Incidence of three-rooted mandibular first molars among contemporary Japanese individuals determined using multidetector computed tomography

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ABSTRACT

Purpose: The purpose of this study was to determine the incidence of three-rooted mandibular first molars in a contemporary Japanese population using multidetector computed tomography (MDCT) and examine whether this characteristic root form may be useful for identification purposes.
Methods: Prior to their forensic autopsies, we obtained MDCT scans of 365 cadavers (255 males, 110 females) with mandibular first molars on both sides. Altogether, 730 mandibular first molars were examined morphologically on reconstructed CT images, and the incidence of three-rooted molars was recorded. The results were analyzed statistically to determine sex and left–right differences using the chi-square test.
Results: In all, 189 (25.9%) of the 730 mandibular first molars had three roots: 79 (31.0%) in the 255 males and 35 (31.8%) in the 110 females. No statistically significant difference was found between the sexes. In the 39 individuals who had unilateral three-rooted mandibular first molars, 7 (17.9%) were on the left side and 32 (82.1%) were on the right side, indicating a statistically significant predominance on the right side.
Conclusions: The incidence of three-rooted mandibular first molars in contemporary Japanese individuals was 25.9%, with no statistically significant sex difference, but in the case of unilateral three-rooted teeth, with a statistically significant predominance on the right side. Our study found that Japanese and north-eastern Asians have a high incidence of the three-rooted mandibular first molars among individuals of Mongolian origin; this finding may be a useful screening tool for identification of unknown individuals.

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1. Introduction

Mandibular first molars usually have two roots, one mesial and one distal, although occasionally they have one or three roots. Anatomical variations in root morphology also exist. In the case of three-rooted mandibular first molars, the additional root is located distolingually, mesiolingually or distobuccally [1]. Most additional roots are distolingual roots, which are smaller than distobuccal roots and tend to be curved [2,3].

The root morphology of three-rooted mandibular first molars provides important information for endodontic and periodontal treatment as well as for other aspects of clinical dentistry [4–6].

Three methods have been used to determine the root morphology of mandibular first molars. The first method is to extract the tooth and then examine it directly [7–12]. The second method is to evaluate dental X-ray images [3,7,14–16], and the third is to evaluate computed tomography (CT) images [4,17–21]. Tooth extraction is a highly invasive method of studying tooth morphology and, depending on the degree of the curve in the distolingual root, there is a high risk of root fracture during extraction [9]. When using dental X-ray images, identifying the distolingual root could be difficult because of its slender dimensions [22]. Additionally, accurate interpretation of periapical radiographic images is particularly difficult [3,18]. In contrast, when CT images are used, three-dimensional (3D) analysis of the roots is possible without damaging their structure [20]. Schäfer et al. argued that mandibular first molar root morphology could be studied with greater accuracy using 3D X-ray imaging technology [15]. Huang et al.

reported that 3D images derived from CT scans were useful for identifying mandibular first molar root morphology [21]. These findings suggest that CT imaging is the most appropriate method for examining mandibular first molar root morphology.

In the anthropological field, a number of studies have indicated that the incidence of three-rooted mandibular first molars varies according to ethnic group [14,23,24]. Ferraz et al. used periapical radiography to study the incidence of three-rooted mandibular first molars in individuals of Mongolian, Black, and Caucasian origin [14]. They found a high incidence of three-rooted mandibular first molars among those of Mongolian origin when compared with other ethnicities (11.4% for Mongolians, 2.8% for Blacks, and 4.2% for Caucasians). Because of the higher incidence in ethnic Mongolians, the presence of three-rooted mandibular first molars is referred to as an "Asiatic trait" [5,8].

Among the Japanese population, the Westernization of the diet and lifestyle may have influenced skeletal change; therefore, current forensic anthropological knowledge should be revised based on modern Japanese data [25,26]. However, no forensic-anthropological studies relevant to three-rooted mandibular first molars have been conducted in the contemporary Japanese population using postmortem CT images.

Therefore, using reconstructed CT images, we examined mandibular first molar root morphology in contemporary Japanese individuals and determined the incidence of third roots on this tooth. These results were compared with previous anthropological studies in the same field.

2. Materials and methods

The roots of 730 mandibular first molars were examined using postmortem CT images of 365 cadavers (255 males: mean age 43.6 ± 16.0 years, 110 females: mean age 42.4 ± 18.6 years) autopsied between August 2010 and November 2015 in the Department of Legal Medicine, Chiba University. Only subjects with mandibular first molars remaining on both sides were included in this study. Samples were excluded if the remaining mandibular first molar was a residual root, the root apex was incomplete, metal artifacts from dental procedures prevented adequate observation of the root, or root separation or hemisection had been carried out.

