle thirds of the root canal allowed a more accurate assessment of the true anatomical diameter.

Considering the findings of Wu *et al.* (2002) and Tan & Messer (2002), the present study aims to evaluate the influence of cervical preflaring performed with different rotary instruments on determination of the apical diameter.

Materials and methods

Forty human maxillary central incisors with complete root formation, obtained from the tooth stock of the Endodontics Research Laboratory of the Ribeirão Preto Dental School, University of São Paulo, were used. The teeth were kept in 0.1% thymol solution at 9 °C, and placed under running water to eliminate traces of thymol 24 h prior to use.

Standard access to the pulp chamber was performed and pulp tissue was removed with a barbed broach (Dentsply Maillefer, Ballaigues, Switzerland), avoiding contact with the root canal walls. The root canal of each tooth was explored using a size 06 K-file (Dentsply Maillefer) until the apical foramen was reached and the tip of the file was visible. The actual canal length was determined and WL was established by deducting 1 mm.

Group 1 received the initial apical instrument without previous preflaring of the root canal. Group 2 had the cervical and middle thirds of the root canals enlarged with Gates-Glidden drills sizes 090, 110 and 130 (Dentsply Maillefer). The length of this preflaring was determined by the resistance felt in the middle portion of the canal. Group 3 had the cervical portion of the root canals enlarged with nickel-titanium Quantec Flare series instruments (Sybron-Endo, Glendora, CA, USA) in the following sequence: 25/.08; 25/.10 and 25/.12, 3 mm short of the WL. Titanium-nitrite treated, stainless steel LA Axxess burs (SybronEndo) sizes 20/.06, 35/.06 and 45/.06 were used for preflaring the cervical and middle portions of root canals in group 4, 3 mm short of the WL. Copious irrigation with 10 mL of 1% sodium hypochlorite was performed during the preflaring of all canals.

Each canal was sized using manual K-files (Dentsply Maillefer), starting with size 08 files until the WL was reached. File sizes were increased until a binding sensation was felt at the WL, and the instrument size was recorded for each tooth. The handles of the files were painted in black in order to avoid identification, thus the operator was unaware of the file size used until a binding sensation at WL was achieved.

After apical file size determination for each tooth, files were fixed with methylcyanacrylate at the WL. Teeth were then sectioned transversally 1 mm from the apex, with the binding file in position. The apical region was then observed under a stereoscopic magnifier (30× magnification, Wild, Heerbrugg, Switzerland) and images recorded digitally. A metal ring (1.35 mm diameter) was used around the area of interest in order to standardize the area for analysis.

The analysis of the images obtained was performed on a computer using the UTHSCSA ImageTool program (developed at the University of Texas Health Science Centre at San Antonio, Texas, USA and available from the Internet by anonymous FTP from ftp://maxrad6.uthscsa.edu). Root canal and file maximum diameters were recorded for each sample. The differences between these measures were submitted to statistical analysis.

A multiple comparison, one variable test (ANOVA) was performed to examine the effect of the four different preflaring techniques on the diameter differences found between root canals and binding instruments. Statistical analysis was performed at the 0.05 level of significance.

Results

The differences between canal size and file diameter are presented in Table 1. The minimum and maximum values registered for each experimental group are presented, together with mean, standard deviation and 95% confidence interval.

The ANOVA test showed a statistically significant difference amongst groups concerning the discrepancy between anatomical diameter at WL and the first file to bind in the canal. Tukey's post-test was used to elucidate which groups were different.

The major discrepancy was found in group 1, where no cervical preflaring was performed (0.151 mm average, Fig. 1). Gates-Glidden drills and Flare files were ranked in intermediary position, with statistically similar results (0.093 mm average, Figs 2 and 3, respectively). The LA Axxess burs produced the smallest differences between anatomical diameter and first file to bind (0.016 mm average, Fig. 4).

Discussion

Canal enlargement has the aim of allowing sufficient space to act as a reservoir for irrigation, of removing the superficial layer of infected dentine and to produce a shape that facilitates sealing. In terms of removal of infected dentine, Peters *et al.* (2001) found in 62% of the roots more than 50 000 CFU g^{-1} in the dentine layer close to the cementum. This may suggest that instrumentation is not able to remove the most infected dentine. On the other hand, Siqueira *et al.* (1999) and Card *et al.* (2002) report that mechanical reduction of the bacterial population in the root canal may be achieved through instrumentation.

