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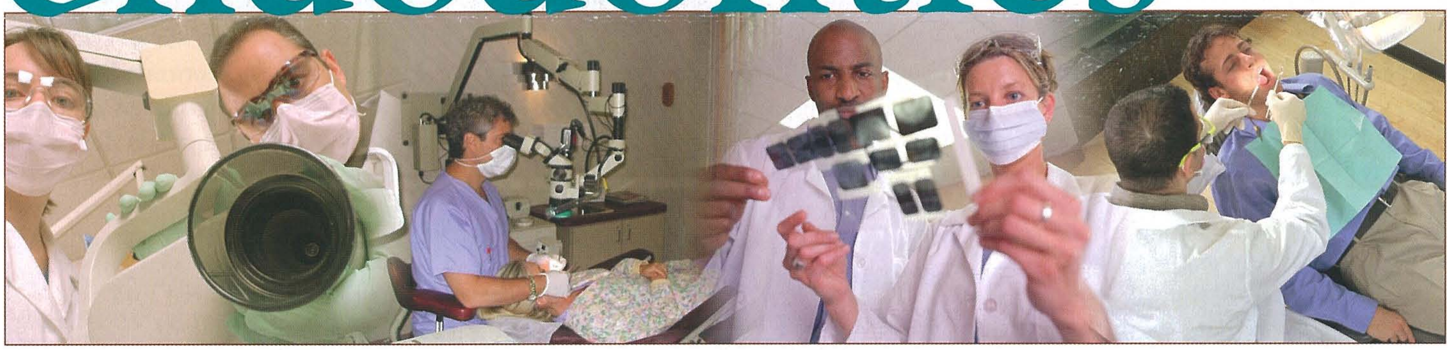

Canal Morphology of the Mandibular First Premolar

Success of nonsurgical root-canal therapy (NSRCT) depends on thorough knowledge of root-canal morphology to locate all canals and then properly clean, shape and obturate them. While the mandibular first premolar is typically a single-rooted tooth, 2-, 3- and 4-rooted varieties have been reported. A 1955 University of Washington study found that the mandibular first premolar had the highest NSRCT failure rate of all teeth, 11.5%. Numerous endodontic failures after routine treatment and flare-ups during the course of NSRCT also occur, possibly because of complex variations in root-canal morphology and the difficulty of treating these additional canal systems.

Cleghorn et al from Dalhousie University, Nova Scotia, reviewed the literature with respect to the number and type of roots and root-canal morphology. More than 6700 permanent mandibular first premolars were analyzed and weighted averages were determined for number of roots, number of canals and apical foramina, ethnic and gender differences, and case reports of other anomalies.

Anatomical studies of 4462 mandibular first premolars revealed complex root morphology. The majority of teeth (97.9%) had a single root; 2 roots were found in 1.8%; 3-rooted (0.2%) and 4-rooted (<0.1%) varieties were quite rare. Internal canal morphology was assessed in 4733 teeth. One canal was present in 3586 (75.8%); ≥2 canal systems were found in 1147 (24.2%). In apical anatomy studies, a single apical foramen was found in 2054 (78.9%) teeth; ≥2 were found in 550 (21.1%). A higher incidence of multiple canal systems in the first premolar was found in African American, Turkish, Chinese and other populations. Most studies disregarded effect of gender on variations.

Conclusion

Most mandibular first premolars have a single root, 24% have ≥2 canals and >20% have ≥2 foramina. Anatomical

differences were related to race. Constant vigilance locating canal systems ensures the highest degree of clinical success. The use of magnification and enhanced illumination increases the chances for locating canal systems.

Cleghorn BM, Christie WH, Dong CCS. The root and root canal morphology of the human mandibular first premolar: a literature review. J Endod 2007;33:509–516.

Dilaceration: An Endodontic Challenge

A tooth with a straight root and root canal is the exception rather than the norm, as most root canals show some degree of curvature and have multiple planes of curvature throughout their length. According to some authors, a tooth exhibits dilaceration if there is a ≥90° angle along the axis of the tooth or root whereas others have defined dilaceration as a deviation from the normal axis of the tooth of ≥20° in the apical part of the root. Jafarzadeh from Mashhad University of Medical Sciences, Iran, and Abbott from the University of Western Australia reviewed this condition and options for managing it.

Dilaceration may result when the calcified portion of the permanent tooth germ is displaced so that the remainder of the permanent tooth germ forms at an angle to it. However, the low incidence of dilacerated permanent teeth is disproportionate to the high prevalence of such trauma. Idiopathic developmental disturbance, a possible cause in cases with no clear evidence of traumatic injury, includes scar formation, developmental anomaly of the primary tooth germ, facial clefting, extensive root-canal infections, ectopic development of the tooth germ and lack of space, anatomic structures that might deflect the epithelial diaphragm, the presence of an adjacent cyst or tumor and hereditary factors.

