CBCT aided detection of 7 root canals in a first maxillary molar

By Dr Antonio Chaniotis, Greece

Introduction
The root canal system of the human teeth consists of a complex anatomic and highly variant network of pulp spaces as seen in micro-ct studies of root canal anatomy (http://rootcanalanatomy.blogspot.com/) (Fig. 1). The thorough cleaning and shaping of this complicated system is considered mandatory for the successful endodontic treatment. The subsequent complete obturation of the cleaned and shaped root canal system with an inert material followed by the appropriate coronal restoration are two important parameters for the longevity of the endodontically treated tooth. Failure to adequately clean, shape and fill this anatomic system all to its dimensions is a major cause of post-treatment disease.

Walton & Vertucci, introducing concepts of internal pulpal anatomy, stated that lack of thorough knowledge of root canal morphology ranks second as a cause of treatment failure, only to errors in diagnosis and treatment planning. This means that having a working knowledge of the number of roots, number of canals per root and their location, longitudinal and cross-sectional shapes, most frequent curvatures and root outliners in all dimensions is essential in order to provide high standard endodontic treatment.

Historically, the evaluation and diagnosis of the anatomy of the root canal system in a clinical set up was achieved mostly with conventional intraoral periapical radiographs. Nevertheless, they weren’t completely reliable because of their inherent limitations associated with the two-dimensional imaging. Currently, the application of further analytic diagnostic tools such as CBCT scanning for the assessment of unusual root canal morphology has provided three-dimensional imaging, aiding the correct endodontic management of the patients with challenging cases. The CBCT data has become a particularly useful tool in assessing the root and canal morphology of complicated cases. In the present paper, the endodontic treatment of a first maxillary molar with complicated root canal anatomy is reported. The pre-surgical use of CBCT imaging in combination with the surgical operating microscope led to the detection and negotiation of 7 root canal systems in a single tooth. The aim of the present case report is to highlight the importance of cbct imaging in assessing the root canal morphology of complicated cases. The use of the surgical operating microscope is also discussed.

Case report
A 4-year old caucasian male was referred to our Endodontic Private Practice Clinic for the endodontic treatment of his right maxillary first molar. At the time of the appointment, clinical examination revealed an intraoral swelling on his right maxillary quadrant. The patient was under amoxicillin regimen (3g every 8 hours) for one month due to his medical history was noncontributory. Further clinical examination revealed a heavily restored permanent first maxillary molar. Thermal and electrical vitality tests were negative, indicating a periapical diagnosis of pulp necrosis. Periodontal probing was within normal limits all around the tooth, except from the buccal furcation area. An endodontic approach was continued and had been established and purulent drainage was evident through the buccal perforation. A periapical radiograph (Fig. 2a) revealed a large periapical lesion associated with the maxillary first molar. The outline of the periradicular lesion couldn’t be identified from the periradicular radiograph. A peritapical diagnosis of acute apical abcess was made.

At the present visit, the patient was referred for endodontic therapy and a rubber dam was placed. Access to the pulp cavity was performed using Endo Access and Endo Z burs (Dentsply Maillefer). Once the pulp cavity has been reached, purulent drainage was observed. After ten minutes, the purulent drainage turned to hemorrhagic, then to a clearer exudate and finally ceased. Initial access preparation revealed 4 orifices under microscopic visualization (Global G6, Global Surgical Co., USA). Two separate orifices were located in the mesiobuccal root, one orifice in the distobuccal root and one orifice in the palatal root. The root canal system of the maxillary molar was irrigated by using 6% NaOCl solution with surface modifiers (Canal Pro Extra, Coltene Whaledent). Initial enlargement of the root canal system of the maxillary molar was achieved by using the Hyflex Controlled memory rotary instrumentation (Coltene/Whaledent). The MB1, MB2 and DB canals were enlarged until a 30/04 was reached to working length, while the palatal canal until an 40/04. The canals were dried and calcium hydroxide (Ultragard, Ultradent) was used as an introradicular dressing. Thermoplastication was achieved by using IRM cement (Dentsply). In order to evaluate the situation a decision was made to perform a CBCT imaging of the tooth and the associating periradicular lesion. The treatment of large periapical lesions is very likely to demand a combination of conventional and surgical techniques. The CBCT three-dimensional imaging of a large periapical lesion is mandatory for the proper pre-surgical evaluation and planning, especially when the outline of the periradicular lesion exceeds the limits of the periradicular radiograph. An informed consent was obtained and the patient was referred for a CBCT evaluation and rescheduled.

