

Original Research Article

Cone-Beam Computed Tomography Evaluation of Root Canal Morphology of Mandibular Canines in Kashmiri Population: An In Vivo Study

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Abstract

Background: Comprehensive knowledge of root canal anatomy is essential in order to properly achieve the objectives of root canal treatment. Occurrence of additional canal and configurations in roots is commonly seen.

Objective: To describe root canal morphology of mandibular canines and their variability in Kashmiri population samples, using Cone-Beam Computed Tomography (CBCT).

Materials and methods: A total of 234 mandibular CBCT images were screened from the data base of CBCT diagnostic Centre in Kashmir. The data was screened for understanding the root canal morphology of mandibular canines in Kashmiri population. The anatomical parameters analyzed were number of roots and canals, canal configuration, gender and bilateral comparisons.

Results: The mandibular canines from the samples presented one root and one canal was present in most cases. A type I root canal configuration was also predominant for the.

Conclusion: Mandibular canines showed prevalence of two roots and canals. Gender had no association with the number of roots and canals in mandibular canines. Mandibular canines showed no significant bilateral symmetries in the number of roots and in the number of canals.

Key words

Root canal, Anatomy, Cone-beam computed tomography, Mandibular canines.

Introduction

Comprehensive knowledge of root canal anatomy is essential in order to properly achieve the objectives of root canal treatment. Occurrence of additional canal and configurations in roots is commonly seen [1-3]. During root development Hertwigs epithelial root sheath plays an important role for occurrence of aberrant canal morphology [3]. Among mandibular anterior teeth canines are referred to as corner stones of dental arches and plays a major role in maintaining the aesthetics and functional occlusion through canine guidance [2]. Canines usually have a simple anatomy and the presence of two canals is rare [4,5]. recently studies on mandibular canines from different populations reported the presence of up to two roots and two canals with Vertucci's types I–V canal configurations [6-8]. It has been recently reported that Two-rooted mandibular canines occur in 5% of population [9, 10] while single-rooted canines with two root canals have a higher occurrence of 15% [11].

Recently cone beam computer tomography has been reported as an important tool for evaluating canal morphology. Neelkantan, et al. reported that CBCT was as accurate as the clearing technique for evaluation of canal morphology [12].

An extensive literature search revealed no studies that reported anatomy of permanent mandibular canines in Kashmiri population using CBCT. The aim was to describe the root canal. Therefore, the present study evaluates (a) the prevalence of a second root and canal in mandibular canines, (b) gender differences, and (c) bilateral symmetry of canines morphology in a Kashmiri population using *in vivo* CBCT.

Materials and methods

This study was designed as a cross-sectional study. CBCT images were obtained from a non-probabilistic intentional sample from a database of a private dentomaxillofacial imaging centre in Srinagar Kashmir. The reasons for undertaking the CBCT imaging was made by the treating dentists as part of dental treatment with reasons such as preoperative implant planning, detections of impactions, complex periapical regions and others. Authorization for using the data base was obtained from the director of the center. Ethical approval was obtained from the institutional ethical committee of dental college and hospital Srinagar. All data sets were anonymized to keep the identity of the patients confidential. The following inclusion criteria were used:

- The patient must present at least one mandibular canine
- The tooth should not present caries
- The tooth should not have had endodontic treatment
- The tooth must present apical closure compatible with complete root formation
- Absence of periapical lesions or Periodontal ligament widening
- Absence of radicular resorptions
- Absence of root cysts or tumor lesions
- The patient must not have a condition that affects the normal development of teeth and
- A high-quality CBTC image must be available.

The CBCT images were obtained using machine used in this *in vivo* retrospective study was done using Carestream 9300 select, France with the scanning parameters: FOV 10×10 mm, 90 kV, 5–8 mA, 17.5 seconds exposure time, and 0.250 mm voxel size. All CBCT images were processed and reconstructed using CS imaging software. All CBCT images were evaluated under standardized conditions in a dimmed room and acquired serial axial, coronal, and sagittal