Crown and root dilacerations complicate treatment, so clinicians must use care to avoid mishaps in such teeth. Diagnosing root dilacerations before commencing endodontic treatment facilitates the safe use of instruments within the curved canal. Failure to recognize the multiplanar nature of the dilaceration might contribute to a higher rate of failure.

Direct access to the apical foramen is an important benefit gained through access cavity preparation. In dilacerated teeth, especially if there is any internal calcification or resorption, it is often difficult to explore and negotiate the canal, resulting in canal blocking, ledging, transportation, zipping, perforation or instrument breakage. It is therefore essential to precurve all hand files to facilitate canal negotiation. While instruments with noncutting tips and those made from nickel–titanium help maintain root-canal curvatures in many teeth, some rotary instruments may not be suitable because of the severe nature and extent of the curvatures. The use of multiple file recapitulations with copious irrigation is required and should be repeated more frequently in all curved canals.

The use of thermoplasticized root-filling techniques may be difficult to perform because of the severity of the canal dilaceration. Root dilacerations also concentrate the occlusal stresses in the supporting structures and should be considered as a risk factor in abutment selection. Increased stress might affect the stability and longevity of the abutment tooth and that of the prosthesis.

The prognosis of endodontically treated dilacerated teeth varies according to the severity of the deformity and the practitioner's skills. In many cases, the prognosis will not become evident until it is determined whether the canal can be negotiated completely and then adequately debrided, disinfected and obturated.

Conclusion

Dilacerated teeth pose a number of diagnostic, management and prognostic challenges to dental practitioners. Once identified, the effect of this anomaly on the endodontic and restorative dental management of the tooth can be more fully assessed.

Jafarzadeh H, Abbott PV. Dilaceration: review of an endodontic challenge. J Endod 2007;33:1025–1030.

Correlation of Bone Defect Dimensions with Healing Outcome

Healing after apical surgery depends on proper sealing of the root-canal system and the size of the periapical lesion. Higher success rates have been reported in teeth with smaller apical lesions. This prospective clinical study by von Arx et al from the University of Berne, Switzerland, assessed the influence of bone defect dimensions on outcome

1 year after apical surgery in 200 apical surgery patients (215 teeth) from April 2001 to October 2005.

Following elevation of a full-thickness mucoperiosteal flap, bone was removed to gain access to the lesion and root end. Affected roots were then resected approximately 3 mm from the apex. After debridement of pathologic tissue, the root end was inspected for the presence of fractures, cracks or isthmuses by using a rigid endoscope. Root-end cavities, prepared with sonic-driven micro-tips, were retrofilled with either SuperEBA (Staident International, Staines, U.K.) or mineral trioxide aggregate (MTA; Dentsply Tulsa Dental, Tulsa, Okla.). Alternatively, a shallow concavity was prepared in the cut root surface by using round diamond burs, with subsequent placement of dentin-bonded resin composite (Retroplast; Retroplast Trading, Rorvig, Denmark). The flap was repositioned and closed with interrupted sutures.

All patients were given nonsteroidal analgesics and instructed to rinse with 0.1% chlorhexidine digluconate twice a day for 10 days. Antibiotics were not routinely prescribed. Sutures were removed 4–7 days after surgery. Patients were recalled 1 year after surgery for reexamination.

The following bone dimensions were measured after bone preparation, root-end resection and removal of pathologic tissue:

- marginal level of facial bone (A);
- height of facial bone plate (B);
- height of access window to bony crypt (C);
- length of access window of bony crypt (D);
- depth of bony crypt (E);
- approximate volume (V) of bony crypt (C × D × E); and
- horizontal dimension from the facial bone surface to the root canal (F).

All measurements were taken to the nearest 0.5 mm with a periodontal probe. In molars with 2 separate bony crypts for individual access to the mesial and distal roots, the lengths of both crypts (D) were added whereas for defect height and depth (C and E) and bone level and height of facial bone plate (A and B) averages were calculated.

The lesion had to be limited to the periapical area with surgical access from the facial aspect. Teeth with tunnel lesions and complete loss of facial bone plate were excluded.

One-year follow-up radiographs determined radiographic periapical healing according to the following criteria: complete, incomplete (scar tissue formation), uncertain (some reduction of radiolucency) or unsatisfactory (no reduction or enlargement of former radiolucency).

In healed cases, the radiograph demonstrated complete or incomplete healing of the preoperative radiolucency, with no clinical signs and symptoms present. In nonhealed cases, the radiographic healing was uncertain or unsatisfactory, or clinical signs or symptoms were present.

A total of 183 teeth met the inclusion criteria. Six teeth were lost to follow-up. The majority of treated teeth were mandibular molars. The mean age of the patients was 50 years. The overall success rate (healed cases) was 83%.

