

# Radiographic location of accessory canals

Professor of endodontics Donald Yu describes the eight ways to predictably locate the accessory canals on radiographs prior to endodontic treatment and his theory behind these phenomena

The principal objective of successful nonsurgical endodontic therapy is the total debridement of the entire root canal system, followed by three-dimensional obturation of the entire endodontic space with an inert core filling material (Yu DC, 1998; Yu DC and Schilder H, 2001) (see Figures 1 and 2, page 38). This meticulous, attentive cleaning and shaping procedure eliminates the microbes, noxious materials, bacterial by-products, organic substrates, and the possible sources of inflammation and infection. The total obliteration of the portal(s) of exit prevents irritants from causing detrimental effect on the attachment apparatus and periodontium. Multiple studies have shown that the root canal system has a complex anatomical morphology, characterised by the existence of accessory canals and tortuosities, especially in the apical third (Yu DC and Schilder H, 2001; Yu DC, 2005; Hess et al, 1928) (see Figures 3, 4, 5 and 6, page 38). Much clinical experience has led Yu and Schilder (Yu DC and Schilder H, 2001) to the conclusion that approximately 70% of teeth filled have accessory canals (see Figures 2 and 6, page 38).

There are two main theories for the formation of accessory canals (Orban and Bhaskar, 1991; Avery JK, 1987). First, during odontogenesis, without any explanation, the continuity of Hertwig's root sheath is broken or is not established prior to dentin formation, so a defect in the dentinal wall of the pulp ensues. This accounts for the opening of accessory canals on the periodontal surface of the root. A premature break in the epithelial diaphragm would not further differentiate the cells to odontoblasts. Hence dentin would not be formed, leaving a portal of exit.

Second, when the maturing Hertwig's epithelial root sheath encounters a neurovascular bundle, the dentin forms around this bundle, resulting in portal of exit. Similarly defects in the furcation region of premolars and molars may be due to incomplete fusion of the tongue-like extensions of the epithelial diaphragm dividing the root trunk. This may also happen in the apical region of the fused roots of multi-rooted teeth.

This article will describe the eight ways to predictably locate the accessory canals on the radiographs before endodontic treatment and the author's attempts to explain the reasons for these phenomena.

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### Widened PDL space in the middle of the root

The bone loss around the middle of the root occurred because of noxious materials such as enzymes named sulphatases, hyaluronidases, inflammatory agents such as PGE<sub>2</sub>, TNF alpha, coming out of the accessory canal (see Figure 7, page 38). These materials promote bone loss, and frequently the incipient bone loss is evident as widened periodontal ligament (PDL) space. It is interesting to note that occlusal trauma may cause widened PDL spaces, however this is commonly limited at the crestal bone as circumferential nature, but not located at the mid root region.

### Tangent radius relationship

Frequently, these noxious materials may cause a relatively large bone loss along the root surface. These bony lesions of endodontic origin (LEO) are commonly ovoid-shaped along the root surface (see Figures 8 and 9, see pages 38 and 41). Seemingly, the irritants coming out of the accessory would push directly onto the bone and move it furthest away from the root surface. Imagine you draw a circle that is fitted into this ovoid lesion, and if you drop a tangent line to the peak of the lesion of endodontic origin, the radius of the circle is 90° (perpendicular) to this tangent line (see Figures 10 and 11, page 41). This radius line will usually direct you to the precise location of the accessory canal's portal of exit (see Figure 12).

### Disappearance of the main canal (or 'white out')

The canal is branching out and these smaller accessory canals are invisible on the radiograph. Sometimes, you may verify this

Multiple studies have shown that the root canal system has a complex anatomical morphology, characterised by the existence of accessory canals and tortuosities, especially in the apical third

with the lateral lesion at the root surface (see Figures 13 and 14, page 41).

### Bulbous root tip

It is well understood that the odontoblasts of the pulp deposit calcium and subsequently dentin is formed. If the end of the root is bulbous, this means the pulp has formed more dentine. However, the main pulp canal is usually finer and narrow at the apical region, giving a tapering root. If it is a bulbous root, the main pulp canal must branch into more accessory canals. These ramifications of pulp tissues are now able to deposit all this extra dentin at the end of the root, giving the bulbous root appearance (see Figures 15 and 16, page 41).

