Case Report

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FOUR ROOTED MAXILLARY FIRST MOLAR WITH FIVE ROOT CANALS AND TWO ENAMEL PEARLS

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ABSTRACT:

A rising number of case reports regarding supernumerary roots in permanent teeth reflect the growing interest for dental and especially endodontic topics. Generally, maxillary first molars exhibit a mesiobuccal, distobuccal and palatal root and a very rare anomaly is a second palatal root. Due to periodontal destruction we extracted a tooth with this morphological aberration and 3D-visualized the external and internal anatomy by micro-CT. All essential parameters for the description of four rooted maxillary molars were measured and calculated based on the derived 3D-model. In addition, the tooth presented in this communication has five root canals (mesiobuccal root Vertucci class II) and was categorized as Type I according to Christie's radicular classification as well as Type B in Versiani's pulpal floor type. Furthermore, the investigated tooth exhibits another seldom anatomical alteration by presenting two distinct enamel pearls.

Keywords: enamel pearl; five canals; four-rooted maxillary first molar; micro computed tomography (µ-CT)

INTRODUCTION:

Clear understanding of dental anatomy including root number and canal morphology is an essential prerequisite for surgical and endodontic therapies. Maxillary first molars are generally described as three rooted, namely: the mesiobuccal, distobuccal and palatal root.[1] According to meta-analytical data the majority of mesiobuccal roots exhibits a second canal, whereas the other roots commonly contain only one canal.[1] Moreover, maxillary first molars demonstrated multiple anatomical variations resulting in a huge diversity in the amount of roots and canals illustrated by numerous studies and case reports.[1] However, the first four rooted maxillary first molar was found during an endodontic treatment in 1979.[2] In the following years several cases around the world were published concerning this anatomical aberration.[3-5] Maxillary molars with four roots (commonly two buccal and palatal) were classified according to their shape and degree of separation of the palatal roots in three types.[3] Interestingly, another classification defined the additional palatal root as *Radix mesio-* or *distolingualis* based on its direct affinity to the pronounced part of the crown.[4] Due to the rarity of four rooted maxillary molars (prevalence of 0.31 %) these classifications depended mainly on investigations of second and third molars.[1,3-5] However, this communication presents the first micro-CT analysis of an extracted four-rooted maxillary first molar.

CASE DETAIL:

A 51-year-old male patient from southern Italy reported to our Department in Bassum, Lower Saxony, Germany presenting a swelling of the left maxillary molar region. The patient's

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medical history was noncontributory. He complained of pain on the left side of the face starting three days prior to the appointment. The maxillary first molar was tender to horizontal and vertical percussion and caused a submucosal abscess. Further examination revealed tooth mobility grade II (Grace & Smales Mobility Index) and pocket depth of 8 mm mesial and 10 mm distal with furcation involvement. Upon periodontal probing pus leaked massively. All medical findings resulted in the diagnosis of a periodontal destruction. After obtaining a preoperative radiograph (Figure 1) the patient received 1 ml local anesthesia containing 40 mg articaine hydrochloride and 0.005 mg epinephrine (Septanest, Septodont, Saint-Maur-des-Fossés, France). Then the tooth was surgically extracted without complications with dental forceps (devemed GmbH, Neuhausen ob Eck/Tuttlingen, Germany). Gauze swabs (M+W Dental, Bundingen, Germany) were applied and after the formation of a blood clot the patient was discharged. The aftercare schedule was not respected by the patient.

Figure 1: A) Preoperative panoramic radiograph showing the periodontal destruction of the left maxillary fist molar. B) The magnification demonstrates the difficult radiographic interpretation due to the overlapping buccal and palatal roots.