While healing outcome was not significantly related to the level and height of the facial bone plate, a significant difference was found for the mean size of the bony crypt. Healed cases had smaller bony crypts compared with nonhealed cases. In addition, healed cases had a significantly shorter mean distance from the facial bone surface to the root canal compared with nonhealed cases.

Table 1. *Logistic regression for significance of measured parameters*

Parameter	Point estimate	95% Confidence interval limits Lower	Upper	*p* value
(A) marginal bone level	1.014	0.598	1.720	.96
(B) height of facial bone plate	0.918	0.692	1.218	.55
(C) height of access window to bony crypt	0.707	0.500	1.001	.05
(D) length of access window to bony crypt	0.746	0.573	0.970	.03
(E) depth of bony crypt	0.826	0.603	1.132	.23
(V) volume of bony crypt (C × D × E)	1.002	0.999	1.004	.15
(F) canal access distance	0.862	0.601	1.235	.42

Conclusion

The only parameter significantly related to healing outcome at 1-year postapicoectomy was the length of the access window of the bony crypt (Table 1).

von Arx T, Hänni S, Jensen SS. Correlation of bone defect dimensions with healing outcome one year after apical surgery. J Endod *2007;33:1044–1048.*

Biofilm Formation Of *E. faecalis*

Biofilms, sessile microbial communities composed of cells attached to a substratum and interface or to each other, form tower- or mushroom-shaped microcolonies with interspersed channels, through which fluids move by convection. The cells within biofilms produce extracellular polymeric substances. Cells located more deeply in the biofilm are exposed to environmental conditions different from those at the surface, including decreased oxygen tension, resulting in altered growth rates and gene transcription that might facilitate survival and virulence characteristics. The slow metabolic rate of microorganisms in biofilms and the extracellular matrix of the biofilm can impede the effectiveness of many antimicrobial agents, such as antibiotics and endodontic irrigants and medicaments.

Enterococcus faecalis, an opportunistic pathogen and one of the leading causes of nosocomial infections, is frequently isolated from failed root canals and the oral cavity. Clinical strains of *E. faecalis* from infective endocarditis patients have been associated with greater biofilm formation than nonendocarditis clinical isolates. This may be attributable partly to specific virulence traits, such as gelatinase production and presence of the adherence determinant *esp*, a combination associated with the formation of thicker biofilms.

Conditions under which biofilms might occur in infected root canals in vivo are not well understood. In vitro studies have focused on the efficacy of selected irrigants and medicaments to remove biofilms grown in wells, on membrane filters and on dentin samples by using several strains of selected species found in root-canal infections, including *E. faecalis*. However, little information has been found on the biofilm-forming capabilities and characteristics of clinical isolates of *E. faecalis* or on their capacity for biofilm formation compared with strains associated with other human infections.

Duggan and Sedgley from the University of Michigan evaluated quantitatively biofilm formation by *E. faecalis* isolates recovered from root canals ($n = 33$) and the oral cavity ($n = 21$) to determine whether *E. faecalis* strains from different sources vary in their ability to form biofilms. A group of nonoral, nonendodontic strains ($n = 16$) was included for comparison. For each strain, expected colony and cell morphology and Gram stain reaction were verified.

Optical density was measured using a microtiter plate reader. Mann-Whitney and Kruskall-Wallis tests compared median readings according to source (root canal, oral, nonroot canal/nonoral) and the presence of enterococcal virulence genes for aggregation substance (*asa*), surface adhesin (*esp*), cytolysin activator (*cylA*) and gelatinase (*gelE*).

No biofilms were detected in negative controls. There was no significant relationship between the ability of *E. faecalis* to form biofilms and the source of isolates ($p = .066$). Within the root canal and oral isolates, there were no significant associations between biofilm optical density readings and the presence of the virulence determinants *asa*, *esp*, *cylA* and *gelE* (all at $p > .05$).

Conclusion

Results indicate that, in contrast to strains from other clinical sources, particularly endocarditis strains, *E. faecalis* strains from oral and endodontic sources have a lower inherent capacity to form biofilms. This is of interest because prophylactic antibiotic coverage is provided for patients at risk although its value and efficacy is difficult to confirm.

Although more data are required on the biofilm-forming capabilities when grown on biological surfaces, including dentin and heart valves, the absence of these putative virulence characteristics further questions the significance of *E. faecalis* in endodontic infections.

Duggan JM, Sedgley CM. Biofilm formation of oral and endodontic Enterococcus faecalis. J Endod *2007;33:815–818.*

In the next issue:

- Cracked teeth and pulpitis: treatment and prognosis
- Bacterial DNA persist long after cell death
- Cone beam tomography to identify root-canal systems

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