### Inner curvature of a turn

During the odontogenesis, the root surface is formed by the Hertwig's epithelial root sheath. Simultaneously, the blood cells are differentiated, and neurovascular bundles start to confine these blood cells. As these bundles mature, their walls get thicker. The root sheath then has to make a turn or detour in order to accommodate the relatively mature neurovascular bundles. Here, odontoblasts are not formed and no dentine is deposited, as a result, accessory canals are formed. It is very common at the apical region, where these neurovascular bundles are most mature and their walls are thicker, so we have more tortuosities

and more accessory canals (see Figures 17 and 18, page 41 and 43).

### File is not in the centre of the root

Fundamentally, as the pulp forms the dentin, the configuration of the root follows that of the pulp three-dimensionally (see Figure 19, page 43). If you have a root that is oval shaped, and the file is not in the centre shown in an off-angled radiograph (see Figure 20, page 43), there should be another accessory canal or main canal to 'balance' out the oval shape, if this pulp canal itself is not oval shaped, but rather geometrically round (see Figure 21, page 43).

### 'Pairing' of the root canal anatomy

Our body is essentially symmetrical in appearance. If you have a  $\overline{7}$  with one root canal and very fine accessory canals at the apex, you should also have a  $\overline{7}$  with the same (see Figures 22 and 23, page 43).

### Expect the unexpected

Even if you have no evidence of an accessory canal, using the Schilder-Yu philosophy and technique (Yu and Schilder, 2001; Schilder H, 1967; Schilder H, 1974) you can expect to fill accessory canals unexpectedly (see figures 24 and 25, page 43). ■

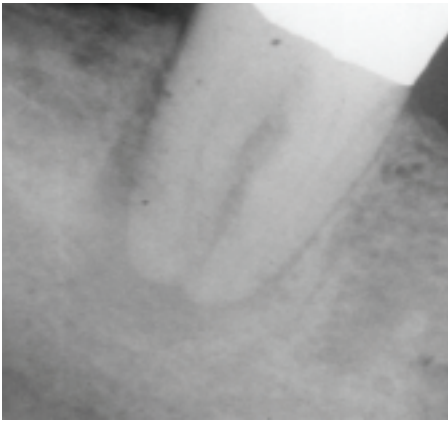


Figure 1: Pre-op film of 7 indicating radiolucency surrounding the converging roots, in particular at the distal side of the distal root. The usual calcification is at the coronal part of the root canal because of the various insults to the pulp coming from coronally, and never apically. The fusing roots formed from the convoluted Hertwig root sheath frequently indicate multiple portals of exit for the root canal system

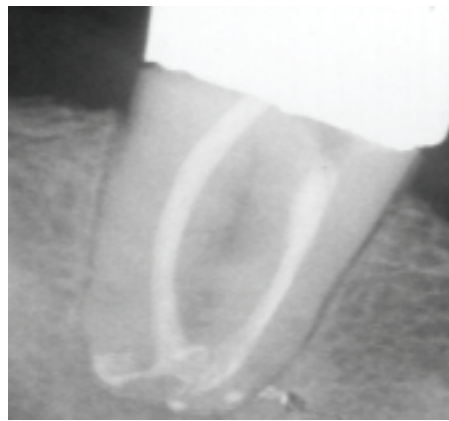


Figure 2: The six-month follow-up radiograph indicates the complete osseous fill-in. The complexity of the root canal system is revealed by the dental gutta-percha and Kerr Pulp Canal Sealer (Kerr Hawe, 07711 750622). The stability of the filling materials is appreciated here

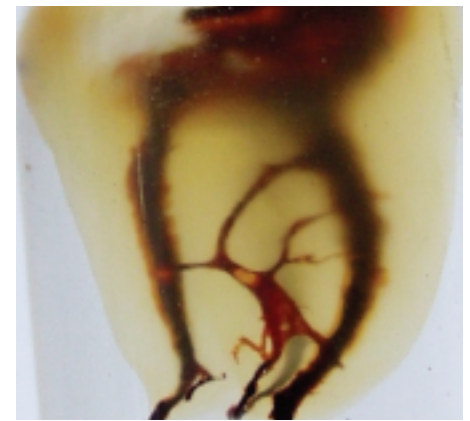


Figure 3: The dye shows the total complexities of the root canal system

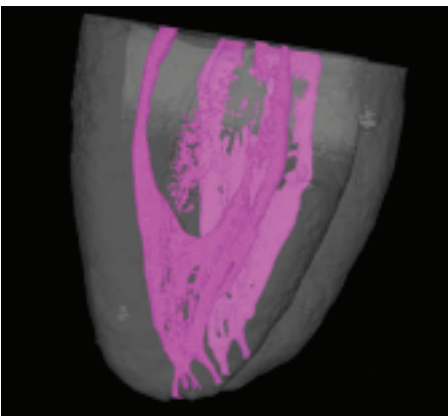


Figure 4: The innovative micro-computed tomography revealed the apical ramifications. There are seven portals of exit in this lower first molar