In general, the classic parameter for enlargement of the apical region at WL is still the use of three file sizes greater than the first file that fits at the apex (Grossman *et al.* 1988, Ingle *et al.* 1994, Torabinejad 1994, Walton & Rivera 1996, Weine 1996). However, determination of the real anatomical diameter at WL

	Discrepancy ($\times 10^{-2}$ mm)				
Instrument	Minimum	Maximum	Mean	SD	95% Confidence interval
Without flaring	5	21	15.1	5.7	11.7, 18.5
Gates-Glidden drills	5	20	9.3	5.5	5.9, 12.7
Quantec Flare series	1	18	9.3	5.4	6.0, 12.6
Axxess burs	1	3	1.6	0.7	1.2, 2.0

Table 1 Discrepancies measured between canal diameter at working length and binding file ($\times 10^{-2}$ mm) with different preflaring techniques

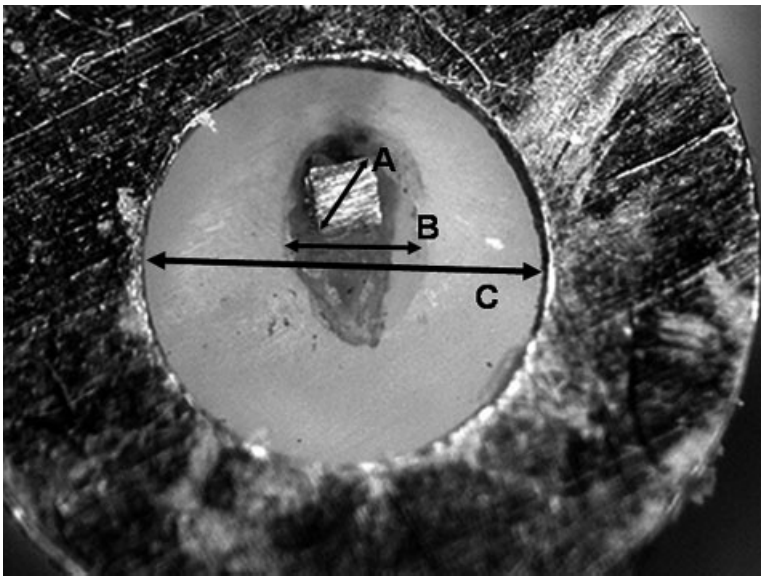

Figure 1 Group 1: no cervical and middle preflaring. Transverse section at working length. A: instrument diameter; B: canal diameter; C: standard measure.

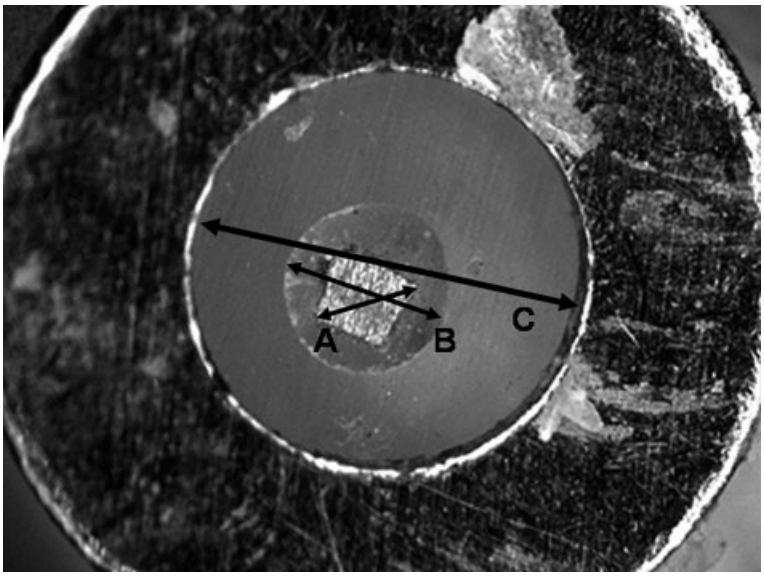

Figure 2 Group 2: cervical and middle preflaring with Gates-Glidden drills. Transverse section at working length. A: Instrument diameter; B: canal diameter; C: standard measure.

