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Evaluation of the change in root canal morphology of mandibular canine teeth with respect to age and gender using cone beam computerized tomography

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Abstract
The objective of this study is to evaluate the root canal morphology of mandibular canine teeth in the population of the South-eastern Anatolia of Turkey with cone beam computed tomography (CBCT). The CBCT images of 400 patients (795 teeth in total) with at least one of the mandibular canine teeth were included in the study. The root canal morphology was evaluated according to the Vertucci classification. The chi-square test was used to compare the frequencies and ratios of the types determined by the Vertucci classification with respect to the age and gender. In our study, the most common root canal morphology in mandibular canine teeth was type I (86.29%). The incidence of two roots in mandibular canine teeth was 2.26%. The incidence of two canals was 12.78% and 14.65% in the right and left canine teeth, respectively. Considering the variation of two canals and two roots in canal treatments performed on the mandibular canine teeth; including additional roots and canals would increase the success of the treatment.

Keywords: Canine teeth, cone-beam tomography, internal morphology

Introduction

Complete cleaning and filling of the root canal system are important factors affecting the success of the treatment [1]. Many teeth have additional canals besides normal canal configurations [2]. Therefore, an adequate knowledge about root canal morphology and the variations is an essential for the success of root canal treatment [3].

The canine teeth that have long roots and remain in the mouth for the longest time have an important function in the dental arch [4]. It has been reported in many studies and case reports that the root canal morphology of canine teeth may vary greatly [5-8].

Transparency, staining and sectioning studies as well as radiographic examinations, cone-beam computed tomography (CBCT) and micro-computed tomography (μCT) studies were used in the root canal morphology examinations. [9-11]. It has been stated that CBCT was as reliable as canal staining and transparency technique in three-dimensional evaluation of the root canal morphology [12].

There are a limited number of studies in the literature evaluating the root canal morphology of canine teeth with CBCT in the Turkish population [13-16]. Therefore, our study aimed to examine the root canal morphology of the lower canine tooth with CBCT in the people of South-eastern Anatolia in Turkey and to reveal differences with respect to age and gender.

Material and Method

The present study was approved by the Dicle University Faculty of Dentistry Ethics Committee (2021-5). In our study, The CBCT images from the archive of Dicle University Faculty of Dentistry Department of Oral and Maxillofacial Radiology were evaluated.

The CBCT images (I-Cat, Imaging Sciences International, Hatfield, PA, USA) taken between the years of 2013 and 2011 had been obtained with 120 kVp 3-7 mA parameters and with the voxel size of 0.30 mm. Inclusion criteria of teeth in the study were the completion of apexification of all teeth, the teeth with no large decay and the teeth without calcification in root canals.

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The patients younger than 20 years of age and the teeth having any pathological lesions in the evaluated area or adjacent to the tooth roots, the teeth with advanced periodontal damage, external and internal resorption in the root structure, any artefact to reduce the image quality and the teeth treated by prosthetic restoration or root canal procedure and intra-canal post restoration were excluded from the study. The CBCT images of 400 patients meeting those criteria were included in the study and a total of 795 mandibular canine teeth were evaluated by the I-Cat version 1.6.2.0 (I-Cat Imaging Sciences International, Hatfield, PA, USA) software. The canal morphologies and the number of roots of the teeth were examined with coronal, sagittal and axial section views. The root canal configurations were evaluated according to the Vertucci classification. The evaluation was performed by two endodontics specialists, and a joint decision was made on the separate decisions. The patients were grouped according to gender and age.

The age groups of the patients were determined as follows:
Group A: ages 20-29,
Group B: ages 30-39,
Group C: ages 40-49,
Group D: ages 50 and over.

In order to reflect the South-eastern Anatolian population in Turkey of the 400 patients in the study, the number of patients that should be in the groups was determined using the Turkish Statistical Institute 2020 regional population data. The patients were randomly selected according to the numbers determined for the groups [Table 1].

Table 1: Sample size in groups created according to the age distribution of population.

Group	Population of South-eastern Anatolia n / percent	Number of Sampling in the Group n / percent
Group A	1.567.940 (31.40%)	126 (31.50%)
Group B	1.268.677 (25.41%)	102 (25.50%)
Group C	913.423 (18.29%)	73 (18.25%)
Group D	1.243.347 (24.90%)	99 (24.75%)
Total	4.993.387 (100%)	400 (100%)

The root canal morphologies were classified into eight groups according to the Vertucci root canal configurations.

Type I: There is only a single canal extends from the pulp chamber to the apex.

Type II: The two canals that leave the pulp chamber separately join in the apical region and end as a single canal.

Type III: A single canal leaving the pulp chamber first divides into two, then unites in the apical region and ends as a single canal.

Type IV: The two separate canals that leave the pulp chamber end at the apical as two separate canals.

Type V: The canal that leaves the pulp chamber as a single canal divides into two separate and distinct canals with separate apical foramina at the apex.

Type VI: The two separate canals that leave the pulp chamber first unite and continue as a single canal and separate again in the apical region and end in two separate canals.

Type VII: A single canal leaving the pulp chamber first divides into two, then reunites and becomes a single canal, and then divides again at the apical and ends as two separate foramina.

Type VIII: There are three canals that leave the pulp chamber separately and end separately.

The SPSS (Version 25; IBM Inc., Chicago, IL, USA) software was used in the statistical analysis of the data and if the p-value was less than 0.05, the difference was regarded significant. The chi-square test was used to evaluate the morphological differences in different age groups and genders.

