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update on endodontics™

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Measuring Anterior Maxillary Teeth Roots

Although the relationship between the roots of posterior maxillary teeth and the maxillary sinus has been investigated in multiple studies, only 1 study, from 9 years ago has investigated the relationship between the roots of anterior maxillary teeth and the nasal floor using computed tomography. In the intervening years, the development of cone beam computed tomography (CBCT) has improved 3-dimensional imaging in dental medicine, resulting in better identification of endodontic pathologies and more clearly showing the relationship between pathological changes and important neighboring anatomical structures.

A new study by Ducommun et al from the University of Bern, Switzerland, focuses on the teeth in the anterior maxilla (canines, lateral incisors and central incisors). They retrospectively studied CBCT scans of patients referred for possible apical surgery taken over a 9-year period. A total of 93 teeth (39 central incisors, 35 lateral incisors and 19 canines) were analyzed. The researchers recorded a series of measurements:

- distance from the apex to the nasal floor measured in the sagittal plane
- distance from the periapical radiolucency to the nasal floor measured in the sagittal plane
- distance from the root to the labial and palatal bone plates measured in the sagittal plane
- distance from the root to the adjacent mesial and distal teeth measured in the coronal plane

The maxillary sinus rather than the nasal floor was used as the measurement landmark for teeth located closer to the maxillary sinus than to the nasal floor. Contralateral teeth were designated as the control group.

The shortest distance from the apex to the nasal floor was longer for central and lateral incisors than for canines, although no difference was found in the distance from the apex to the nasal floor in the extension of the longitudinal tooth axis. Similarly, the shortest distance from the periapical radiolucency to the nasal floor measured

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from the upper cortical border of the lesion was greater for incisors than for canines, but, again, no difference was found when measured from the upper cortical border of the lesion to the nasal floor.

Distances from the root to the labial bone plate were similar regardless of the tooth; however, the distances from the root to the palatal bone plates were greater for the canines than for the incisors. Lateral incisors were closer to mesial adjacent teeth than were the central incisors or canines; central incisors were closer to distal adjacent teeth. No significant differences were found between the test and control teeth except for a shorter distance between the root and the palatal bone plate in teeth with periapical lesions.

Conclusion

Understanding the findings of this study can help the practitioner avoid potential complications when performing endodontic surgery on anterior maxillary teeth. CBCT scans can be an effective adjunctive diagnostic tool prior to apical surgery in these cases.

Ducommun J, Bornstein MM, Wong MCM, von Arx T. Distances of root apices to adjacent anatomical structures in the anterior maxilla: an analysis using cone beam computed tomography. Clin Oral Investig *2019;23:2253-2263.*

Removing Biofilm From Isthmuses and Lateral Canals

Root canal irrigation is an important step in endodontic treatment. The primary aim of root canal irrigation is the removal of biofilms that form from microorganisms that adhere to the root canal wall. In particular, irrigation can penetrate isthmuses, fins, oval extensions and lateral canals that cannot be reached by instrumentation.

Irrigation with sodium hypochlorite (NaOCl)—the most widely used irrigant—removes biofilm in 2 ways:

- through a chemical reaction that interacts with bacteria
- through a mechanical effect effected by the wall shear stress exerted by the flowing irrigant

While the mechanical effect is strongly affected by the flow rate, very little information has been published about how the flow rate affects irrigant penetration in areas beyond the main root canal. Nor do studies exist on the chemical effect of NaOCl, a strong antimicrobial solution, on biofilm removal outside the main root canal.

Finding answers to these questions presents serious technical challenges—even when using an artificial root canal in an in vitro setting. To overcome these difficulties, Pereira et al from Universidade de São Paulo, Brazil, used a computational fluid dynamics (CFD) model to

- quantify biofilm removal from a simulated isthmus and lateral canal using syringe irrigation with NaOCl at different concentrations and flow rates
- determine whether a final high-flow-rate rinse with an inert irrigation improves biofilm removal

The researchers created 96 artificial root canals, 48 with a simulated isthmus and 48 with a simulated lateral canal. Biofilms created from *Streptococcus oralis* and *Actinomyces naeslundii* and human saliva were inserted into the artificial canals; approximately 60% of the isthmus was occupied by the biofilm, as was approximately 17% of the lateral canal.