Afterwards, the extracted tooth was X-ray micro-CT scanned using the CT-ALPHA system (ProCon, Germany) of the Petrology of the Ocean Crust research group, Department of Geosciences, University of Bremen, Germany. The extracted tooth was scanned with a beam energy of 80 kV, an energy flux of 350 µA, and using a thin copper filter in a 360° scan rotation with a step size of 0.3° at a detector resolution of 8.81 µm per pixel. After an acquisition time of 3 h, an image volume of 2304 × 2304 × 2138 voxels was available. Correction of ring artefacts and reconstruction of the spatial information on the linear attenuation coefficient in the samples was done with the Fraunhofer software VOLEX, using a GPU-hosted modified Feldkamp algorithm based on filtered backprojection.[6] Subsequent filtering (2-D non-local means) of the raw data, volume reconstruction, segmentation, rendering, and landmark-based distance measurements were done using Avizo 9.5.0 (Thermo Fisher Scientific). The 3D-model of the investigated maxillary first molar unveiled, besides the four roots (Figure 2 A), five canals (Figure 2 B). The two mesiobuccal canals confluence and represent Vertucci class II (Figure 2 C1). The local thickness of the root canal system was determined using the module Thickness-Map in Avizo. The local thickness at a given point in a structure is defined as the diameter of the largest sphere (sphere fitting)[7], which includes the point and which can be fitted completely inside the structure (i.e. it would address the thickness of a pencil regardless of its length). The result of this method is a colour-coded representation of the structural thickness (Figure 2 C). Subsequently, all defined dental lengths, distances and diameters were measured and calculated like previously described for four-rooted second molars [8] (Figure 3 A1-C2) (Table 1). Furthermore, the initial

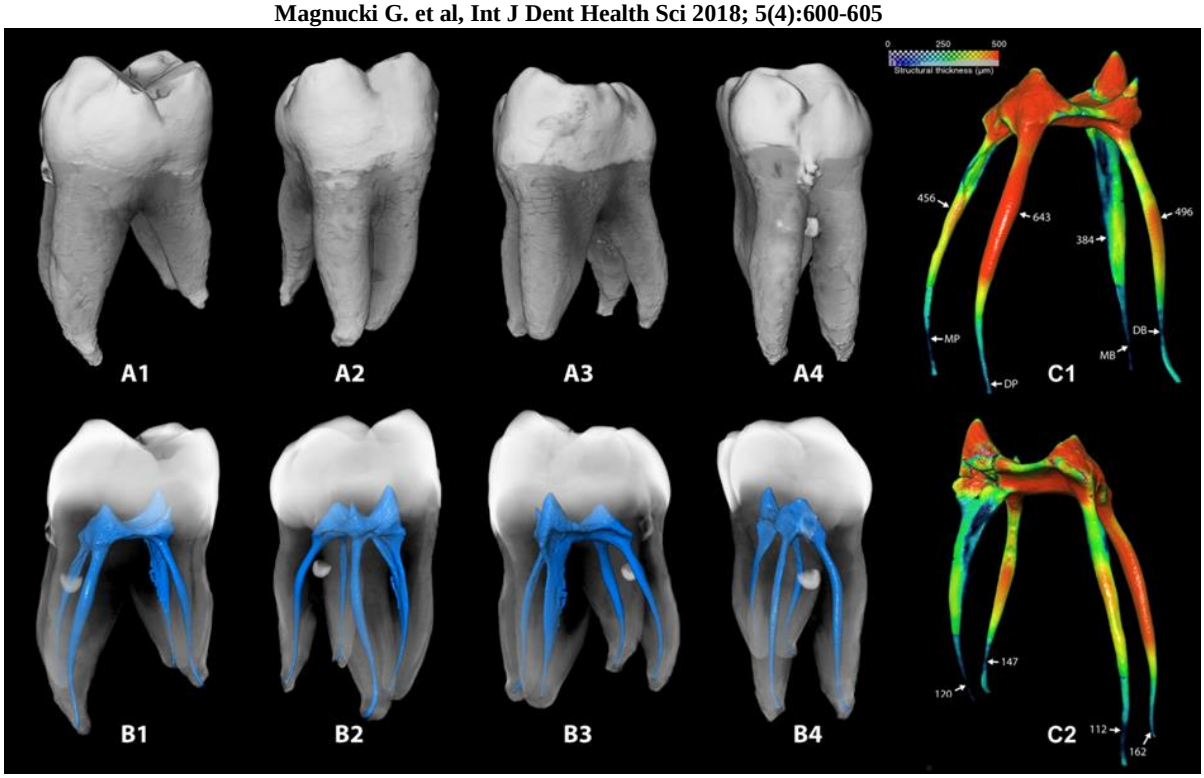

Figure 2: A) Micro-CT Volume reconstruction of the four-rooted maxillary first molar viewed from different angles - 1:distal, 2:buccal, 3: mesial, 4 palatal. B) Semitransparent visualization of enamel and dentin combined with the 3-D model of the root canal system in comparable angles. To enhance visibility of the two enamel pearls, angles of B) might slightly differ from A). C) Micro-CT volume rendering of the root canal system of the four-rooted maxillary first molar. Note that the surface of the 3-D model is overlain by the colour-coded representation of the canal thickness (for details of the local thickness method see text). The minor and major diameter of the root canal are marked. C1) View from distal. C2) View from mesial. Units are in micron. MB - mesiobuccal, DB - distobuccal, MP - mesiopalatal, DP - distopalatal.