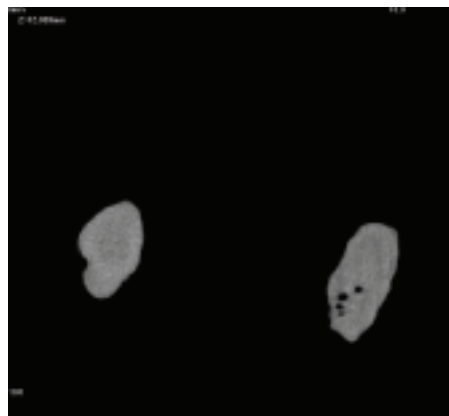


Figure 5: The micro-computed tomography in cross section demonstrates four canals at the apical region of the mesial root of a lower molar



Figure 6: The radiograph shows the accessory canals in the middle area of the mesial root, and 'the five fingers of death' in the apical area of the distal root

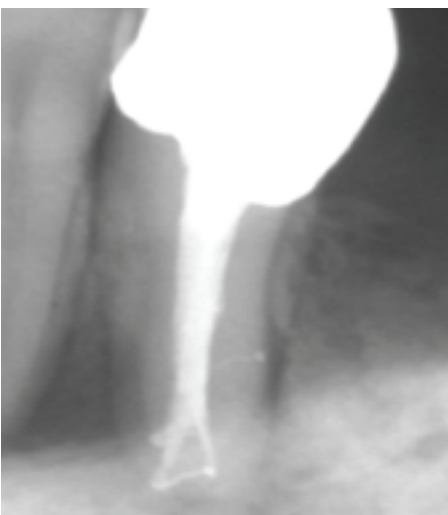


Figure 7: The radiograph of a lower first premolar shows the accessory canal going not only distally but also slightly coronally. We believe during the dentinogenesis of the root, the relatively mature neurovascular bundle prevents the root sheath to lay down the dentin. The widened periodontal ligament space in the middle of the root indicates the exact locale of this accessory canal exit on the root surface. Notice the apical ramification. A premolar is commonly a hybrid of an anterior tooth of one root externally and a molar of multiple canals internally (Courtesy of Dr Eric Kwan)

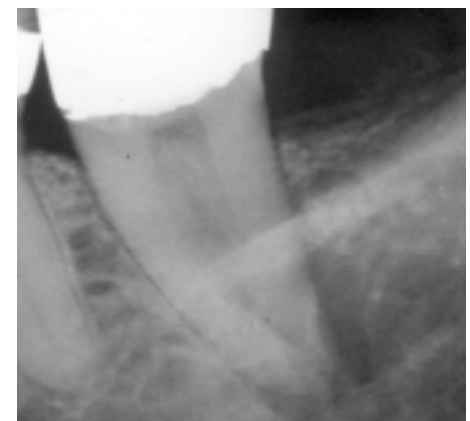


Figure 8: The pre-operative radiograph of this lower molar shows the lesion of endodontic origin (LEO) located at the distal surface of the root. Careful examination reveals the multi-lobular LEO

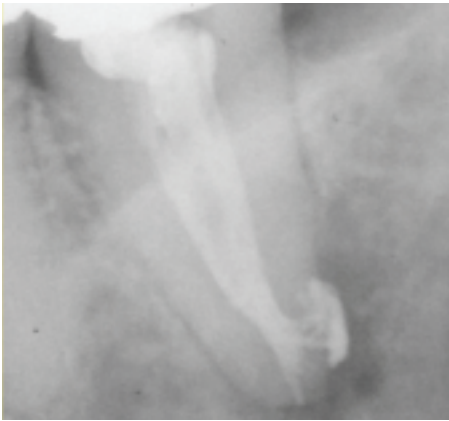


Figure 9: The post-op radiographs show the multiple accessory canals contributing to the multi-lobular LEO