The root canals were then divided into groups based on NaOCl solution concentrations (0%, 2%, 5%, 10%) and irrigant flow rate (0.166 mL/s, 0.083 mL/s, 0.033 mL/s, 0 mL/s). After a final 30-second rinse irrigation with an adhesion buffer, the biofilms in all root canals were scanned using optical coherence tomography (OCT).

The highest velocities for irrigation were achieved by placing the needle 3 mm from the apical endpoint of the root canal. In the teeth with a simulated isthmus, the irrigant flow rate had a significant impact on the percentage of remaining biofilm, with the highest flow rate producing the best results. The final adhesion buffer irrigation significantly reduced the percentage of biofilm, regardless of the original irrigant flow rate.

The 10% concentration of NaOCl achieved the best results, but this level of concentration did not show a significant difference. Little difference among the groups was found in biofilm removal from the lateral canal; the final adhesion buffer irrigation had a significant effect only after previous irrigation at the highest rates.

Conclusion

The results of this study suggested that high-flow-rate irrigation using NaOCl, regardless of the level of concentration, followed by high-flow-rate irrigation with an inert irrigant, simulated significantly improved biofilm removal in root-canal isthmuses and lateral canals.

Pereira TC, Boutsioukis C, Dijkstra RJB, et al. Biofilm removal from a simulated isthmus and lateral canal during syringe irrigation at various flow rates: a combined experimental and Computational Fluid Dynamics approach. Int Endod J *2021;54:427-438.*

Analysis of the Distolingual Root And Canal

Mandibular molars often present with complex root canal anatomies that require endodontic treatment. Knowledge of such complex root canal anatomy and an understanding of how best to manage these challenges clinically is crucial to ensure a successful outcome of endodontic treatment. One such challenging anatomical variation in mandibular first molars is the presence of a third root, the radix entomolaris (RE), also called a distolingual root, the prevalence which has been shown to vary between 3.7% and 45.6%, among different ethnic groups. This typically severely curved root has 1 canal with a small diameter.

It is often quite difficult to collect sufficient numbers of extracted teeth with such anatomical variations in a particular ethnic group for laboratory-based investigations. To propose a new classification of RE roots, Wu et al from Sichun University, China, conducted a comprehensive study by micro-computed tomographic (micro-CT) imaging of the anatomic features of distolingual roots and canals in mandibular first molars collected from one native Chinese population.

Extracted mandibular first molar teeth that had 3 roots were collected, cleaned and disinfected according to approved protocols. Teeth that had previous endodontic treatment, root fractures or external resorption defects were excluded, leaving 102 teeth for the study.

These teeth were scanned by a micro-CT scanner (mCT-50; Scanco Medical, Bassersdorf, Switzerland) with an isotropic resolution of 30 mm at 90 kV, 88 mA and 8 W. The images obtained were 3-dimensionally reconstructed and visualized using VGStudio MAX 2.0 software (Volume Graphics GmbH, Heidelberg, Germany), and CTAn v.1.18.8.0 (Bruker micro-CT, Kontich, Belgium) software was also used for further analysis and measurement. The distance of apical deviation and the angle of root curvature were defined and measured.

All RE roots had 1 canal only; 75% (77/102) had no accessory canals. The distance from the RE root canal orifice to the line connecting the mesiobuccal and mesiolingual canal orifices and its horizontal bisector was 3.66 ± 0.61 mm and 2.95 ± 0.70 mm, respectively. The average diameter of the root canal at 0.5 mm from the apical foramen was 0.21 ± 0.09 mm. The average root canal taper at 5 mm from the apical foramen was 0.04 ± 0.03. Almost three quarters of distolingual canals did not have an apical construction.

Conclusion

This comprehensive assessment of the distolingual root canal system, the anatomic features demonstrated that the average canal curvature of the distolingual roots was >25 degrees. Special care should be taken during clinical instrumentation and obturation because the canals often lack an apical constriction.