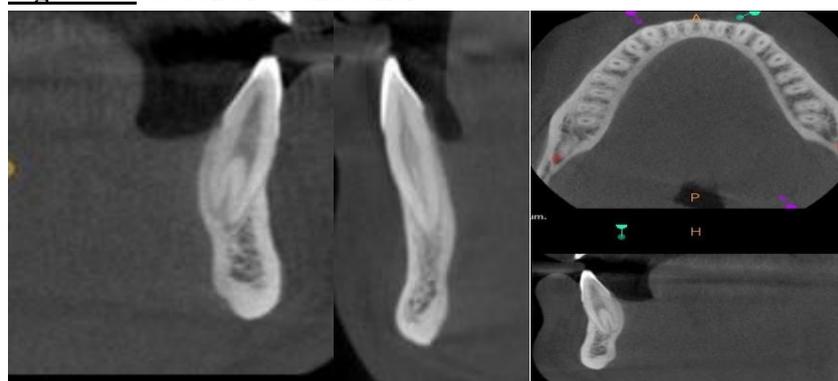
sections were displayed on the monitor and complete data set was evaluated for external and internal morphology of mandibular canines. Two endodontists evaluated the samples separately. Cohen's kappa test was used for concordance. An almost perfect agreement between observations was noted with coefficient of .89. The endodontists assessed the CBCT images and evaluated the following parameters:

- The number of roots, number of canals, and canals' configurations according to Vertucci's classification (**Figure - 1**) in mandibular canines.
- The prevalence of a second root and a second canal.
- Differences between genders.
- Bilateral symmetry of the number of roots, number of canals, and canals configurations.

Figure – 1: Vertucci's classification.

| Vertucci 1984 | | | | | | | |
|--|--|--|--|--|---|--|--|
| Type 1 | Type 2 | Type 3 | Type 4 | Type 5 | Type 6 | Type 7 | Type 8 |
| 1-1 | 2-1 | 1-2-1 | 2-2 | 1-2 | 2-1-2 | 1-2-1-2 | 3-3 |
|  |  |  |  |  |  |  |  |

Figure – 2: Second root and canal.



Statistical Analysis

The collected data was entered into the Statistical Package of Social Sciences software program for Windows (SPSS V25; IBM, Chicago, IL), followed by coding and analysis. The results report frequencies and percentages with a 95% confidence interval (CI). The Z test determined whether differences existed in the independent

groups. A Chi-square test assessed differences between males and females as well as left and right locations, and Cohen's Kappa test determined the presence of bilateral symmetry and assessed inter observer reliability. The level of significance for all statistical tests was set at $p < 0.05$.

Results

A total of 234 mandibular CBCT scans were evaluated. Canines were evaluated. These teeth were examined from the CBCT radiographs of 200 subjects including 108 (52%) males and 92 (48%) females and whose ages ranged from 17 to 62 years. Mean age 28.95 ± 9.80 years (median = 26 years).

Prevalence of Second Root and Canal

Of the 411 mandibular canines, (97.3%) teeth had one root and 11 (2.7%) teeth had two roots. Additionally, 363 (90.7%) of the teeth had one canal and 37 (9.3%) teeth had two canals (**Figure - 2**). Vertucci's type I was present in 363 (90.7%) teeth, while 24 (6.1%) teeth had Vertucci's type III and 13 (3.2%) teeth had Vertucci's type V (**Table - 1**).

Table – 1: Prevalence of second root and canals.

| No of teeth | Single rooted | | | Two rooted |
|-------------|-----------------|-------------------|-----------------|------------|
| | Vertucci Type I | Vertucci Type III | Vertucci Type V | |
| 411 | 363 | 24 | 13 | 11 |

Table – 2: Gender difference.

| | Male | Female |
|-----------------|------|--------|
| No of teeth | 195 | 216 |
| Single root | 190 | 210 |
| Two rooted | 6 | 11 |
| Vertucci type 1 | 175 | 190 |

Table – 3: Bilateral symmetry.

| No of samples | Both right and left canines | Bilaterally single root | Bilaterally two roots | Bilaterally Vertucci type 1 | Bilaterally Vertucci type III | Bilaterally Vertucci type V |
|---------------|-----------------------------|-------------------------|-----------------------|-----------------------------|-------------------------------|-----------------------------|
| 234 | 199 | 196 | 3 | 191 | 7 | 1 |

Gender Differences

There were no statistically significant differences between genders regarding the number of roots ($p = 0.064$) and canals ($p = 0.088$). Regarding canal configurations, there was no statistically significant difference between genders (**Table - 2**). Among the 195 mandibular canines in males, 189 (97.0%) had one root and 6 (3.0%) had two roots. Among 216 mandibular canines in females, 210 (96%) teeth had one root and 11 (4%) had two roots. In males, 175 (89%) mandibular canines had one canal; in females, 190 (88.3%) mandibular canines had one canal. Vertucci's type I appeared more frequently in males than it did in females (94.4% compared to 87.3%).

