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Assessment of Variations of Root Canal Morphology in Permanent Canines in Population of Central Gujarat - A Retrospective Study

Dr. Manan D. Desai[1], Dr. Shraddha Chokshi[2], Dr. Zarna Sanghvi[3], Dr. Pooja Joshi[4], Dr. Riya Desai[5], Dr. Setu Kalaria[6]

[1]Post Graduate Student, Department of Conservative Dentistry & Endodontics, Ahmedabad Dental College & Hospital, Ahmedabad, Gujarat, India
[2]Profesesor and Head, Department of Conservative Dentistry & Endodontics, Ahmedabad Dental College & Hospital, Ahmedabad, Gujarat, India
[3,4]Professor, Department of Conservative Dentistry & Endodontics, Ahmedabad Dental College & Hospital, Ahmedabad, Gujarat, India
[5]Associate Dentist, Ex Student, Vaidik Dental College and Research Centre, Daman, India
[6]Reader, Department of Conservative Dentistry & Endodontics, Ahmedabad Dental College & Hospital, Ahmedabad, Gujarat, India

Corresponding author: Dr. Manan D. Desai, Department of Conservative Dentistry & Endodontics, Ahmedabad Dental College & Hospital, Ahmedabad, Gujarat, India

KEYWORDS

Permanent Canines, OPG, Root Canal Morphology

ABSTRACT

Background: Understanding the changes in root canal anatomy is critical for successful endodontic treatment. The changes in root canal morphology differs in each tooth. Canines are also described as “cornerstones” of the arch because they assist the jaw into normal alignment during chewing and biting. This study was done to evaluate the variability of root canal morphology in maxillary and mandibular canines.

Aim: to evaluate the variations of root canal morphology in maxillary and mandibular canines, in males & females, in both right and left sides in central Gujarat population using OPG.

Material and Methods: In this In vitro study; total of 775 OPG samples (448 males & 327 females) were evaluated. High- quality images that showed maxillary & mandibular canines with untreated canals, absences of restorations or post endodontic restoration, absence of periapical lesions was included in the study while distorted OPG images, canines with previously initiated or completed root canal treatment, canines with immature root apex, presence of post or crown were excluded from the study. The prevalence of each type was determined through evaluating the OPG (ie, 1-1,2-1,2-2,2-1,1-2-1 configuration etc.) by a single operator.

Results: The most common canal configuration was 1-1 in both maxillary and mandibular canines (97.76 % maxillary right canines, 98.15 % maxillary left canines, 91.14 % mandibular right canines, 93.22 % mandibular left canines). 98.1% , 97.2 % of males and females respectively showed 1-1 canal configurations in maxillary right canines. 98.61% , 97.48 % of males and females respectively showed 1-1 canal configurations in maxillary left canines. In case of mandibular right canines 92.55% males and 89.23 % females showed 1-1 canal configurations. In case of mandibular left canines 94.13% males and 92 % females showed 1-1 canal configurations.

Conclusion: The presence of Type I canal configuration mostly seen in the Central Gujarat population with higher frequency in maxillary canines compared to mandibular canines and more in males compared to females.

Introduction

Every tooth tells its own story: the anatomy of root canals can vary greatly, requiring a tailored approach for each patient to ensure successful treatment." Understanding the variations in root canal anatomy is crucial for successful endodontic treatment. Each tooth can have unique structures, including additional canals, unusual curvatures, or complex branching. Recognizing these variations helps clinicians to ensure complete Cleaning and Disinfection, prevent Instrument separation thus improving Long-Term Outcomes. The variations in root canal morphology differs in each tooth. Hence a deep understanding of root canal variations is key to achieving optimal results and preserving natural teeth for the long duration. Canines are integral to the structure, function and appearance of the maxillary and mandibular arch. They are also considered as “cornerstones” of the arch because they guide the jaw into proper alignment during chewing and biting. Their role in maintaining a proper bite, supporting surrounding teeth and enhancing facial aesthetics makes them essential for oral health. As root canal morphology is considered; Various studies show that canines usually have a single canal from orifice to the apex.[1] But it may also have numerous variations depending on ethnic differences, origin, age, gender, study design and it also varies in maxillary and mandibular canines in right & left sides. One study concluded that 15 % of mandibular canines show a single root with two canals.[2,3] The presence of two roots and two canals is a rare entity. It ranging from 1.7 to 6.2% of double-rooted and 10.6% of two or more canals.[4,5]

The orthopantogram also known as OPG is a panoramic single image radiography that provides a broad view of maxilla, mandible, teeth and surrounding structures. It is used as a convenient, relatively inexpensive and rapid way to evaluate not only the gross anatomy of the jaws and related pathologies but can also be used in evaluating minute details such as morphology of root canal.6 Hence this study was undertaken to analyze the variations of root canal morphology in maxillary and mandibular canines.

