# Variations in the Root Form and Root Canal Morphology of Permanent Mandibular canine

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## ABSTRACT

**Background:** Mandibular canines are recognized as usually having one root and one root canal in most cases. However, many investigators have reported the anatomical variations associated with mandibular canines. Thus; the objective of this study is to determine the number of roots and morphology of the root canal system of permanent mandibular canine in a Nepalese population.

**Methods:** Cone Beam Computerized Tomography images of 390 patients in a Nepalese population were selected, and a total of 780 mandibular canines were analyzed. The number of root and the canal configurations were investigated. Data were analyzed with descriptive analysis and Chi-square tests using the Statistical Package for the Social Sciences (SPSS) software version 20 (SPSS Inc, Chicago, IL, USA).

**Results:** Out of the 780 mandibular canines, 741(95%) were single-rooted canines while only 39 (5%) were double-rooted canines. The most common type of Vertucci in single-rooted canines was Type I (1-1) in the percentage of 85.6% and the least type was Type IV (1-2) in the percentage of (2.5%). The Chi-square tests showed no significant association between gender and number of roots (P = 0.87) and gender and root canal configuration in single-rooted canine (P = 0.52).

**Conclusions:** All mandibular permanent canines were single rooted but 5.2% of the permanent mandibular canines had two roots.

**Keywords:** Canine; Cone Beam Computerized Tomography (CBCT); double root; root canals.

## INTRODUCTION

Knowledge of root canal morphology and their variations is crucial for the success of root canal therapy.[1] The root canal morphology varies greatly among different populations and even in different individuals within the same population.[2]

Generally, mandibular canines contain a single root and canal. The occurrence of two roots and two canals is a rare entity ranging from 1.7 to 6.2% of double-rooted and 10.6% of two or more canals.[3,4] Therefore, the main objectives of the present study is to find out the variations in the root form and root canal morphology of permanent mandibular canine in a Nepalese population and highlight the regional morphological variation of this tooth based on mixed community of Aryan and Mongoliod race. As, literature review has revealed lack of data on morphological variation of permanent mandibular canine.

## METHODS

The present study evaluated the three dimensional CBCT images of 780 completely erupted mandibular canines belonging to 390 patients with age ranging from 18-60 years that presented to Department of Oral Radiology,UCMS Bhairhawa, Nepal over a one-year period since June 2021 to July 2022 with due approval of Institutional Review Committee (UCMS/IRC/077/21) of Universal College of Medical Sciences, Bhairahawa,

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Nepal. Patients who needed CBCT radiographic examinations for their routine examination, diagnosis, and treatment planning and those who were referred for treatment with CBCT images were included. Cases where the anatomy was damaged and original root canal morphology was unclear were excluded. Only the canines with no endodontic treatments were examined.

All the CBCT images were taken with Clear rainbow™ CT (Dentium Co. Ltd, Korea) at 94 kVp, 9 mA and an exposure time of 19 sec and 5×5 FOV. The voxel size of the images was 100 µm. The CBCT cross-sections were 1 mm thick taken from the apical to the coronal regions.

The canines were categorized by the patients' gender, tooth quadrant (left or right), the number of the roots and the root canal morphology. The data were analyzed in SPSS software (SPSS version 20.0, SPSS, Chicago, IL, USA) using the Chi-squared test and the t test. The level of statistical significance was set at 0.05.

## RESULTS

Among 780 examined mandibular canines, 5%( n=39) were two rooted whereas prevalence of one rooted was high i.e. 95%( n=741).Canal configuration for all the two rooted canine were Type I (1-1) whereas for one rooted, canal configuration is illustrated in Table 2 with high prevalence for Type I i.e. 85.6%(n=634) followed by Type II 4.6%(n=34),Type V 3.8%(n=28),Type III 3.5%(n=26) with least in Type IV 2.5%(n=19).

Similarly, prevalence of one rooted and two rooted canine was more in male than female with one rooted more in left side and two rooted in right side. Higher prevalence of Type I was found in male left side whereas for female Type II in left side was predominant.

The Chi-square tests revealed that there was no significant statistical association between gender and number of roots (P = 0.87) and between side and number of roots (P = 0.25) and also between gender and types of Vertucci in single-rooted canines (P = 0.52) and also between side and types of Vertucci in single-rooted canines (P = 0.10).