The multi slice CBCT evaluation of the maxilla (NewTom, VG, 3D, high resolution, slices every 1mm, voxel size 0.13mm) revealed the extent of the periradicular lesion (Fig. 3a-d). Interestingly, when the involved tooth was focused and the morphology was obtained in transverse axial and sagittal sections, it can be seen six canals (three mesiobuccal, two palatal and two distobuccal) (Fig. 3a-d). In the transverse axial and sagittal slices, the remnants of the calcium hydroxide dressing were evident. In the axial slices (Fig. 3a-d), the calcium hydroxide dressing was evident inside the palatal canal. CBCT images allowed the missed MB3 canal to be identified, devoid of calcium hydroxide. This finding was consistent with the missed distobuccal canal. Moreover, a second distobuccal canal without calcium hydroxide dressing was evident (Fig. 2c, d). The second distobuccal canal was not seen in the sagittal slices as well (Fig. 2e). The two distobuccal root can be seen only in merged axial and not in the sagittal ones (Fig. 2f, g). CBCT images provided valuable information in terms of number and configuration. This information revealed three additional canals missing from the initial negotiation. At the second appointment, the patient was asymptomatic and the intraoral swelling had resolved. The tooth was re-accessed under rubber dam isolation, the MB3 canal was inspected under the microscope (Global G6, Global Surgical Co.). The inspection under the surgical microscope combined with the microscope for the detection of the additional root canals was achieved by using MC files with extra long handle (VDW, Endodontic Surgery). The MB1, MB1 and MB2 canals were enlarged until a 35/04 rotary Hyflex CM (Coltene) file (VDW, Germany) was reached and 25/04 DB canals was achieved by using MC Files with extra long handle (VIT, Endodontic Surgery). The MB1, MB1 and DB canals were enlarged until a 35/04 rotary Hyflex CM (Coltene) rotary file reached the working length. The MB1 canal merged with the MB2 canal and was enlarged until a 25/04 Hyflex CM file reached the merging point. The missed DB3 canal was enlarged until a 30/04 hyflex cm rotary file reached the working length. During the instrumentation of the MB1 canal, the MB1 canal was identified and confirmed by using a miniature endodontic file in a ribbon shaped configuration. The working length was determined by using an electronic apex locator (Root ZX, Morita). Apical gauging was achieved by using hand files. Irrigation was achieved by using syringe irrigation of 6% NaOCl solution with surface modifiers (CanalProExtra,Coltene/Whaledent). The cleaning efficacy of the irrigant was enhanced by using passive ultrasonic irrigation (Fig. 3b). Ultrasonic activation of the irrigant in the MB1 canal created streaming of the irrigant solely in the MB1 canal configuration. The visualization of the missed MB3 canal is highly demanding because of the periapical lesion that is seen in figure 3f. The patient was referred back to his general dentist for appropriate...
restoration and monitoring. Surgical excision of the periapical lesion is planned only if no signs of healing appear during the monitoring phase.

**Discussion**

The variability of the root canal system of maxillary molars poses a constant challenge for the dentist who wishes to provide successful endodontic treatment. The number, form and configuration of root canals present in maxillary first molars have been thoroughly investigated in the literature for almost a century. They are the largest teeth in volume and of the most complex in root and canal anatomy. The three individual roots of the maxillary first molar form a tripod. The palatal root generally is the longest, has the larger diameter and offers the easiest access. It often curves buccally at the apical one third and can contain one, two or three root canals in various percentages according to studies of apical canal configurations and case reports. The distrubucral canal is conical and may have one or two canals. The mesiobuccal root may contain one, two or three root canals and is the most studied root in the mouth. A number of factors contribute to the variation found in maxillary molar anatomy studies. Variations may result because of ethnic background, age, gender or the population studied.