Aim of this in vitro study was to evaluate the variations of root canal morphology in maxillary and mandibular canines, in males & females, in both right and left sides in central Gujarat population using OPG.

Material and Methods

In this In vitro study; total of 775 OPG samples (448 males & 327 females) were evaluated. OPG for patients in the range from 15-70 years of age were selected from the database of the department of oral medicine diagnosis and radiology and other diagnostics centres of Ahmedabad City. High- quality images that showed maxillary & mandibular canines with untreated canals, absences of restorations or post endodontic restoration, absence of periapical lesions was included in the study while distorted OPG images, canines with previously initiated or completed root canal treatment, canines with immature root apex, presence of post or crown were excluded from the study. It was made sure that all the panoramic images were taken at 70 kvp, 10mA, 14.0sec exposure time. The prevalence of each type was determined through evaluating the OPG (ie, 1-1,2-1,2-2,2-1,1-2-1 configuration etc.) by a single operator.

Results

Table 1: Comparison among Maxillary and Mandibular root canals various width

	1-1 N (%)	2-1 N (%)	2-2 N (%)	1-2 N (%)	1-2-1 N (%)	Total N (%)
Maxillary right canine	744 (97.76%)	6 (0.8%)	1 (0.1%)	10 (1.31%)	0	761 (100%)
Maxillary left canine	743 (98.15%)	4 (0.53%)	3 (0.4%)	7 (0.92%)	0	757 (100%)
Mand ibular Right Canine	700 (91.14 %)	21 (2.7 1%)	3 (0.4 %)	25 (3.25 %)	19 (2.5 %)	768 (100 %)
Mand ibular Left Canine	715 (93.22	24 (3.1	0	17 (2.23	11 (1.4	767 (100

	%)	2%)		%)	3%	%)
P value	0.19	0.10	0.21	0.07	0.37	

Test Used : ANOVA Test (p< 0.05), Total Samples= 775
N= Total number of samples

Table 2: Comparison among Male and Female
Test Used: Independent Sample Test (p< 0.05)

Maxillary Right Canine	1-1 N (%)	2-1 N (%)	2-2 N (%)	1-2 N (%)	1-2-1 N (%)	Total N (%)
Male	434 (98.1 %)	2 (0.4 %)	1 (0.2 %)	5 (1.3 %)	0 (0)	442 (100 %)
Female	310 (97.2 %)	4(1. 25%)	0 (0)	5 (1.55 %)	0 (0)	319 (100 %)
'p' value	**0.02***	0.27	1.10 0	0.59	-	

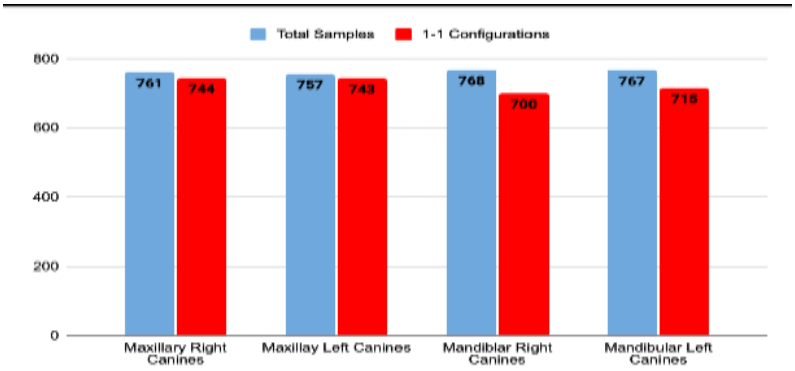
Maxillary Left Canine	1-1 N (%)	2-1 N (%)	2-2 N (%)	1-2 N (%)	1-2-1 N (%)	Total N (%)
Male	433 (98.6 1%)	1 (0.2 4%)	1 (0.24 %)	4 (0.91 %)	0 (0)	439 (100 %)
Female	310 (97.4 8%)	3(0. 94%)	2 (0.62 %)	3 (0.96 %)	0 (0)	318 (100 %)
'p' value	**0.012***	0.20	0.78	0.62	-	