Wu W, Guo Q, Tan BK, et al. Geometric analysis of the distolingual root and canal in mandibular first molars: a micro–computed tomographic study. J Endod *2021;47:779-786.*

Malignant Nonendodontic Periapical Lesions

Because malignant nonendodontic periapical radiolucencies are rare, the lack of data can result in serious diagnostic errors. Most periapical radiolucencies in the jaw are

Table 1. ***Morphometric 2-dimensional data of the distolingual canal (mean ± standard deviation) in distolingual roots.***

	Cervical	Middle	Apical	Total
Cross-sectional canal area (mm^2)	0.17 ± 0.09	0.09 ± 0.07	0.04 ± 0.03	0.10 ± 0.06
Perimeter (mm)	1.52 ± 0.45	1.00 ± 0.41	0.66 ± 0.28	1.05 ± 0.35
Form factor	0.90 ± 0.06	0.97 ± 0.06	1.01 ± 0.08	0.95 ± 0.05
Roundness	0.77 ± 0.09	0.83 ± 0.06	0.79 ± 0.06	0.80 ± 0.05

the result of periapical lesions resulting from pulpal necrosis. A small percentage of clinically diagnosed periapical lesions arise from nonendodontic causes. Most of these cystic and tumorous lesions, often misdiagnosed as periapical disease, are benign; however, a very small number may be malignant.

Given the potential for diagnostic failure in such cases, Schuch et al from Universidade de Campinas, Brazil, conducted a systematic review in order to draw together currently available evidence about malignant nonendodontic periapical lesions and determine whether reported cases reveal any clues that could help improve endodontists' diagnostic accuracy.

The authors followed the standard guidelines for systematic reviews, searching 3 major databases for published studies reporting malignant lesions with a clinical diagnosis of periapicopathy. From 231 references, they reviewed 49 studies (including case series, case reports and cross-sectional studies) reporting 60 cases for inclusion in their qualitative synthesis.

The articles were evaluated according to the following criteria:

- patient demographics
- medical history
- current clinical condition
- clear description of preliminary treatment
- clear description of clinical condition posttreatment
- adverse reactions
- lessons provided by the case report

The amount and type of information provided in the studies varied; all of the studies provided histopathologic diagnoses.

Table 2. *Histopathologic diagnoses of malignant lesions mimicking endodontic pathoses.*

Diagnosis	*n*
Metastasis	16 (26.7%)
Salivary gland	15 (25.0%)
Sarcoma	12 (20.0%)
Lymphoma	11 (18.3%)
Carcinoma	6 (10.0%)

The sex of the patient was reported in 59 cases; 30 were women. Almost half of the malignant nonendodontic periapical lesions were found in patients between ages 40 and 59 years. More than half the lesions were located in the mandible, most commonly in the posterior mandible; maxillary lesions were more common in the anterior maxilla. Cases presented with a radiolucent image 90% of the time; 44 out of 45 cases reporting showed a unilocular image.

Histopathologic diagnoses by cellular origin fell into 5 different groups with none of the diagnoses predominating (Table 2); more than 90% of all patients reported some symptomatology.

- **Metastatic jaw lesions** frequently presented with a bony swelling with tenderness over the affected area, pain and paresthesia; most of these lesions were accompanied by bone mobility or bone resorption.
- **Sarcomas** were slightly more likely to occur in women 40 to 49 years of age, typically in the posterior mandible, and were often accompanied by bone resorption, tooth mobility and root resorption.
- **Malignant neoplasms of the salivary glands** presented both with or without pain; they often presented as a painless submucosal swelling.

Tooth mobility and root resorption were not typical with salivary gland lesions.

Conclusion

Information on these cases, limited to case reports, case series and retrospective studies, remains scattered, and reported data are inconsistent. Because misdiagnosis of malignant nonendodontic periapical lesions can have serious consequences if the malignancy is not identified at an early stage, practitioners need to be aware of those situations in which a nonendodontic malignancy may be present.

Schuch LF, Vieira CC, Vasconcelos ACU. Malignant lesions mimicking endodontic pathoses lesion: a systematic review. J Endod *2021;47:178-188.*

In the next issue:

- Vertical root fractures after apical surgery
- Apical periodontitis and type 2 diabetes mellitus
- Regenerative techniques on the outcome of endodontic surgery

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