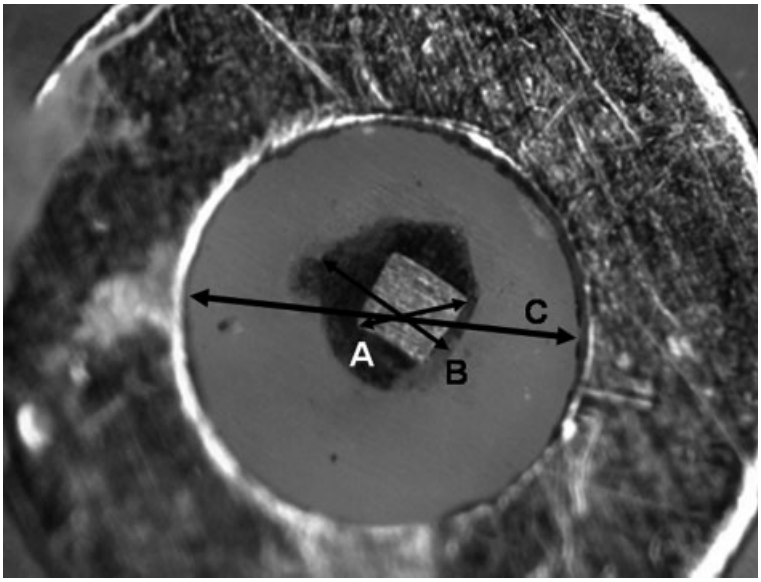

Figure 3 Group 3: cervical and middle preflaring with Quantec Flare series instruments. Transverse section at working length. A: Instrument diameter; B: canal diameter; C: standard measure.

is difficult when no preflaring is performed. This accuracy may be enhanced when anatomical diameter determination is performed after flaring (Leeb 1983, Contreras *et al.* 2001, Tan & Messer 2002).

K-files introduced in the canal before any flaring of cervical and middle thirds presented the greatest diameter discrepancy (0.151 mm average) when compared with the other experimental groups. Preflaring allowed an increase of instrument size binding at WL, which was reflected in a lower discrepancy values between file and anatomical diameter. These results are similar to previous studies (Leeb 1983, Contreras *et al.* 2001, Tan & Messer 2002).

When the K-file used for determining the anatomical diameter touches a minimum of two opposing points of the root canal, the operator is misled into thinking that the file is of adequate size, since a binding sensation is felt. This is particularly common in oval canals (Wu *et al.* 2000). The use of more flexible instruments, such as Ni-Ti Lightspeed, did not produce better results in canals previously flared with Gates-Glidden drills (Wu *et al.* 2002). These authors found that K-files or

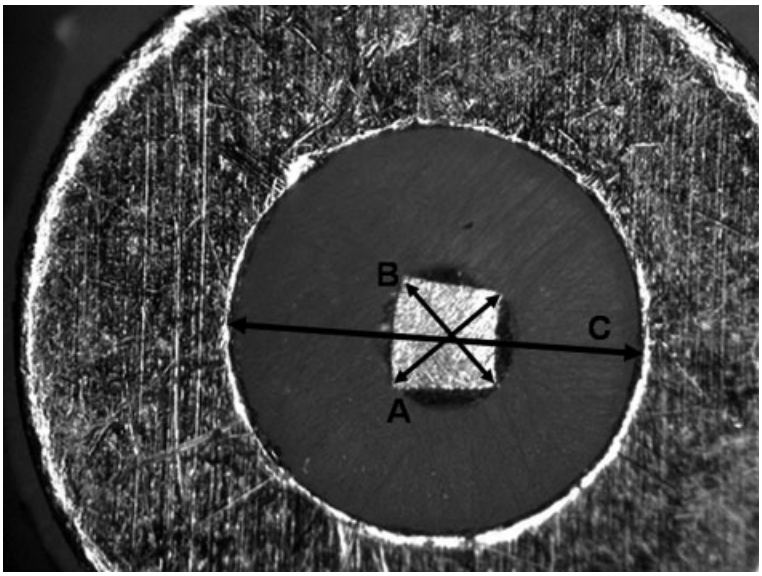

Figure 4 Group 4: cervical and middle preflaring with LA Axxess burs. Transverse section at working length. A: Instrument diameter; B: canal diameter; C: standard measure.

Lightspeed instruments did not reflect accurately the apical canal diameter.

Tan & Messer (2002), using ProFile rotary instruments to preflare the middle and cervical portions of the canal, found that when Lightspeed instruments were used in the apical region, it resulted in an increase in the instrument size that bound at WL. However, the use of Lightspeed instruments to gauge the foramen is not as common as the use of K-files in regular practice. Moreover, these authors also stated that 'it may not be appropriate to state that Lightspeed is more ''accurate'' (i.e. closer to true canal diameter) than K-files in gauging the apical constricture'.

The concept of preparing the canal using three successively larger instruments than the binding file needs to be reviewed, as it is ineffective and may leave canal walls untouched when no preflaring is performed.

Conclusions

1. The instrument binding technique for determining anatomical diameter at WL is not precise;
2. Preflaring of the cervical and middle thirds of the root canal improves the determination of the anatomical diameter;
3. The instrument used for preflaring may play a role in determining the anatomical diameter at the WL. Canals preflared with LA Axxess burs presented the lowest discrepancy values between file size and anatomical diameter.

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