A primary observation on the preparation and obturation of oval canals

M-K. Wu & P. R. Wesselink

Department of Cariology Endodontology Pedodontology, Academic Centre for Dentistry Amsterdam (ACTA), Amsterdam, the Netherlands

Abstract

Wu M-K, Wesselink PR. A primary observation on the preparation and obturation of oval canals. *International Endodontic Journal*, **34**, 137–141, 2001.

Aim The aim of this study was to observe the existence and assess the quality of obturation of uninstrumented recesses in oval canals.

Methodology The balanced force technique was used in two groups of oval canals in human mandibular incisors. The canals in group 1 were enlarged to conventional sizes, whereas canals in group 2 were enlarged more widely. All canals were obturated with cold laterally condensed gutta-percha. Two horizontal sections were cut in the apical portion of each filled root. Images of the cross-sections were scanned and analysed using the KS100 Imaging system.

Results Uninstrumented recesses appeared in 13 (65%) oval canals. The recesses in five of these 13 canals were obturated without visible voids. The recesses in the other eight canals were either obturated with visible voids or completely unfilled. The percentage of filled area was significantly higher in group 1 than in group 2 ($P < 0.05$).

Conclusions Uninstrumented recesses may be left in many oval canals after preparation using the balanced force technique and these recesses may often not be completely obturated with cold laterally condensed gutta-percha.

Keywords: oval canal, recess in oval canal.

Received 31 August 1999; accepted 22 March 2000

Introduction

Wu *et al*. (2000a) reported the prevalence of oval canals in the apical portion of human tooth roots. An oval canal was defined in that study as one with a cross-sectional long : short diameter ratio, determined using a measuring microscope, of ≥ 2. It was found that in those tooth groups where the percentage of oval canals was ≥ 50%, the long : short diameter ratio was even > 10× (Table 1). It may be difficult to instrument the entire wall of oval canals and uninstrumented recesses may remain after preparation, involving rotation of instruments (Fig. 1).

Although these recesses may not be well cleaned, it is desirable to obturate them completely with gutta-percha and sealer because sealer may assist in microbial control (Gutmann & Witherspoon 1998). Filling these recesses may trap the remaining bacteria and isolate them from sources of nutrients (Peters *et al*. 1995, Sundqvist & Figdor 1998). However, whether these recesses can be obturated by the current root filling techniques has not been studied.

The purpose of this study was to observe the appearance of uninstrumented recesses in oval canals after instrumentation using a balanced force technique and then to determine the quality of obturation with cold laterally condensed gutta-percha in these recesses.

Materials and methods

Twenty mandibular incisors with a single oval canal were selected after bucco-lingual and mesio-distal radiographs indicated an internal long : short diameter of ≥ 2 at a level 5 mm from the apex. The crowns were removed at the enamel–cement junction using a cylindrical bur and airotor. The full working length was established by deducting 1 mm from the actual canal length, which had been determined by inserting a size 15 file into the canal until the tip of the file was just visible at the apical foramen. The coronal half of each

Correspondence: M.-K. Wu, Department of Cariology Endodontology Pedodontology, Academic Centre for Dentistry Amsterdam (ACTA), Louwesweg 1, 1066 EA Amsterdam, the Netherlands (fax: +31 20 6692881; e-mail: M.Wu@acta nl).

Table 1 Categorization of canals into groups based on long : short diameter ratios (from Wu *et al.* 2000a)

Tooth(canal) position	Number of canals with different long : short diameter ratios							
	Total	≤ 1.5×	≤ 2×	≤ 4×	≤ 6×	≤ 8×	≤ 10×	> 10×
Maxillary								
Premolar								
Single canal	8	1	2	3	1	1	0	0
Molar								
Single MB*	10	1	3	2	0	2	1	1
2nd MB*	10	3	1	4	1	0	1	0
Mandibular								
Incisors	19	7	2	5	3	2	0	0
Molar								
Single M*	12	0	1	3	3	0	2	3
MB*	8	2	2	4	0	0	0	0
	67	14	11	21	8	5	4	4

*B, buccal; M, mesial.

