Does the first file to bind correspond to the diameter of the canal in the apical region?

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Abstract

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Aim The aim of this study was to determine whether the first file that binds at the working length corresponds to the canal diameter.

Methodology Two similar groups ($n = 10$) of mandibular premolars with curved canals were selected on the basis of their morphology. Following access and pulp tissue removal, the first instrument that bound in each canal at the working length was determined. In one group the instrument used was a K-file, in the other group a Lightspeed instrument was used. After fixing the instruments in place, the apices were ground to the level of the working length and the diameters of both the instrument and the apical canal were recorded.

Results In 75% of the canals, the instruments bound at one side of the wall only; in the other 25%, the instrument did not contact the wall. In 90% of the canals, the diameter of the instrument was smaller than the short diameter of the canal; this discrepancy was up to 0.19 mm. No significant difference in discrepancy was found between instruments ($P > 0.05$).

Conclusions Neither the first K-file nor the first Lightspeed instrument that bound at the working length accurately reflected the diameter of the apical canal in curved mandibular premolars. It is uncertain whether dentine can be removed from the entire circumference of the canal wall by filing the root canal to three sizes larger than the file that binds first.

Keywords: binding file, canal diameter.

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Introduction

In histological sections of infected teeth bacteria were found in the dentinal tubules adjacent to the pulp (Armitage *et al.* 1983, Ando & Hoshino 1990, Peters *et al.* 2001). It is therefore considered appropriate to remove the most heavily infected layer of dentine. Since the diameters of the apical canals vary greatly in all tooth groups (Wu *et al.* 2000), no standard size is advisable for the apical enlargement. One recommended approach is to enlarge the apical root canal to three sizes larger than the first file to bind (Walton & Torabinejad 1996, Weine 1996). The concept behind this approach is that the first file to bind reflects the diameter of the apical canal; by using three successively larger files to the same working length the layer of heavily infected dentine should be removed from all regions of the apical canal wall. Another purpose of this approach is to create an apical stop (apical matrix) that was supposed to facilitate reduced leakage and material extrusion. On the other hand, taking successively larger files to the same length in a curved root canal can predispose to apical lacerations or ledging (Tang & Stock 1989, Briseno & Sonnabend 1991, Nagy *et al.* 1997, Buchanan 2000).

However, there is no evidence that the instrument that binds first does actually reflect the diameter of the canal in the apical region. Furthermore, since many canals are oval (Wu *et al.* 2000) it is uncertain whether removing dentine from the wall of the recesses is always possible (Reynolds *et al.* 1987, Zuolo *et al.* 1992, Siqueira *et al.* 1997). Indeed, cleaning in these regions of the canal may have to rely more on irrigation (Hand *et al.* 1978, Lumley *et al.* 1993). At the same time, whether removing a layer of dentine is always necessary for successful debridement

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is also unknown (Lussi *et al.* 1999). Thus, the concept of widening the apical canal to three sizes larger than the first file to bind is not based on evidence.

The purpose of this study was to determine whether the first file that binds reflects the diameter of apical canal.

Materials and methods

Twenty mandibular premolars with single curved canals and an apical foramen at the apex were selected. In all cases the curved portion was not longer than the apical half of the root. The curvature of each canal was determined from bucco-lingual and mesio-distal radiographs using the method suggested by Schneider (1971). Following access to the canal system, apical patency was confirmed by inserting a size 10 file through the apical foramen. The teeth were divided equally into two groups on the basis of their bucco-lingual internal diameters as determined from the radiographs.

A size 10 file was inserted into the canal until the tip of the file was just visible at the apical foramen. The actual canal length was determined and the working length established by deducting 1 mm. The coronal aspect of each canal was flared using Gates Glidden drills (Dentsply Maillefer, Ballaigues, Switzerland); size 50 (No. 1) was used to a depth where resistance was met, and then sizes 70–110 (Nos 2–4), respectively, to 1, 2 and 3 mm shorter. In all canals the No. 1 Gates prepared approximately the coronal two-thirds of the canals. Each canal was irrigated with 2 mL of a freshly prepared 2% solution of sodium hypochlorite after each Gates Glidden drill.