apical file was simulated to derive the working length calculating the distance between the apical constriction and the corresponding cusp tip. The measured distance was strictly within the center of the root canal and was finally extended to the tooth cusp tip (Table 1). The palatal surface of the investigated tooth exhibited a enamel pearl with a diameter of 730 µm (Figure 3 D1-2) and a second enamel pearl was found interradicular with a diameter of 1400 µm (Figure 3 D3).

DISCUSSION:

For the characterization of four rooted maxillary first molars the criteria of four rooted maxillary second molars were commonly used.[3, 8] According to these

Table 1:
All measured para-meters of the investigated tooth. Units are in micron.
MB - mesiobuccal, DB - distobuccal, MP - mesiopalatal, DP - distopalatal.

Measured dental parameter	Root or corresponding root canal			
	MB	DB	MP	DP
Anatomical root length (apex to cusp tip)	17010	16714.5	17059.9	18386.3
Root length (apex to enamel-dentin-junction)	11696.1	10664.8	12801.8	12750.9
Working length (apical constriction to cusp tip)	15671	15013	15525	15165
Minor diameter of the root canal	120	147	162	112
Major diameter of the root canal	384	496	456	643
	MB to DB	DB to DP	DP to MP	MP to MB
Distance between the apices	2119.5	8558.5	5168.3	8259
Distance between the orifices	2489.05	4315.03	2617.41	5155.53

indices the tooth presented in this communication was classified as radicular Type I (Figure 2) and pulpal chamber floor Type B (Figure 3 A1).[3,8] Based on Carlsen and Alexandersen the investigated tooth was categorized as *Radix distolingualis* (of the separated type) due to the direct affinity of the root to the pronounced distal part of the crown (Figure 3 B2 & C1).[4] Interestingly, this is the first description of a maxillary first molar with such a configuration, since Carlsen and Alexandersen identified only first molars classified as *Radix mesiolingualis* or *Radix mesiolingualis/distolingualis*.[4] All mentioned classifications and defined parameters are of great anatomical worth, but, under clinical, especially endodontic conditions only a few (e.g. pulpal chamber floor configuration, the major and minor canal perimeter) seem to be suitable. Hence, we calculated the working length from the apical constriction, trending central in the root canal and ending at the corresponding cusp tip. We simulated the initial apical file that reached from the apical constriction to the cusp tip prior the radiographic working length measurement (Table 1). However, the indicated dental lengths, distances and diameters were measured (Table 1) and almost all were within the average values defined for four rooted maxillary second molars (Figure 3 A1-C2).[8] The length of the distobuccal root was shorter than previously described due to difficulties in the definition of the gyrose enamel-dentine-junction. Moreover, a