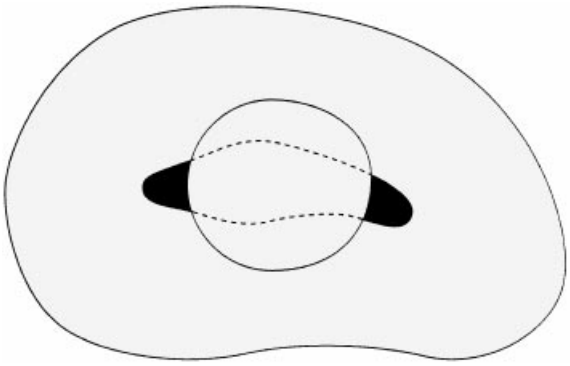

Figure 1 A schematic representation of the prepared oval canal. Uninstrumented recesses (dark areas) are left after a round preparation by rotation of instruments.

canal was preflared using Gates Glidden drills (Dentsply Maillefer, Ballaigues, Switzerland) sizes 1–3 (ISO sizes 50, 70, 90).

All the canals were prepared with Flexofiles (Dentsply Maillefer) by one operator using a balanced force technique as described by Roane *et al.* (1985). Briefly, a size 15 file was introduced into the canal until it bound; it was then rotated clockwise 90–180 degrees with light apical pressure. The file was then turned in a counterclockwise rotation 120–360 degrees with light inward apical pressure. Debris removal was accomplished with a slight outward pull with clockwise rotations. Preparation was continued until the working length was reached. This procedure was repeated for all the subsequent instruments, sizes 20–40, ending with a size 40 master apical file. Apical pressure during counterclockwise rotation increased with file sizes greater than 25.

Step-back circumferential filing was then performed at 1 mm increments. In group 1 (conventional flare, $n = 10$) a size 45 file was used to a depth 1 mm shorter than the working length, followed by size 50–2 mm short and 55–3 mm short of working length. In group 2 (enhanced flare, $n = 10$) sizes 45, 50, 55 and 60 files were used 1 mm shorter than the working length, followed by size 70 2 mm short and size 80 3 mm short of working length. Teeth in both groups had similar ratios of the long : short canal diameter. Each canal was irrigated with 2 mL of fresh 2% sodium hypochlorite solution using a syringe and 27-gauge needle between each file. After preparation, the patency of each canal was confirmed by inserting a size 20 file through the apical foramen and a final flush with 10 mL of 2% NaOCl was performed.

The canals were obturated by a second operator without knowledge of the preparation technique. After drying the canals with paper points (Dentsply Maillefer), AH26 silver-free root canal sealer (De Trey Dentsply, Konstanz, Germany) was mixed manually according to the recommendations of the manufacturer and introduced into the root canal with a size 35 file. A size 40 master gutta-percha cone (Dentsply Maillefer) lightly coated with sealer was placed in the canal to the full working length. Cold lateral condensation was achieved in each canal using size 25 accessory gutta-percha cones and an endodontic finger spreader size B (Dentsply Maillefer) that initially reached to within 2 mm of the full working length. The tip of each accessory gutta-percha cone was lightly coated with sealer.

The filled teeth were stored in 100% humidity at 37 °C for 1 week. Using a low-speed saw (Sägemikrotom 1600; Leitz, Wetzlar, Germany) with water coolant each root was horizontally sectioned 3 and 5 mm from the apex. Colour photographs of the sections were taken using a Wild Photomakroskop M400 microscope and camera (Wild, Heerbrugg, Switzerland) at ×40 magnification. The photographs were scanned as TIFF (Tagged Image File Format) images. To detect uninstrumented recesses the ratio of diameter of the round preparation (RP) long^{-1} diameter of the original canal (L) was measured using the KS100 Imaging system 3.0 (Carl Zeiss Vision GmbH, Hallbergmoos, Germany). RP/L < 1 indicated the existence of an uninstrumented recess. Filling quality in the recesses was evaluated; score 1: the recess was completely filled without visible voids; score 2: the recess was incompletely filled with visible voids; score 3: the recess was completely unfilled. Finally, the percentage of filled area in each canal was measured using the KS100 Imaging system 3.0. The difference in the percentage of filled area and scores between two groups were statistically analysed using a Mann–Whitney *U*-test.