Bilateral Symmetry

199 of 234 participants (85.1%) had both right and left mandibular canines. The bilateral symmetry for the number of roots was 95.5% ($p = 0.023$); the majority of participants ($n = 196$; 95.1%) had one root on both sides and three participant (0.5%) had two roots on both sides. Bilateral symmetry for the number of canals was 90.1% ($p < 0.001$); 86.1% ($n = 176$) of participants had one canal on both sides and only 6.9% ($n = 15$) had two canals on both sides. Regarding canal configurations, the total bilateral symmetry was 90.1% ($p < 0.001$); 86.1% ($n = 191$) of the participants had Vertucci's type I on both sides, 3.5% ($n = 10$) of participants had Vertucci's type III on both sides, and only one

participant (0.5%) had Vertucci's type V on both sides (**Table - 3**).

Discussion

Many researchers have investigated root canal anatomy of different populations using different methods and techniques [1-3]. The gold standard for evaluating the morphology has been the clearing technique [13]. Recently, radiographic technique like use of *in vivo* CBCT has become paramount to obtaining proper details of the root canal morphology during the dental examination [14, 15]. CBCT is a 3D sophisticated technology with low radiation dose, that doesn't present geometrical distortion and anatomical noise. It allows for the in depth analysis of a relatively large sample size safely and noninvasively to achieve a reliable prevalence [16].

Any error in diagnosis of the anatomical configuration can lead to serious complications and failure of endodontic treatment. Therefore for achieving successful outcome the treating dentists should be aware of the variations that might present in teeth before treating them.

The present *in vivo* CBCT study investigated the prevalence of a second root and canal of mandibular canines. All CBCT images were obtained from the same scanner. In this study, the prevalence of two roots and two canals in mandibular canines was 2.7% while two canal canines was 9.3 %. In teeth with two canals, the most common internal configurations were Vertucci's type 1 91.1%, type III in 5.1% and type V in 3.1%. Our results revealed a higher prevalence than a finding in a recently published article¹⁷ where they reported 0.2% and 4.6% for roots and canals, respectively. The differences and inconsistencies of their results and ours might be explained by the regional differences where the study samples were obtained.

Other studies from different populations have found two-rooted mandibular canines to be in a range of 0–11.54% [6-10, 17] and two canals in a range of 0–15.1% [18-23].

Our study is the first in a Kashmiri population that evaluated mandibular canines using CBCT and it seems that the presence of two roots or canals is rare in this population as well.

Concerning gender, our study showed no significant differences in the number of roots and canals in males and female in both mandibular and maxillary canines. However, between genders regarding canal configurations, where Vertucci's types III and V were more prevalent in females than in males, and type I was more prevalent in males than in females. This finding is in partial agreement with a study of the on mandibular canines in which there was no significant difference in the number of roots between genders, although the presence of two canals was significantly higher in males [24, 25].

Pan, et al. [26] reported results similar to ours, noting no differences between genders in regard to the number of roots and canals. Soleymani, et al. [27] studied an Iranian population that showed that males have a higher prevalence of two roots and double canals in mandibular canines; in contrast, a study of a Portuguese population by Martins, et al. [25] revealed that women had significantly more roots and root canals than men.

The present study also investigated bilateral symmetry and found high bilateral symmetry 93.5%, 89.1%, and 91.1% for the number of roots, number of canals, and canal configurations, respectively, in mandibular canines. These findings are consistent with two studies carried out in Saudi¹⁷ and Irania⁷ populations, which reported a high probability of bilateral symmetry of 97% and 95.4% in the number of roots and canal configuration, respectively.

The researchers of a 2019 systematic review of 102,610 teeth using *in vivo* CBCT from 28 countries concluded that some groups of teeth had a similar morphology among different populations [25], therefore, the results of this

anatomical study on mandibular canines were within the global range and did not show notable diversity.

Conclusion

Within the limitations of the present study, mandibular canines showed prevalence of two roots and canals. Gender had no association with the number of roots and canals in mandibular canines. Mandibular canines showed no significant bilateral symmetries in the number of roots and in the number of canals. Therefore, this finding could be of clinical importance during RCT related to mandibular canines. Treating dentists should properly evaluate the tooth before starting the endodontic treatment.

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