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Root and canal morphology of mandibular first premolars with radicular grooves

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ABSTRACT

Objective: To investigate the relation between the radicular groove (RG) and the internal root canal morphology in mandibular first premolars by using micro-computed tomography.
Methods: A total of 249 extracted mandibular first premolars were collected from a native Chinese population. After scoring the RGs according to the Arizona State University dental anthropology scoring system (ASUDAS), 148 teeth were selected and scanned by using micro-computed tomography. The root canal systems were examined two- and three-dimensionally under the software Mimics 10.01. The depth and angle of the RGs at different levels were measured.
Results: The presence of Tomes' root trait (ASU = 3–5) was identified in 47/249 of the sample teeth (18.9%). The mean depths of the shallow (ASU = 1), moderately deep (ASU = 2) and deep grooves (ASU = 3) were 0.18, 0.36 and 1.24 mm, and the mean angles were 28.8°, 47.5° and 101.7°, respectively. The incidences of complicated root canal systems were 15.5% (ASU = 0), 18.7% (ASU = 1), 37.0% (ASU = 2) and 90.0% (ASU = 3). In nine scanned specimens, accessory canals were found communicating between the main canal and the RG. Invagination canals were observed in four specimens, and C-shaped canals were found in 29 specimens (19.6%).
Conclusions: The complexity of root canal systems in mandibular first premolars is determined by the severity of RGs, which can be scored by the ASUDAS. Detecting the incidence of various root canal forms corresponding to each ASUDAS score is useful for calculating the standardized rates from published data of dental anthropology. Understanding the anatomic features of the RG and the internal root canal system is essential for successful dental treatment.

1. Introduction

The mandibular first premolar is typically single-rooted. However, reports of multi-rooted variations were not uncommon in the literature.[1,2] In a number of individuals a radicular groove (RG) occurs on the mesial aspect of the tooth, forming a "C" configuration in the cross-sections of the root.[3] It was suggested that the unilateral induction of one interradicular process during tooth development resulted in this root deformation.[1]

In anthropology, partially and completely divided roots of mandibular first premolar is named Tomes' root to credit anatomist Tomes CS, who was the first to define this phenomena as a root trait in 1923.[4,5] From 1970, Turner et al.,[6] began to develop ranked scales for a variety of dental

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morphological traits, and in 1991 published rules for use of the Arizona State University dental anthropology scoring system (ASUDAS). This standardized observation method divides Tomes' root trait into six grades on the basis of the severity of the RG. As an important racial trait, Tomes' root is widely used for population comparison. It is rare in West Eurasia with incidence lower than 10%, less common in North and East Asians (10–15%) than in Sunda-Pacific groups (15–25%), whereas highest in Sub-Saharan Africans (>25%).[6]

In dentistry, mandibular premolars with RGs have great clinical significance. The developmental groove is relevant to the onset of localized periodontitis. The depth of the groove may act as a haven for bacteria and cause a persistent pathosis. For a considerable number of clinical cases, the prognosis is unfavourable.[7,8] In addition, the RG in mandibular first premolars is suggested to be associated with occurrence of the C-shaped canal or multiple canals, which may present endodontic challenges.[9–11] Amos[12] studied full-mouth series of radiographies from 1000 patients and reported a higher incidence of canal bifurcation in mandibular first premolars of African American patients (21.6%) compared to Caucasian patients (16%). Lu et al.,[3] studied 82 mandibular first premolars in a Taiwanese population by using a cross-sectioning method, and found 22% contained two canals and 18% had C-shaped canals. By using nondestructive micro-computed tomography (micro-CT), Fan et al.,[9] examined 140 mandibular first premolars (86 teeth had the RGs) in a Chinese population. They found C-shaped canals could vary considerably at different root levels and the incidence of two canals at the middle and apical levels was 21% and 81%, respectively. However, to date, few scholars have quantitatively measured the RG on mandibular first premolars, and its relationship to root canal variation has not yet been fully elucidated.

The purpose of this study was to investigate the relation between the radicular groove and the internal root canal morphology in mandibular first premolars by using micro-CT. The standardized ASUDAS was introduced to evaluate the severity of RGs.

2. Materials and methods

2.1. Sample

A total of 249 extracted mandibular first premolars were collected in the Dental Department of the First People's Hospital of Wujiang District during 2006–2011. All subjects were native Chinese. The teeth were extracted because of non-restorable caries, trauma, periodontal disease, and orthodontic reasons. Teeth with hypercementosis were not observed. Before investigation, the specimens were cleaned of calculus and remaining external tissue and stored in 10% formalin solution. Information of patients including age, sex and reasons of extraction were accurately recorded (Table 1).

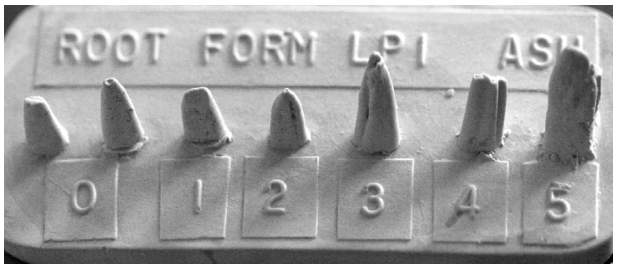

Fig. 1 – ASUDAS reference plaque of the Tomes' root trait.

2.2. Scoring roots according to the ASUDAS

Each specimen was scored by the first author according to the ASUDAS, and a standardized reference plaque was used during scoring[6] (Figs. 1 and 2):

Grade 0 (recorded as ASU = 0): developmental grooving is absent, or if present, shallow with rounded rather than V-shaped indentation. Grade 1 (ASU = 1): developmental groove is present and has a shallow V-shaped cross-section. Grade 2 (ASU = 2): developmental groove is present and has a moderately deep V-shaped cross-section. Grade 3 (ASU = 3): developmental groove is present, V-shaped, and deep. Groove extends at least 1/3 of total root length. Grade 4 (ASU = 4): developmental grooving is deeply invaginated on both the mesial and distal root surfaces. Grade 5 (ASU = 5): two free roots are present. Their length is at least 1/4 to 1/3 of the total root length. Grades 0–2 are taken as absence of the root trait (non-Tomes' root group), and grades 3–5 as presence of the trait (Tomes' root group).

The number and location of the developing grooves on the root surface were examined. They were divided into two types: RG and concavity. A RG has a V-shaped cross-section, and is mostly located on the mesiolingual or distobuccal side. A concavity is a shallow and rounded indentation; it extends longitudinally on the proximal surface.

2.3. Micro-CT analysis

Excluding teeth with caries, restorations or other major defects, 148 mandibular first premolars were selected for

Table 1 – Information of the patients.

Sample teeth	N	Sex (n)		Side (n)		Reasons for extraction (n)				Age (years)
		Males	Females	Left	Right	Periodontitis	Orthodontic reason	Caries and RCT failure	Other reasons	Mean ± SD
Total premolars	249	119	130	123	126	58	86	98	7	44.2 ± 22.0
Scanned premolars	148	71	77	78	70	58	86	0	4	38.2 ± 22.2

RCR, root canal treatment; SD, standard deviation.