Results

The results are shown in Table 2. The numbers of root canals with uninstrumented recess in groups 1 and 2 were not significantly different. At the level 5 mm from the apex, uninstrumented recesses (RP/L < 1) appeared in 13 (65%) canals. In five of these 13 canals the recesses were filled completely and had no visible voids (score 1) (Fig. 2). In the other eight canals the recesses were either incompletely filled with visible voids (score 2) (Fig. 3) or completely unfilled (score 3) (Fig. 4). No significant difference was found in scores between the two groups. After combining the data at 3 and 5 mm from the apex, the percentage of the filled area was significantly higher in group 1 than in group 2 ($P < 0.05$).

Discussion

Teeth with oval canals were selected only when the ratio of the long : short diameter of a canal was ≥ 2 at the level 5 mm from the apex. The long diameter of oval canals has been found to decrease apically (Wu *et al.* 2000a). Therefore, the long diameter of canals at the level 3 mm from the apex may not be as long as that at the 5 mm level. This explains why uninstrumented recesses appeared less frequently at the 3 mm level (45%) compared to the 5 mm level (65%) (Table 1). In eight (40%) canals the recesses were neither instrumented nor completely filled (Table 2, Figs 3,4). Obviously these recesses were not prepared by the balanced force technique involving rotation of instruments. Although force was applied to press the instrument against all walls during the step-back circumferential filing phase, the files used in this stage may have been too large to instrument the narrow recesses. Whether the uninstrumented recesses can be obturated by laterally condensed gutta-percha may depend on their width, length and cleanliness. At the level 5 mm from the apex, in five of the 13 canals with uninstrumented recess, the recesses were completely unfilled (Table 2) because the recesses were narrow and long and had been filled with a large amount of debris (Fig. 4).

Canals in group 2 were flared widely in order to determine whether this enhanced shape would include the entire oval canal. Uninstrumented recesses were still apparent in six of the 10 canals (Table 2), indicating that the original length of these six oval canals was > 0.82 mm at the 5 mm level since the largest file used in group 2 (ISO 80) was 0.82 mm (Spångberg 1998) and the working length for this file was 4 mm from the

Table 2 Percentage of filled area and number of root canals (*n*) with and without uninstrumented recess (UR) in the two experimental groups with different canal enlargement

Flare	mm from apex	*n*	Percentage of filled area (mean ± SD)	N without UR (RP/L = 1)	N with UR (RP/L < 1)	N with filled or unfilled UR*		
						Score 1	Score 2	Score 3
Conventional	3	10	99.5 ± 1.0	5	5	5	0	0
	5	10	98.8 ± 2.1	3	7	3	2	2
Enhanced	3	10	91.9 ± 8.7	6	4	0	1	3
	5	10	92.5 ± 9.9	4	6	2	1	3
Total				18	22	10	4	8

*Filled and unfilled UR were evaluated with scores. Score 1: the UR was completely filled without visible voids; score 2: the UR was incompletely filled with visible voids; score 3: the UR was completely unfilled.