Since the Lightspeed instruments have no handle, their shanks were embedded in acrylic resin within a piece of silicone rubber tube. Acrylic resin handles were created on removal of the rubber tubes after polymerization. This procedure was repeated for the K-files to ensure that the handles of both instruments would have the same size and shape. The apical half of the cutting head of Lightspeed instrument was removed using wet SiC-paper, resulting in an instrument that had its largest diameter at its tip.

Without seeing the instrument or the tooth, one investigator inserted increasing sizes of instruments into the canals starting with size 10. When binding occurred, this was reported to a second investigator who recorded the length: at the working length or short of the working length. When short, the instrument was inserted to the working length by clockwise and counter clockwise rotation. The files were fixed at the working length in root canals with acrylic resin.

The apical 1 mm of each root was removed horizontally by grinding on wet SiC-paper to expose the canal and instrument at the WL level. Care was taken not to grind into the instrument and no instrument became dislodged. All teeth were then washed in a 0.5% NaOCl solution and distilled water successively for 15 min each. The root surface exposed by apical grinding was then stained with 2% methylene blue and observed under a Wild Photomakroskop M400 microscope with camera (Wild, Heerbrugg, Switzerland) at a ×40 magnification. Colour slides of the exposed surfaces were taken and the slides were scanned as TIFF (Tagged Image File Format) images. Using a KS100 Imaging system 3.0 (Carl Zeiss Vision GmbH, Hallbergmoos, Germany) two measurements of canal diameter were made with accuracy of 0.01 mm at right angles for each root; the shorter dimension was recorded as the short canal diameter. The instruments had a circular, square or triangular shape at the working length. The length of the diagonal line of a square, the diameter of a circle or the length of one side of a triangle was measured using the same program and considered as the diameter of instrument. The discrepancy between the canal and instrument diameters in the two instrument groups was compared and analysed statistically using the Mann–Whitney *U*-test.

Results

The average curvature of the canals was 26.5° for the K-file group and 27° for the Lightspeed group. The sizes of the first file to bind and the diameters of both the instrument and the canal at working length are shown in Table 1. In 18 (90%) canals (nine canals in each instrument group), the diameter of the instrument was smaller than the short diameter of the apical canal; the discrepancy was up to 0.19 mm in the K-file group and 0.14 mm in the Lightspeed group. The discrepancy between the canal and instrument diameters in the two instrument groups was similar ($P > 0.05$). In five (25%) canals (one from the K-file group and four from the Lightspeed group) the instrument did not touch the wall at the

Table 1 Comparison of instrument and canal diameters at the working length (WL)

Type of instrument	Range of ISO sizes of the first binding instruments	Average diameters (± SD) in mm at WL	
		Instrument	Canal*
Lightspeed	22.5–42.5	0.22 (±0.04)	0.27 (±0.06)
K-file	20–40	0.23 (±0.06)	0.28 (±0.08)

*Canal diameter: short diameter of the canal.

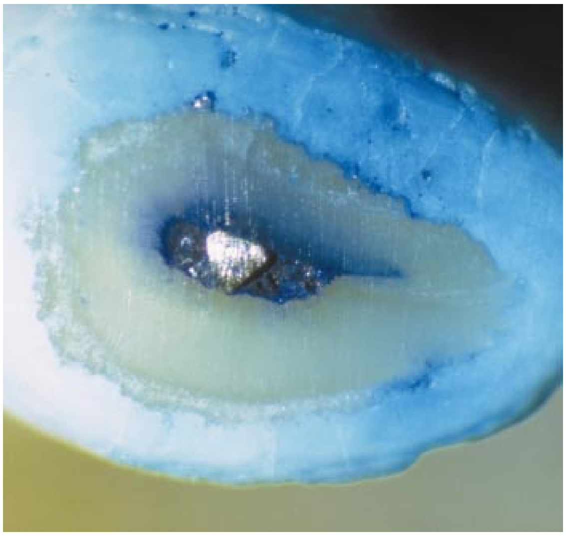

Figure 1 A ground root surface at the working length showing that the triangular shaped first binding K-file touched one side of the canal. The diameter of the file was not only much shorter than the long canal diameter, but also shorter than the short canal diameter.