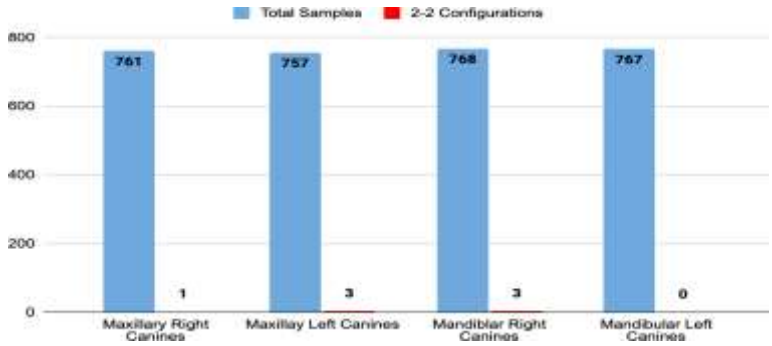
Mandibular Right Canine	1-1 N (%)	2-1 N (%)	2-2 N (%)	1-2 N (%)	1-2-1 N (%)	Total N (%)
Male	410 (92.55%)	10 (2.26%)	1 (0.22%)	11 (2.48%)	11 (2.49%)	443 (100%)
Fem ale	290 (89.23%)	11(3.38%)	2 (0.61%)	14 (4.30%)	8 (2.48%)	325 (100%)
'p' value	**0.00****	0.48	0.78	0.59	**0.04***	

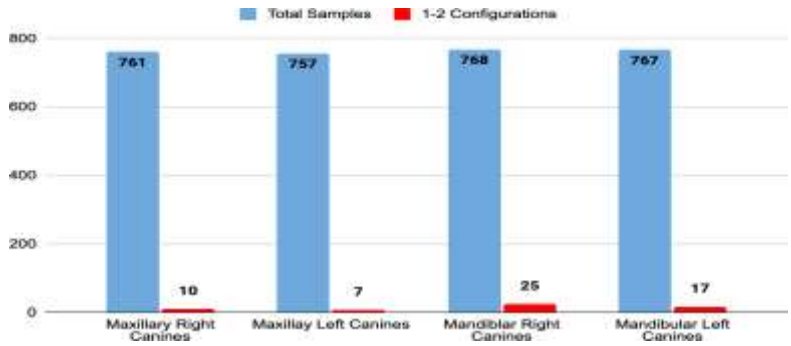
Mandibular Left Cani ne	1-1 N (%)	2-1 N (%)	2-2 N (%)	1-2 N (%)	1-2-1 N (%)	Total N (%)
Male	416 (94.13%)	12 (2.71%)	0 (0)	7 (1.58%)	7 (1.58%)	442 (100%)
Female	299 (92%)	12(3.69%)	0 (0)	10 (3.07%)	4 (1.24%)	325 (100%)
'p' value	**0.012***	0.200	0.78	**0.05***	1.62	

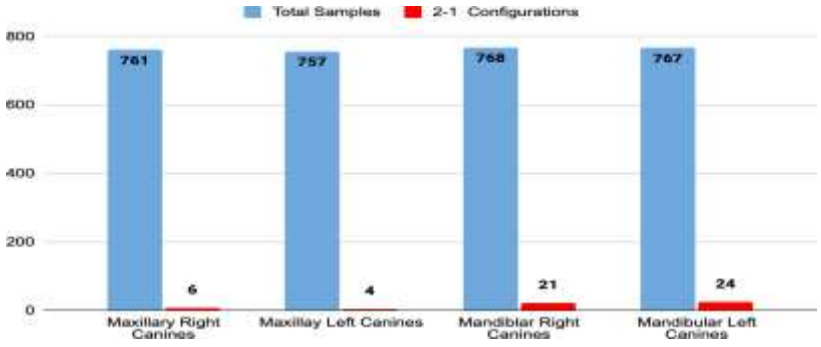
Table 3: Comparison among Male and Female (ANOVA)