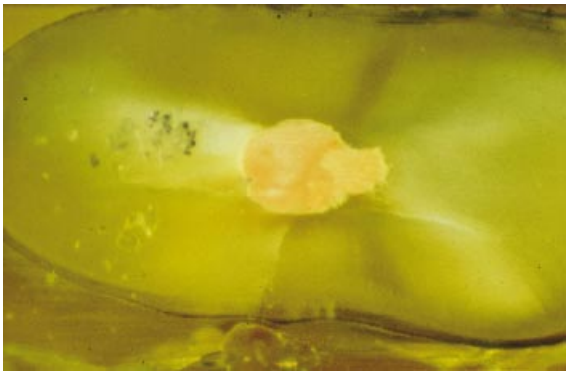

Figure 2 Cross-section of cold lateral condensation filled root. The round preparation by balanced force did not include the entire original root canal and left an uninstrumented recess. The recess was filled without visible voids (original magnification ×40).

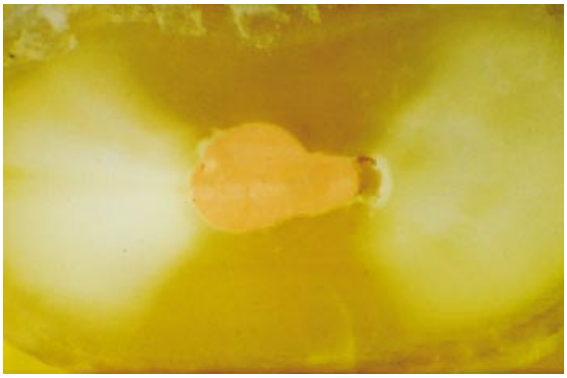

Figure 3 Cross-section of cold lateral condensation filled root. The recess was filled with visible voids (original magnification ×40).

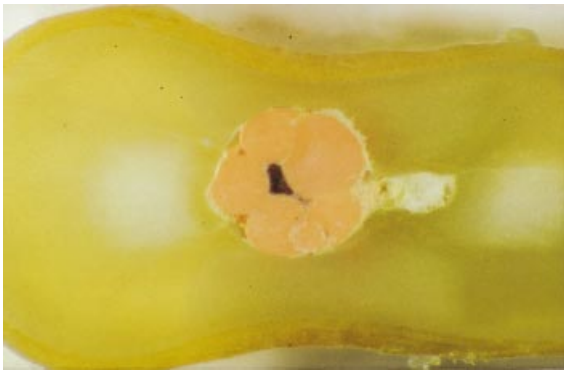

Figure 4 Cross-section of cold lateral condensation filled root. The recess was full with debris and completely unfilled (original magnification ×40).

apex. In the study of Wu *et al.* (2000a), the buccal-lingual canal diameter in mandibular incisors 5 mm from the apex was up to 1.80 mm. Clearly, using an instrument of 0.82 mm diameter may not touch the recesses in some long oval canals and therefore leaves uninstrumented recesses.

On the other hand, the increased flare in group 2 created problems during obturation using cold lateral condensation since the percentage of filled area was significantly lower (Table 2). Clearly, canals were not sufficiently filled with accessory cones. Five millimetres from the apex the canal was enlarged to a 0.82-mm diameter in group 2. A number of accessory cones were required to fill the enlarged canal space. However, the coronal part of the canal which had been enlarged to Gates Glidden drill size 3 (0.9 mm in diameter), may not have been wide enough to allow sufficient accessory cones to be placed, resulting in a low percentage of filled area in the apical region. Kersten *et al.* (1986) compared oval canals prepared to ISO size ≥ 50 with those prepared to size 30 or 35. They also reported that the quality of laterally condensed gutta-percha root fillings in the widely prepared canals was significantly worse. In the same study, some other oval canals were prepared to ≥ 50 and filled with warm gutta-percha; the quality of filling was found to be significantly better than using cold lateral condensation. This indicates that a warm gutta-percha technique is less influenced by the width of the coronal part of the prepared canal.