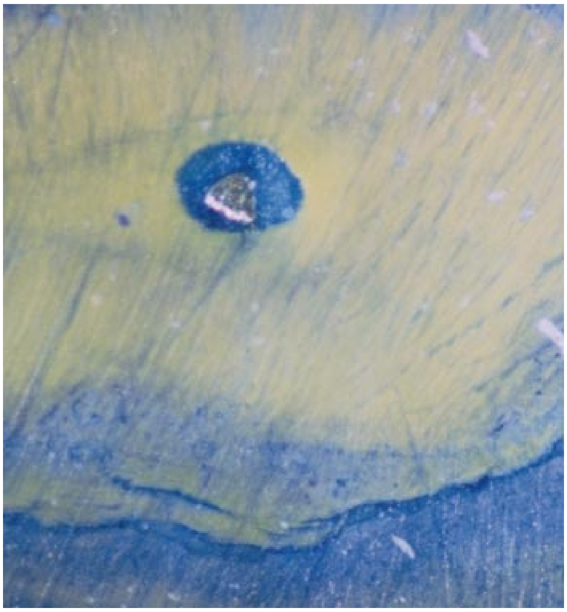

Figure 2 A ground root surface at the working length showing that a modified Lightspeed instrument did not touch the canal wall and that the area of root canal was much larger than the area of instrument.

WL, whereas in the other 15 (75%) canals the instrument was found binding at one part of the wall (Figs 1, 2).

Discussion

If the apical root canal has a round shape and the first file that binds indeed reflects the diameter of the apical canal, the inner layer of dentine of the root canal that may be heavily infected, can be removed by preparing the canal using three successively larger files. However, many apical root canals are oval (Wu *et al.* 2000) and indeed, the results of this study have shown that the first file to bind did not reflect the apical diameter and that the size of the file was noticeably smaller than the size of root canal at the WL (Figs 1, 2). Therefore, the aim of removing the infected layer of dentine may not be achieved.

The aim of canal preparation is to widen the apical canal enough (i) for placement and replacement of the irrigation solution (Wu & Wesselink 1995); (ii) for placement of intracanal dressing; and (iii) to facilitate obturation procedures. On the other hand, it should not be so wide that it unnecessarily weakens the root and increases the risk of fracture.

The coronal portion, rather than the tip, of a K-file may bind the wall because it has a larger diameter coronally. Therefore, a K-file that binds may not bind at the WL. The modified Lightspeed instrument, however, has the largest diameter at its tip. In addition, the Lightspeed instrument may follow the curvature better than K-file because of its enhanced flexibility (Spångberg 1998). Therefore, it was hypothesized that the modified Lightspeed instruments could provide a solution. Unfortunately, the results showed that the Lightspeed instruments did not reflect the apical canal diameter (Table 1). At the WL in four canals, the Lightspeed instrument did not touch any region of the canal wall (Fig. 2), showing on one hand, its centring ability in curved canals, and on the other hand, that other factors, including existence of calcified tissues or dense collagen fibres, may lead to a sense of binding.

Another purpose of the approach to use successively larger files to the same working length is to create an apical stop. Considering the fact that the first file to bind frequently bound at one side of canal wall, the apical stop may be created only on one side. Although this small shelf may prevent the master file moving apically, it is questionable whether it has any function in reducing leakage and material extrusion (Kašt'áková *et al.* 2001).

The Gates Glidden drills straightened the coronal two-thirds of the root canals in an attempt to reduce binding in the coronal region. Obviously, even this procedure could not guarantee that the instruments bound only at the working length. Clinically, it is not always possible to straighten the coronal two-thirds of root canal because sometimes the radius of root curvature is long.

Conclusion

In conclusion, the first file to bind did not reflect the canal diameter at the WL. As a result, preparing the canal to three sizes larger than this file does not assure removal of the inner layer of dentine from all regions of canal wall. Thus, using the first file to bind for gauging the diameter of the apical canal and as guidance for apical enlargement is not reliable.

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