Results

In our study, the root canal morphology of 795 mandible canine teeth of 400 individuals (200 males, 200 females) was evaluated with CBCT. The age range of the individuals included in the study was 20-75 years, with the average age of 38.15. The majority of teeth were single rooted (n = 777, 97.74%), only 2.26% (n = 18) had two roots [Figure 1]. The canal morphologies in the mandibular canines were observed to be type I (86.29%), type II (6.54%), type III (5.91%), and type V (1.26%) [Figure 2].
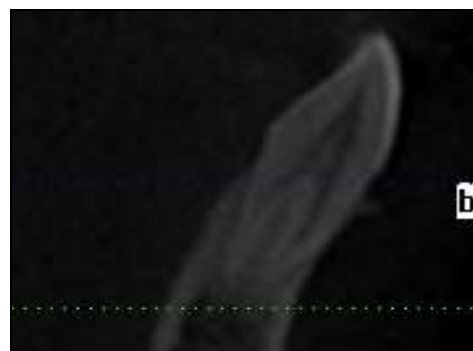
Fig 1: The two rooted canine tooth observed in our study.
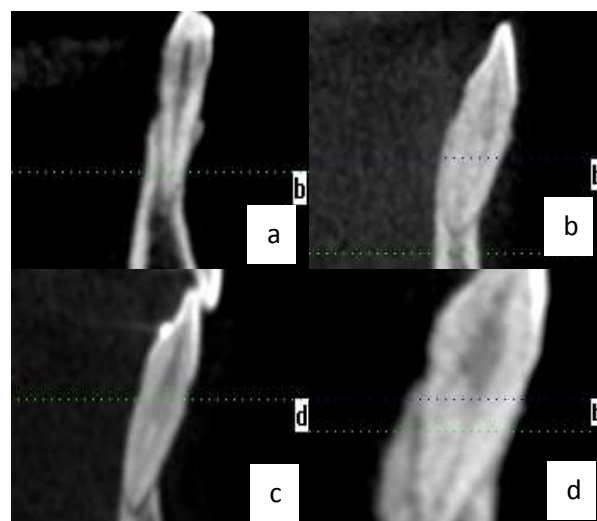
Fig 2: The teeth with the Vertucci Type I (a), II (b), III (c) and V (d) morphology, respectively, observed in our study.

The statistical analysis revealed that there were no significant differences in terms of the morphology of the canine teeth among the age groups ($p = 0.124$) and genders ($p = 0.121$) ($p > 0.05$). In the canal morphologies of the teeth examined in our study, no teeth with Vertucci Type IV, Type VI, Type VII and Type VIII configurations were observed [Table 2].

Table 2: The distribution of examined teeth according to the canal morphology

	Right Canine (43) (n / %)	Left Canine (33) (n / %)
Total teeth number	399 (%100)	396 (%100)
Type I	348 (87.22%)	338 (85.35%)
Type II	22 (5.51%)	30 (7.58%)
Type III	23 (5.76%)	24 (6.06%)
Type IV	0 (0.00%)	0 (0.00%)
Type V	6 (1.50%)	4 (1.01%)

Discussion
Some root canals may not be detected if the clinician performing the root canal treatment had inadequate knowledge of the root canal anatomical variations or insufficient search was performed for additional canals. Finding these canals and including them in the root canal treatment significantly increases the success of the treatment [17].

Many different techniques that have been proposed and used to evaluate the root canal morphology of teeth include microscopic evaluation of sections, decalcification of tooth or µBT. Unlike such invasive techniques that require tooth extraction, digital radiography, periapical radiography or CBCT have been recommended for use in the morphological studies. In the study comparing the CBCT scans and µCT which is accepted as the best method, it was stated that CBCT was reliable in evaluating root canal morphologies [18]. Also, Matherne et al. showed that, when evaluating radiographs, the clinicians missed one or more root canals in more than 40% of the cases, and this rate decreased in the evaluations made with the CBCT images [19].

FOV (field of view) and voxel size are important in evaluating small anatomical structures such as in root canal morphology examinations with CBCT. As the FOV size and voxel size increase, the details are less observed in the image [20]. The FOV size of the CBCT images we examined in our study was 100x50 mm and the voxel size was 0.30 mm, which allow the evaluation of root and canal morphologies with these resolution values.

In the canine teeth examined in our study, the incidence ratio of those with two roots was 2.26% and those with a single root were 97.74%. While the ratio of two roots determined in the present study was higher than those in studies by Orhan et al. (1%), Han et al. (1.32%) and Pecora et al. (1.7%), it was similar to that of Magat (2.2%) [13, 15, 21, 22]. The reasons for the different findings could be attributed to the sample size and the difference in population.

In our study, mostly type I canal morphology was observed. The type I incidence ratio was 87.22% and 85.35% for right and left canine teeth, respectively, and 86.28% in total. This ratio was lower than the results found by Kayaoglu et al. (93.9%) and Magat (90.6%), while higher than those of Orhan et al. (47.87%), Sert et al. (76%) and Caliskan et al. (80.39%). The different results in the studies could be due to the sample sizes, the geographical variations and whether the assessment of morphology was conducted with extracted teeth or the CBCT method [13, 15, 16, 23, 24].

The canal morphology incidences in the mandibular canines were determined to be type I (86.29%), type II (6.54%), type III (5.91%), and type V (1.26%). In the study conducted by Vertucci, after type I morphology, the second and third most common morphologies were type II (14%) and type III (2%), respectively [10]. Whereas Orhan et al. and Sert et al. observed more type II morphology after type I, Magat and Caliskan et al. observed more type III morphology after type I [13, 15, 23, 24].

Conclusion
It was observed in our study that 2.22% had two roots and 12.3% had two-canal morphology in lower canine teeth. The clinician's knowledge of the variations in the root canal morphology is important, and the success of canal treatment can be increased by considering the possibility of having two roots and two canals during endodontic treatment.

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