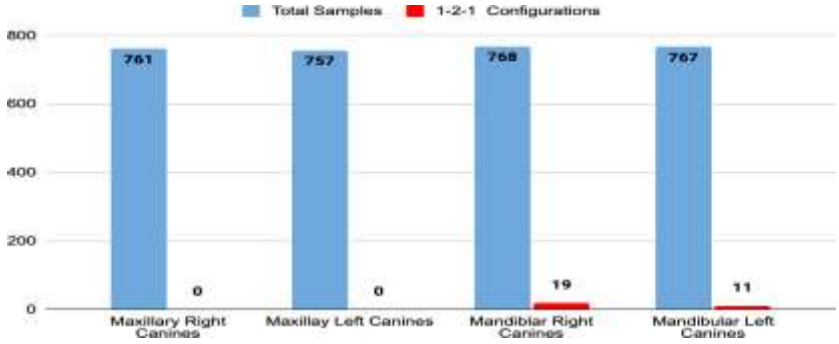
	Maxillary Right Canine	Maxillary Left Canine	Mandi bular Right Canine	Mandi bular Left Canine	'p' Value
Male	442 (98.6 %)	439 (97.99 %)	443 (98.88 %)	442 (98.66 %)	**0.002***
Female	319 (97.55 %)	318 (97.24 %)	325 (99.38 %)	325 (99.38 %)	











Total 775 samples (448 males & 327 females) were evaluated by a single operator. The most common canal configuration was 1-1 in both maxillary and mandibular canines (97.76 % maxillary right canines, 98.15 % maxillary left canines, 91.14 % mandibular right canines, 93.22 % mandibular left canines). In maxillary right canines 1.31 % of samples (10) showed 1-2 configuration, 0.8 % (6) samples showed 2-1 configuration, 0.13 % of samples showed 2-2 configuration. 0.92 % (7), 0.53 %(4), 0.4 % (3) samples of maxillary left canines showed 1-2,2-1 and 2-2 configurations respectively.

No samples of maxillary canines showed 1-2-1 configuration. 3.25 % mandibular right canines showed 1-2 configuration followed by 2-1 (2.71%),1-2-1 (2.5 %) and 2-2 (0.4%) configurations. In mandibular left canines after 1-1 configuration; 2-1 configuration was seen in 3.12%of samples followed by 1-2 (2.23%) and 1-2-1 (1.43%) configurations. No sample showed 2-2 configuration in mandibular left canines. 98.1% , 97.2 % of males and females respectively showed 1-1 canal configurations in maxillary right canines. 98.61% , 97.48 % of males and females respectively showed 1-1 canal configurations in maxillary left canines. In case of mandibular right canines 92.55% males and 89.23 % females showed 1-1 canal configurations. In case of mandibular left canines 94.13% males and 92 % females showed 1-1 canal configurations. This study revealed that canal variations are more common in mandibular canines compared to maxillary canines and canal variations are more common in the right side compared to left side and more common in females compared to males.

Discussion

The present study was designed and conducted to evaluate the canal configurations of permanent canines in the central Gujarat population in order to provide the dentist with understanding of the root canal morphology to be expected during clinical treatment. Based on Vertucci's classification; results of our study revealed that the prevalence of root canal variation was different in maxillary and mandibular canines on the right and left side. During root canal treatment to avoid the possibility of a missed canal and postoperative complications thorough understanding of the root canal configurations of permanent canines is crucial as the possible cause of failure of endodontic therapy is missed root canal as well as an unobturated canals. A study carried out by costa FF et al (2019) concluded that 82.6% of the teeth with missed canals were associated with periapical lesions.[7]

Another research performed by Baruwa AO et al (2020) revealed that the frequency of post treatment apical periodontitis in the teeth with at least one untreated canal was 98 %.[8]

Hence before initiating any endodontic procedure to minimize the possibility of missed canals; clinicians should be completely aware of the root canal anatomy and configurations, with their possible variations. Systemic review and meta-analysis conducted by Thomas Gerhard Wolf et al (2024) reported that in maxillary canines most common canal configuration was Vertucci's I(1-1) with a frequency of 75.4-100%. The second most common Root Canal Configuration in Maxillary Canine is 2-1 also known as Vertucci's II with 0.1 – 20% and the following common Root Canal Configuration with frequency up to 11.6% is Vertucci's III (1-2-1).