When curved oval canals are prepared, rotation of instruments produces less apical transportation than a push–pull filing movement (Wu *et al.* 2000b). However, the rotation motion may leave uninstrumented recesses. It may be that during preparation with a technique involving rotation, a small file should be used in a circumferential filing movement in order to clean the recesses in oval canals as much as possible. However, the tip of such an instrument may not be controlled easily by the operator. Whether circumferential filing can indeed instrument more canal wall in the apical portion of root canal remains to be studied. Importantly the efficacy of irrigation should be enhanced, perhaps, by raising temperature (Cunningham & Balekjian 1980, Cunningham & Joseph 1980), concentration (Hand *et al.* 1978) and volume (Wu & Wesselink 1995) of NaOCl solution. A 5% NaOCl solution may effectively dissolve tissues in those uninstrumented recesses (Hand *et al.* 1978) to facilitate disinfection and sealing. Whether a 5% NaOCl solution causes more severe response in the periapical tissues than solutions of lower concentrations is unknown. Meanwhile ultrasonic irrigation with

a file oscillation toward the oval recesses is indicated to promote cleaning (Lumley *et al.* 1993).

From the results of this study the following conclusions may be drawn.

1 Uninstrumented recesses may be left in many oval canals after preparation using the balanced force technique. This problem is not solved by increasing the apical flare.

2 In many cases these uninstrumented recesses cannot be completely obturated by cold lateral condensation of gutta-percha.

3 If the middle and coronal parts of root canals have not been sufficiently flared before cold lateral condensation of gutta-percha, then an insufficient number of accessory cones can be fitted.

Acknowledgements

The authors thank Drs A. Koch and L. van Nieuwenhuijzen for their laboratory work.

References

Cunningham WT, Balekjian AY (1980) Effect of temperature on collagen-dissolving ability of sodium hypochlorite endodontic irrigant. *Oral Surgery, Oral Medicine and Oral Pathology* **50**, 569–73.

Cunningham WT, Joseph SW (1980) Effect of temperature on the bactericidal action of sodium hypochlorite endodontic irrigant. *Oral Surgery, Oral Medicine and Oral Pathology* **49**, 175–80.

Kersten HW, Fransman R, Thoden van Velzen SK (1986) Thermomechanical compaction of gutta-percha. II. A comparison with lateral condensation in curved root canals. *International Endodontic Journal* **19**, 134–40.

Gutmann JL, Witherspoon DE (1998) Obturation of the cleaned and shaped root canal system. In: Cohen S, Burns RC, eds. *Pathways of the Pulp*, 7th edn. St. Louis, MO, USA: Mosby, 258–361.

Hand RE, Smith ML, Harrison JW (1978) Analysis of the effect of dilution on the necrotic tissue dissolution property of sodium hypochlorite. *Journal of Endodontics* **4**, 60–5.

Lumley PJ, Walmsley AD, Walton RE, Rippin JW (1993) Cleaning of oval canals using ultrasonic or sonic instrumentation. *Journal of Endodontics* **19**, 453–7.

Peters LB, Wesselink PR, Moorer WR (1995) The fate and the role of bacteria left in root dentinal tubules. *International Endodontic Journal* **28**, 95–9.

Roane JB, Sabala CL, Duncanson MG (1985) The 'balanced force' concept for instrumentation of curved canals. *Journal of Endodontics* **11**, 203–11.

Spångberg LSW (1998) Instruments, materials, and devices. In: Cohen S, Burns RC, eds. *Pathways of the Pulp*, 7th edn. St. Louis, MO, USA: Mosby, 476–531.

Sundqvist G, Figdor D (1998) Endodontic treatment of apical periodontitis. In: Ørstavik D, Pitt Ford TR, eds. *Essential Endodontology*. London, UK: Blackwell Science, 242–77.

Wu M-K, Fan B, Wesselink PR (2000b) Leakage along apical root fillings in curved root canals. Part I: Effects of apical transportation on seal of root fillings. *Journal of Endodontics* **26**, 210–6.

Wu M-K, Roris A, Barkis D, Wesselink PR (2000a) Prevalence and extent of long oval canals in the apical third. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics* (in press).

Wu M-K, Wesselink PR (1995) Efficacy of three techniques in cleaning the apical portion of curved root canals. *Oral Surgery, Oral Medicine and Oral Pathology* **79**, 492–6.