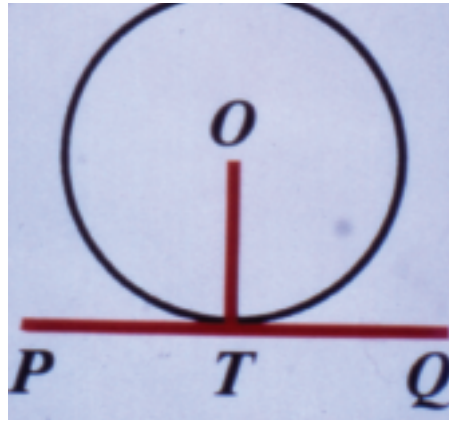


Figure 10: In geometry, the tangent PTQ is perpendicular to the radius OT of a circle O, at the point T

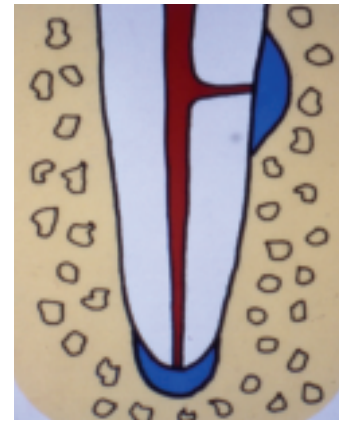


Figure 11: The graphic picture shows the lateral LEO on the root surface, and the lateral accessory canal exiting at the root surface



Figure 12: Drawing the tangent line at the peak of the oval LEO, then perpendicularly drawing the radius line can locate the exit portal of the accessory canal

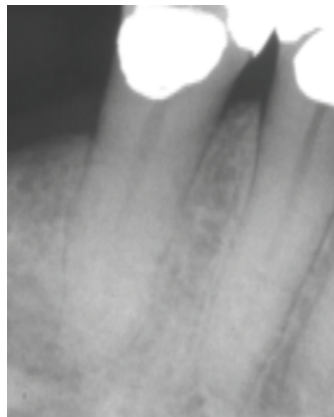


Figure 13: The lower first premolar has one large canal, however this canal disappears (white out) at the middle and apical thirds



Figure 14: The post-operative radiograph depicts the apical ramification and complexities of the root canal system. These accessory canals are extremely small and radiographically invisible, and can be indicated only by the puffs of Kerr Pulp Canal Sealer (Kerr Hawe, 07711 750622) on the root surface

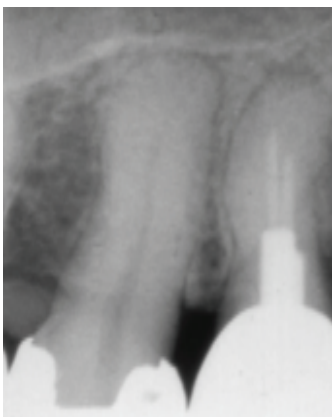


Figure 15: The upper second premolar shows the bulbous root apex, and the 'white out' of the main canal at the apical third

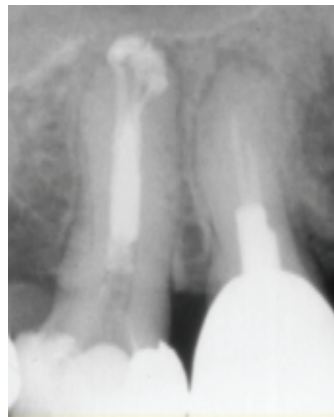


Figure 16: The complex trifidity is fully filled with a surplus of sealer puffs

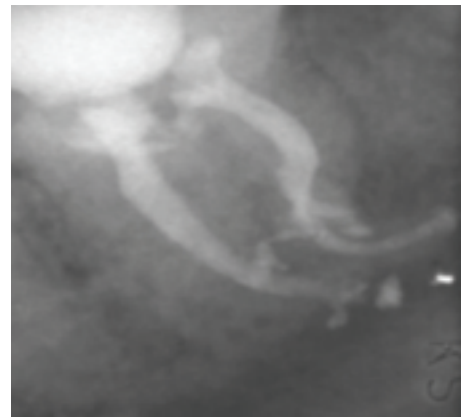


Figure 17: The severe tortuosities of the lower second molar show the accessory canals branching out from the inner curvatures of the main canals (courtesy of Dr Eric Kwan)