**Table 1. The frequency and percentage of number of roots according to side and gender in mandibular canine teeth.**

| Number of root | Side | | Gender | | Total |
|---|---|---|---|---|---|
| | Right | Left | Male | Female | |
| One-rooted | 367(94.1%) | 374(95.9%) | 389(94.9%) | 352(95.1%) | 741(95%) |
| Two- rooted | 23(5.9%) | 16(4.1%) | 21(5.1%) | 18(4.9%) | 39(5%) |
| Total | 390 | 390 | 410 | 370 | 780 |
| p* value | 0.25 | | 0.87 | | |

*chi square test at the significance level of 0.05

**Table 2. The frequency and percentage of root canal configuration according to side and gender in mandibular canine teeth.**

| Canal configuration | Right | Left | Male | Female | Total |
|---|---|---|---|---|---|
| Type I (1-1) | 314 (85.6%) | 320 (85.6%) | 337 (86.6%) | 297 (84.4%) | 634 (85.6%) |
| Type II (2-1) | 14 (3.8%) | 20 (5.4%) | 19 (4.9%) | 15 (4.3%) | 34 (4.6%) |
| Type III(1-2-1) | 18 (4.9%) | 8 (2.1%) | 11 (2.8%) | 15 (4.3%) | 26 (3.5%) |
| Type IV (2-2) | 11 (3%) | 8(2.1%) | 7(1.8%) | 12(3.4%) | 19 (2.5%) |
| Type V(1-2) | 10 (2.7%) | 18 (4.8%) | 15 (3.9%) | 13 (3.6%) | 28 (3.8%) |
| Total | 367 | 374 | 789 | 352 | 741 |
| p value | 0.10 | | 0.52 | | |

**Table 3. The frequency and percentage of bilateral root in mandibular canine.**

| Unilateral root | Bilateral root | Total |
|---|---|---|
| 34 (87.2%) | 5(12.8%) | 39 |

Among 39 patients with two rooted, the prevalence of unilateral root was 87.2% (n=34) while for bilateral root was 12.8% (n=5).

## DISCUSSION

During root canal treatment to avoid the possibility of a missed canal the knowledge of the root and canal configurations of mandibular canines is crucial as the possible cause of failure of endodontic therapy is missed root canal. There may be no clinical symptoms to severe acute apical abscess. A study stated that 82.6% of the teeth with missed canals were associated with periapical lesions.[5] The frequency of post treatment apical periodontitis in the teeth with at least one untreated canal to be 98% reported in another study.[6] Therefore, before commencing endodontic treatment to minimize the possibility of missing canals during treatment clinicians should be completely informed and aware of the root anatomy and root canal configurations, with their possible variations.

Cone-beam computed tomography (CBCT) has become a successful tool to explore the root canal anatomy. Neelakantan et al. had concluded that CBCT is an accurate as modified canal staining and clearing technique which is a gold standard in identifying root canal anatomy.[7] A recent study reported that CBCT was as precise as the modified canal staining and tooth clearing method in determining root canal morphology.[8] The high accuracy, significantly lower effective radiation dose or short exposure time, and lower expense are the most notable advantages of CBCT.[9]

In a study done in Iranian Population it was found 12.08 %[10] have two roots, in Serbian population 5.8%[11], Han et al. found 1.3 %[12] using CBCT method. Kandasamy et al found a rare variation in anatomy of permanent canine with three rooted canine tooth.[13] In our study it was found that 5.9% of the population had two roots which was similar to the study done in Serbia where he found 5.8% and Khan NB et al found 5.2% [14] of the population had two roots. Similarly, the prevalence of two roots was high in right side (5.9%) than in left side (4.1%) while male had high prevalence of two roots (5.1%) than female (4.9%) in our study. This result is in agreement with the study by Soleymani[15] in which the double-rooted canines were significantly more common among men than women and in contrary to Doumani et al[3] and Srivathsa[16] where female were more predominant with double rooted.

The present study reported the most common root canal morphology for mandibular canines to be Type I (85.6%) for both right and left as consistent with the results obtained by Pineda and Kuttler (81.5%)[17] and Soleymani (89.7%)[4].The second most common morphology detected was type II (5.4% on left) and type III (4.9% on right), followed by type V (4.8% on right) and Type IV (3% on right).Similarly, Type I morphology was most common in male (86.6%) followed by Type II (4.6%) in female. Type III (4.3%) and Type IV (3.4%) was predominant in male while Type V (3.8%) was in female.

In clinical terms, morphological bilateral symmetry is crucial in the treatment of patients with contra lateral teeth. As in our study, the prevalence of bilateral two root was 12.8% (n=5) which was in accordance with Khan NB[14] et al where 4 patients had bilateral root.

Prior to this study, we haven't found any specific studies that had addressed the anatomic diversity of mandibular canines in Nepalese population but the results of this study cannot be generalized to the whole population of Nepal as the sampling was conducted in a specific center in Rupandehi district; thus it is suggested that further studies be conducted in different parts of Nepal to obtain more applicable results.

## CONCLUSIONS

In this study, 5% of mandibular canines were double-rooted. These findings emphasize the importance of clinician's knowledge of morphological diversity of root canals. Since leaving a canal untreated is one of the main causes of root canal treatment failure, the presence of a second canal must always be considered by the dentist in mandibular canine root canal treatments. Cone-beam computed tomography provides an accurate tool for the morphological assessment of canines.

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