Prior to their forensic autopsies, postmortem CT scans were performed using 16-row multidetector computed tomography (MDCT) (Eclos; Hitachi, Ltd., Tokyo, Japan). The MDCT imaging parameters were 0.625 mm collimation, 0.63 mm reconstruction
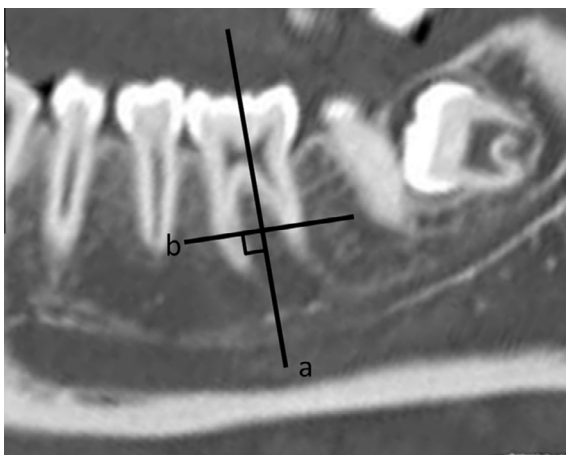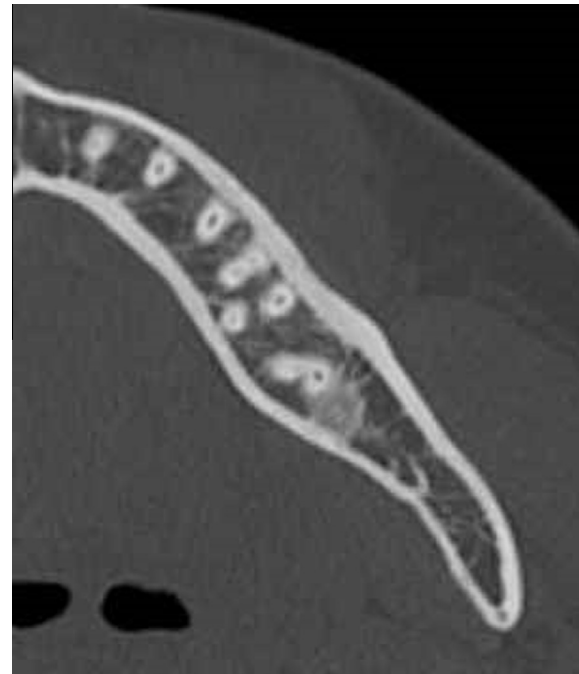
Fig. 2. Three-rooted mandibular first molar on the MPR images. Most additional roots are located in the lingual side of the distobuccal root.

interval, 120 kV tube voltage, 250 mA tube current, and 1 rotation/s. The CT data were saved as Digital Imaging and Communications in Medicine (DICOM) files, and a workstation (Synapse Vincent; Fujifilm Medical, Tokyo, Japan) was used to generate multiplanar reconstruction images orthogonal to the tooth axis of the mandibular first molar (Fig. 1). The roots of the mandibular first molars, from the pulp chamber floor to the root apex, were observed using these images (Fig. 2). The determination of an additional root was performed by two forensic dentists. After the mandibular first molar root morphology was evaluated, the incidence of third roots in relation to the total number of teeth in the study was calculated, as was the presence or absence of a sex difference. In cases where a third root was present on only one side, we assessed the left–right difference. IBM SPSS Statistics software version 20.0 (IBM Corporation, Armonk, NY, USA) was used to perform the chi-square tests (statistical significance was defined as $P < 0.05$) to analyze sex and left–right differences.

3. Results and discussion

In a contemporary Japanese population, the root morphology of the mandibular first molars on both sides of 255 males and 110 females, totaling 730 teeth, was examined using reconstructed CT images. Among the 730 mandibular first molars, 189 (25.9%) had three roots (Table 1).

Among the 255 males, 79 (31.0%) had three-rooted mandibular first molars on one or both sides. Of the 110 females, 35 (31.8%) had three-rooted mandibular first molars on one or both sides (Table 2). No clear sex difference was observed ($P > 0.05$).

Fig. 1. Preparation of the multiplanar reconstruction (MPR) images for observing mandibular first molars. Line a: tooth axis of mandibular first molar and Line b: orthogonal to line a and baseline for MPR images.

Table 1
Root anatomical variation of mandibular first molars.

Mandibular first molars	1 root teeth		2 roots teeth		3 roots teeth	
n	n	%	n	%	n	%
730	4	0.5	537	73.6	189	25.9