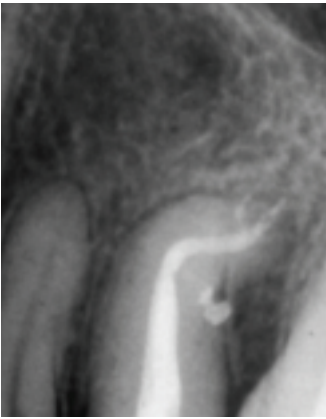


Figure 18: The upper premolar has the accessory canals branching out from the inner curvatures of the single main canal with tortuosities



Figure 19: The Micro CT demonstrates that configuration of the pulp in cross section gives rise to the configuration of the root surface, with relatively even thickness of dentine. The ovoid pulp canal gives the ovoid root, and the two pulp canals give the dumb-bell shaped root

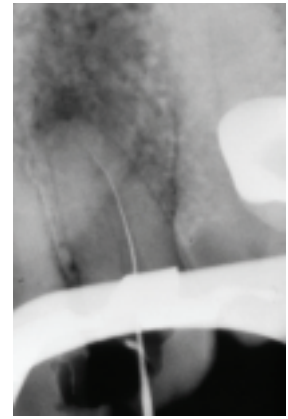


Figure 20: The #10 file is not in the mid-line of the root at the middle third as shown on the off-angled radiograph

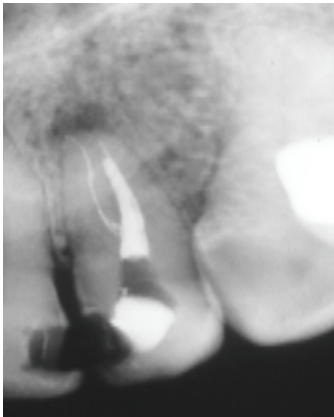


Figure 21: An accessory canal runs relatively parallel to the main canal. These two pulp canals give the ovoid root, as the main canal is round, not ovoid or ribbon-shaped

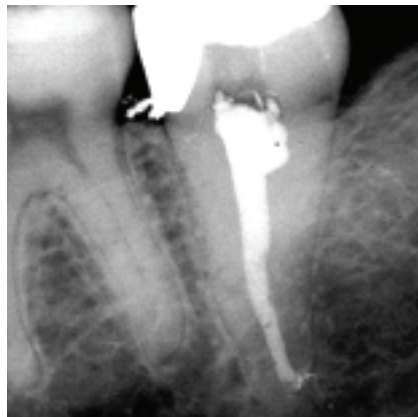


Figure 22: Tooth 17 has only one root and one root canal with very few minute accessory canals at the apex

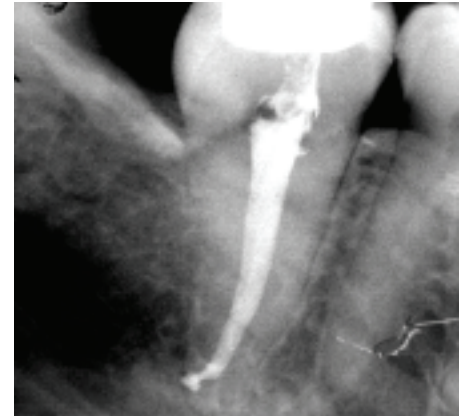


Figure 23: Tooth 71 reveals the same, indicating 'pairing' of root canal anatomy

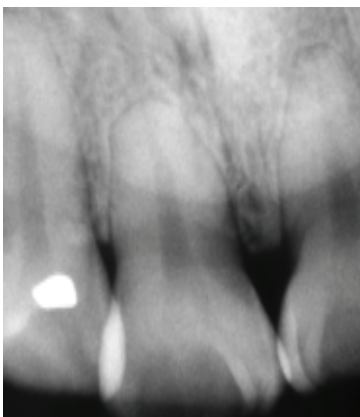


Figure 24: Upper right central incisor has a history of impact accident trauma. The incisor has been extruded. There is no hint of where the accessory canals are

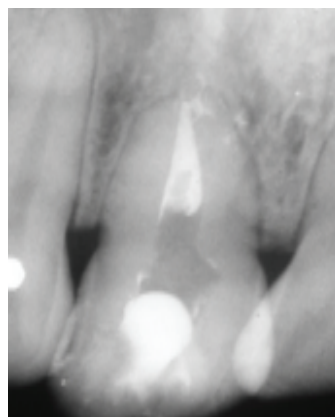


Figure 25: Three extremely small accessory canals are filled unexpectedly

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For a complete list of references to accompany this article, please email the editor at [sarah.manolescue@fmc.co.uk](mailto:sarah.manolescue@fmc.co.uk)