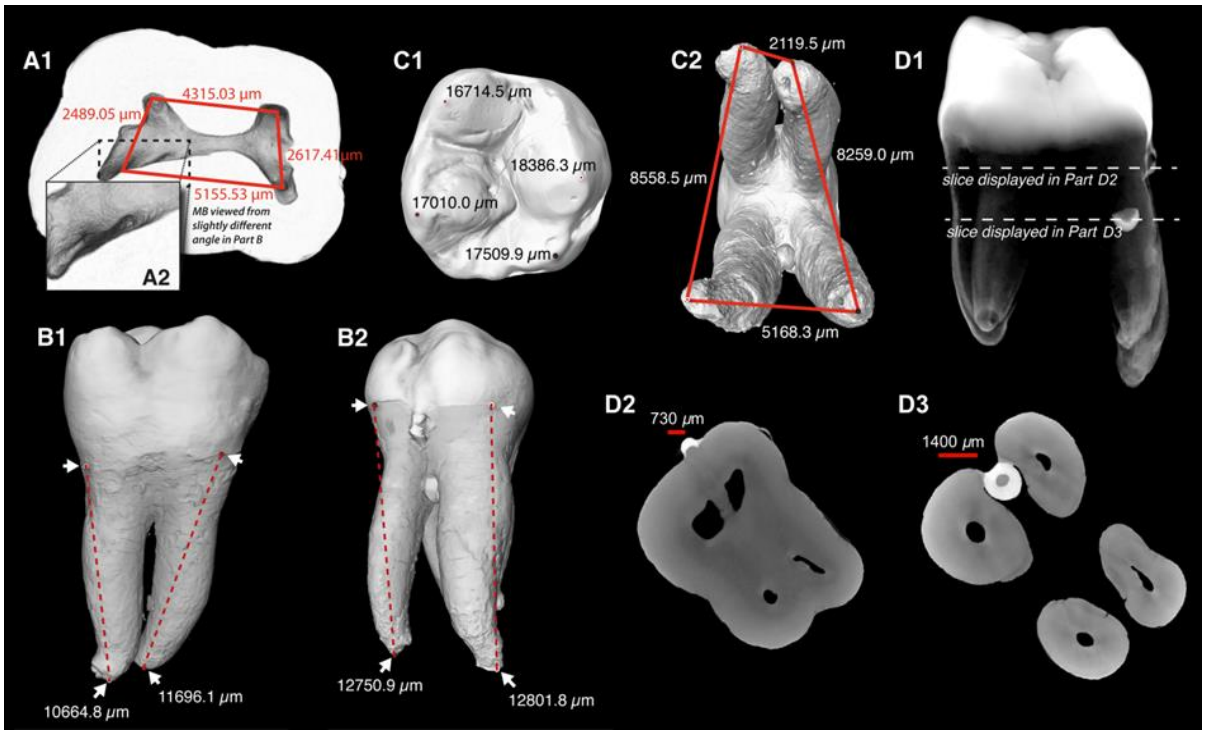

Figure 3: A1) Micro-CT volume reconstruction of the coronal view on the pulpal chamber floor. Localization of the landmarks for distance measurements between the canal orifices. A2) Two MB canal orifices viewed from a slightly different angle. B1) Buccal view on the landmarks for the distance measurements from cemento-enamel-junction to apex. B2) Corresponding palatal view. Note the two Carabelli's tubercles on palatal surface of the crown. C1) Coronal view on landmarks for the distance measurements coronal to apex. Note the pronounced distopalatal cusp. C2) Corresponding apical view on the landmarks. D1) Semitransparent visualization of enamel and dentin to localize the two enamel pearls. D2) and D3) are reconstructed slice depicting either pearl.

reduced distance between mesio- and distopalatal canal orifices on the pulpal chamber floor was detected in comparison to maxillary second molars with four roots.[8]

Furthermore, our investigated tooth demonstrated a second anatomical aberration by presenting two distinct enamel pearls (Figure 3 D1-3). According to Chrcanovic *et al.* the prevalence of one enamel pearl in molars was described as 1.71 %, whereas two were found in 0.28 %.[9] Remarkably, enamel pearls are associated with periodontal destruction,[10] what led also to the extraction in the presented case. In Conclusion, the described rare occurrence of two enamel pearls in combination with the general prevalence of 0.31 % for four rooted maxillary first molars shows the uniqueness of the presented case.[5,9] However, due to the difficult radiographic diagnosis of four rooted maxillary molars (Figure 1) the presence of enamel pearls (Figure 3 D) as well as coronal abnormalities (Figure 3 B2 & C1) can facilitate the identification.[3,4,8]

Hence, all roots exhibited one root canal (Vertucci class I) except the mesiobuccal root showing two canals which confluence in the upper third of the root canal (Figure 2 C1). Therefore, this root was classified as Vertucci class II. Like previously mentioned this root possessed in regular-shaped maxillary first molars generally two canals, but the root canal configuration in four rooted maxillary first molars is largely unknown. That is caused by a complete absence of studies focusing this seldom morphological aberration.[1] Therefore, the collection of case reports, especially anatomical micro-CT presentations, could enhance the endodontic knowledge concerning the amount and configuration of the root canals of four rooted maxillary first molars.

CONCLUSION:

Our case report presents the first micro-CT of a rare four-rooted maxillary first molar. It demonstrates the internal and external anatomy via 3D-model, what was the basis for the calculation of all anatomical parameters. Especially, the calculated working length, the picture of the canal orifices on the pulpal chamber floor and the reconstructed local thickness of the root canal system could be of clinical worth for the dental professional during endodontic treatments of teeth with likewise morphological aberrations. Finally, this case report supports the dental awareness of the described anatomical variant and the avoidance of treatment errors.

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