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

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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 to all 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 failures, 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 outlines 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.

centrally, 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 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 45-years-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 (1g every 8 hours for 7 days) due to an upper respiratory medical history was noncontributory. Further clinical examination revealed a heavily restored permanent right maxillary first molar. Thermal and electrical vitality tests were negative. A periapical radiograph disclosed a diagnosis of pulp necrosis. Periodontal probing was within normal limits all around the tooth, except from the buccal furcation area. An endo-dontic treatment was planned in order to establish and isolated dam isolation and inspected under the microscope (Global G6, Global Surgical Co). The inspection under the microscope 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 and a decision was made to perform a CBCT imaging of the maxillary molar.

The root canal system of the human maxilla is irrigated by using 6% NaOCl solution with surface modifiers (CanalPro 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 and MB2 canals were enlarged until a 25/04 Hyflex CM (Coltene/Whaledent) rotary file was advanced. The missed DB2 canal was enlarged until a 25/04 Hyflex CM file was reached under the working length. At the second appointment, the patient was asymptomatic and the intraoral swelling had resolved. At the second appointment, the patient was referred for a CBCT evaluation and rescheduled.

The multi slice CBCT evaluation of the maxilla (NewTom, VGi, 3d, high resolution, slices every millm, voxel 0.3x0.3x0.3mm) revealed the extent of the periapical lesion (Fig. 2d). Interestingly, when the involved tooth was focused and the morphology was obtained in transverse axial and sagittal sections, it was achieved. The transverse slices revealed seven canals (three mesiobuccal, two palatal and two distobuccal) (Fig. 2a,b,e). The patient was referred back to his general dentist for appropriate...
restoration and monitoring. Surgical extraction of the periapical lesion is considered if too much of healing appears 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 largest 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 distobuccal root 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, Kottor et al reported a CBCT guided endodontic management of a maxillary first molar with seven root canals. Moreover, in another more recent case report, Kottor 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 and CBCT scanning are used in the diagnosis of endodontic pathosis, assessing root and alveolar fractures, analysis of reparative lesions, identification of pathosis of nonendodontic origin, and presurgical assessment before root canal surgery. CBCT images are reconstructed using significantly lower radiation doses compared with alternative conventional computed tomography scanning. This is because with CBCT scanning, 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 making the clinical use more consistent with the ALARA concept. Mathieu 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. He 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. Thorough 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 (MB), mesiobuccal 2 (MB2), mesiobuccal 3 (MB3), distobuccal (DB), distobuccal 2 (DB2), distobuccal 3 (DB3), mesiolateral (MF) and disto-palatal (DP).

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 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 canal orifices with ease. Hence, clinicians should familiarize themselves with dental microscopy and new imaging technology, such as CBCT scanning, to get additional anatomic information in endodontic practice.

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