Of the various comprehensive maxillary first molar ex vivo studies in the dental literature, Baratto Filho et al reported a maxillary first molar with three roots and seven root canals. Recently, Kotoor et al reported a CBCT guided endodontic management of a maxillary first molar with seven root canals. Moreover, in another recent case report, Kotoor et al reported the endodontic management of a maxillary molar with eight root canals by using cone beam computed tomography scanning. CBCT scanning is a relatively new diagnostic imaging modality that has been used in endodontics for the effective evaluation of the root canal morphology. Additionally, CBCT imaging is used in the diagnosis of endodontic pathosis, assessing root and alveolar fractures, analysis of resorptive lesions, identification of pathosis of nonendodontic origin, and presurgical assessment before root canal and surgery. CBCT images are reconstructed using significantly lower radiation doses compared with alternative conventional computed tomography scanning. This is because with CBCT imaging the raw data are acquired in the course of a single sweep of a cone-shaped x-ray source and reciprocal detector around the patient’s head. The efficient use of the radiation beam and the elimination of the need for a conventional image intensification system used in conventional computed tomography scanners resulted in a huge reduction in radiation exposure. The clinical use more consistent with the ALARA concept. Matherne et al investigated the use of CBCT scanning in identifying root canal systems and compared it with images obtained by using digital radiography. They concluded that CBCT images always resulted in the identification of greater number of root canal systems than digital images. Baratto Filho et al. evaluated the internal morphology of maxillary first molars by ex vivo and clinical assessments using operating microscope and CBCT scanning. They concluded that an operating microscope and CBCT scanning were important for locating and identifying root canals, and CBCT scanning can be used as a good method for evaluation of maxillary first molar internal morphology. In the present case, CBCT scanning was used for the pre-surgical evaluation of a large periapical lesion. Through evaluation of the CBCT imaging resulted in the additional detection of the complex root canal anatomy. CBCT axial images revealed the presence of three roots and seven root canals, namely mesiobuccal (MB1), mesiobuccal (MB2), mesiobuccal (MB3), distobuccal (DB1), distobuccal (DB2), mesiopapalatral (MP) and disto-palatal (DP). The negotiation and management of all the canals was accomplished with the indispensable aid of the dental operating microscope.

The role of microscopic magnification is well documented in the endodontic literature. Buhrley et al. had performed an in vivo study to determine the practitioner’s ability to locate the MB2 canal in maxillary molars using the DOM and/or dental loupes. They concluded that when the maxillary first molars were considered separately, the frequency of MB2 canal detection for the microscope, dental loupes, and no magnification groups were 71.1%, 62.5%, and 17.2%, respectively. In the present case, successful negotiation of all canals was largely dependent on the use of pre-surgical CBCT mapping and microscopic magnification, which allowed for the identification of the seven distinct root canals. Hence, clinicians should familiarize themselves with dental microscopy and new imaging technology, such as CBCT scanning, to get additional anatomical information in endodontic practice.

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A graduate of the University of Athens Dental School, Greece. In 2003 he completed the three-year postgraduate program in Endodontology at the Athens Dental School. Since 2003, he owns a limited to microscopically Endodontic private practice in Athens, Greece. For the last ten years, he served as a clinical instructor affiliated with the undergraduate and postgraduate programs at the University of Athens, Athens Dental School, Endodontics department, Greece. In 2012 he was awarded the title of Clinical Fellow teacher at the University of Warwick, Warwick dentistry UK. He lectures extensively nationally and internationally and he has published articles in local and international journals. He currently serves as an active member of the Hellenic Society of Endodontology (ESE full member society), a board member of the Academy of Microscope Enhanced Dentistry (AMED), and a certified member of the European Society of Endodontology (ESE).