Results of our study revealed that 1-1 Canal configuration is more common in maxillary left canines (98.15%) compared to maxillary right canines (97.76%). In Nepalese populations (2012) Kriti Shrestha et al investigated that canal configurations of mandibular canines showed high prevalence for Type I (1-1) i.e. 85.6% followed by Type II (2-1) 4.6%, Type V (1-2) 3.8%, Type III (1-2-1) 3.5% with least in Type IV 2.5%(n=19) which coincides with the results of our study. They also revealed that male had a higher prevalence of two roots (5.1%) than females (4.9%)[9] Our study showed that in mandibular canines 1-1 configuration is more common in mandibular left canine (93.22%) compared to mandibular right canine (91.14%). 2.5% ,1.43% cases of mandibular right canines and left canines respectively show 1-2-1 configurations. While no samples show 1-2-1 configurations in maxillary canines. According to Vertucci's classification, Type I canal configurations was more frequent (78%) than the other canal configurations and it coincides with other studies where the prevalence of Type I was reported to be 80.39% in Turkish,95.4% in the Hamadani population in Iran, and 92% in the South Asian Indian population, 81.5% in Mexican population,[10] One study carried out by Azhar Iqbal et al in 2022 for assessment of root canal variations in permanent maxillary and mandibular anterior teeth in Saudi subpopulation concluded that permanent mandibular canines have complex root and canal which also coincided with our study.[11]

Another study performed in the Turkish population by Semih Sert et al in 2004 reported that 93.48 %of maxillary canines showed 1-1 configurations, 4.38 % showed
1-2-1 configurations, 2.17 % showed 1-2 canal configurations. They also reported that 91 out of 100 males and 96 out of 100 females showed 1-1 canal configurations in maxillary canines. In the case of mandibular canines 65 and 56 out of 100 males & females respectively showed 1-1 configurations which coincide with our findings.[12] In a study done by Mohsen Aminsobhani et al (2013) for the evaluation of the root and canal morphology of permanent mandibular anterior teeth in an Iranian population reported that 96.3 %,4.7 % of permanent mandibular canines showed one and two roots respectively & 71.8 % of mandibular canines had one canal while 28.2 % of mandibular canines had two canals and least prevalent Vertucci canal configuration was type 5 (2.3 %).[13] Julia Yen Yee Pan et al (2019) reported that 6.1 % of mandibular canines showed two canals in Malaysia subpopulation.[14] In our study 0.4 % of mandibular right canines showed 2-2 configurations. Roshan PEIRIS et al (2007) carried out

study on Sri Lankan and Japanese population revealed that in both populations, mandibular canine teeth typically presented with a single canal (type I), the presence of type III canal form was detected in 17.2% of Sri Lankan and in 4.7% of Japanese teeth & there is a lower frequency of occurrence of mandibular canines with two canals in East Asian populations.[15] Our study also revealed that most common canal configuration was 1-1 in both maxillary and mandibular canines.

Vertucci (1984) done study in an American Caucasian population reported the incidence of two canals to be 22.0% for mandibular canines. In our study 0.4 % of mandibular canines showed two separate canals. Deepa Venkatesh et al (2022) conducted investigation in south indian population found that 2.8% of the cases on the right side and 2.6% of cases on the left side had a second canal in mandibular canine which coincides with our study.[16] A study for the assessment of Root canal morphology of anterior permanent teeth in Jordanian population performed by Nessrin A Taha et al (2024); concluded that canal variations in permanent canines are more common in females compared to males which also coincide with our study.[17] Kayaglu et al. (2015) conducted a study in Turkish population concluded that canines with two canals are more common in females than in males.[18] A Study in Portuguese subpopulation carried out by Martinns et al (2018) reported findings that coincide with our finding that females have considerably more roots and Root Canals in mandibular canines than males.[19]

In the Syrian population; Doumani et al (2020) investigated that females were more predominant with double rooted mandibular canines.[4] On the contrary, Soleimani et al carried out study in iranian population (2017) reported that mandibular canines with two roots and two canals are much more common in male than in females.[5]

Conclusion

The presence of Type I canal configuration mostly seen in the Central Gujarat population with higher frequency in maxillary canines compared to mandibular canines and more in males compared to females.

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