Original Article
DOI: 10.22037/jds.v37i4.30466
ISSN 2645-4351

Cone-Beam Computed Tomography Study of the Root and Canal Morphology of Maxillary and Mandibular Canines Regarding Gender and Age in an Iranian Population

Mandana Naseri [a], Nazanin Zargar [b], Alireza Akbarzadeh Baghban [c], Yaser Safi [d], Sepideh Rahimian [e], Zahra Rayeji [f], Fatemeh Soltaninejad [g]

[a]Associate Professor, Dept. of Endodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[b]Assistant Professor, Dept. of Endodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[c]Professor, Proteomics Research Center, Dept. of Biostatistics, School of Allied Medical Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[d]Associate Professor, Dept. of Oral & Maxillofacial Radiology, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[e]Oral and Maxillofacial Radiologist, Tehran, Iran.
[f]Dentist, Tehran, Iran.
[g]Postgraduate Student, Dept. of Endodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
Correspondence to Fatemeh Soltaninejad (email: fsoltani69@gmail.com).
(*Submitted: 17 May 2020 – Revised version received: 26 August 2020 – Accepted: 31 August 2020– Published online: Fall 2020*)

Objectives Canine teeth are supposed to have one single root canal, but they may have some anatomical variations. This study aimed to investigate the morphology of root canals of maxillary and mandibular canines regarding gender and age in an Iranian population using cone-beam computed tomography (CBCT).

Methods Using CBCT images, 126 maxillary and 125 mandibular canines were evaluated. Root anatomy was assessed regarding root length, root curvature, number of roots and canals, and pattern of root canal system. The data were analyzed by the Kruskal Wallis and Mann-Whitney tests and multinomial regression model.

Results The mean root length of male patients was significantly higher than females (p=0.0001). The most frequent root curvatures were towards the distal and buccal. Mandibular teeth (p=0.020) and females (p=0.012) had higher frequency of root curvature. All maxillary canines had one root; whereas 1.6% of mandibular canines had two roots. High prevalence of two canals was reported (34.9% of maxillary and 18.4% of mandibular canines). The most prevalent canal patterns included type I (65.1%) followed by type III (34.9%) in maxillary canines and types I (81.6%), III (16.8%) and V (1.6%) in mandibular canines. Higher frequency of type III canal configuration was reported in maxillary teeth (p=0.001) and male patients (p=0.008). No significant difference was found in any parameter between different age groups (p>0.05).

Conclusion A high percentage of type III canal configuration in canine teeth especially maxillary canines and male patients was reported. Mandibular teeth and females had higher frequency of root curvature.

Keywords Anatomy; Cuspid; Cone-Beam Computed Tomography; Tooth Root

Introduction

Root canal treatment success requires a thorough knowledge about the root canal morphology and its variations pertaining to every tooth regarding age, race, gender, and population.[1-3]

Various methods have been used for analyzing root canal anatomy such as sectioning[4], staining and clearing techniques[5, 6], conventional radiography[7], contrast medium-enhanced radiography[8], and more recently cone-beam computed tomography (CBCT)[9] and micro-CT.[10]

CBCT, as a noninvasive three-dimensional imaging technique, has various applications in endodontics such as assessment of periapical periodontitis, vertical root fractures, outcome of root canal treatment, root canal anatomy and morphology, traumatic dental injuries, management of root resorption, and pre-surgical evaluation.[11-13] Staining and clearing technique as the classic standard for in vitro assessment of the morphology of root canals has some drawbacks such as high technical sensitivity and being time consuming. CBCT and the clearing technique have acceptable agreement for evaluation of root and canal morphology of teeth.[14] Micro-CT can provide detailed information about the root canal anatomy and morphology through individual three-dimensional reconstruction of images[15], but disadvantages such as increased scanning duration, high radiation dose, and size constraints make it unsuitable for clinical use.[16] Although the resolution of CBCT is lower than that of micro-CT, both have high consistency in identifying the root canal morphology of the teeth.[17] Therefore, CBCT is considered as a suitable clinical tool for assessment of root canal morphology and has various applications in endodontics.

Canine teeth are referred to as the cornerstone of dental arch, because of their important role in masticatory function, stability of dental arch, and natural facial expression.[18] Single-rooted canines are usually supposed to have one single root canal, but recently researchers showed variations in root canal anatomy of them.[19-21] Some studies

have evaluated the morphology of canines in the Iranian population[20, 22-24] but to the best of our knowledge, no study has compared variations of maxillary and mandibular canines in an Iranian population. Thus, this study aimed to investigate the morphology of root canals of maxillary and mandibular canines regarding age and gender in an Iranian population using CBCT.

Materials and Methods

This cross-sectional study investigated CBCT images of 100 patients referred to a radiology clinic in Tehran, Iran (ethical approval code: IR.SBMU.RIDS.REC.1395.389). These images had been obtained for various reasons and had been archived in the dental imaging center along with the data such as the patients' age and gender. The current study evaluated CBCT images of 251 canine teeth including 126 maxillary canines [44 (35%) teeth of male and 82 (65%) teeth of female patients) and 125 mandibular canines (53 teeth (42%) of male and 72 (58%) teeth of female patients).

Images were selected according to the following criteria: fully erupted teeth and mature apices, absence of apical periodontitis, no internal/external root resorption or attrition, no root canal fillings, coronal restorations, root fracture, or cracks.

The CBCT images were taken using NewTom VGi CBCT scanner (QR SRL Company, Verona, Italy) at 90 kVp with 8×11 cm field of view, 200 µm voxel size, and exposure time of 3.6 s, and were analyzed with NewTom NNT software version 5.6 (Quantitative Radiology, Verona, Italy). Serial axial, coronal, and sagittal views of CBCT images were examined by rolling the toolbar from the incisal edge to the apex by an endodontist and a radiologist independently, and any disagreement between them was discussed until a consensus was achieved. The following anatomical features were recorded: anatomical length of root from the cementoenamel junction to the apex in the sagittal plane, root curvature in the coronal and sagittal planes, and number of roots and number of canals and their configurations according to the Vertucci's classification (5) in the axial plane. Demographic information such as patients' age and gender was also recorded.

The Mann-Whitney and Kruskal Wallis tests were used to analyze the differences in root length by gender and age, respectively. Multinomial regression model was used to analyze the root curvature, number of canals and canal configuration and their correlation with gender and age.

Statistical analysis was performed using SPSS software version 22.0 (SPSS Inc., Chicago, IL, USA). The significance level was set at 0.05.

Results

Two-hundred and fifty-one CBCT images of maxillary and mandibular permanent canines of 100 patients met the criteria, including 50 female and 50 male patients with a mean age of 27.3 years (range 13-57 years).

Root length:

The mean root length of maxillary canines was 16.4 mm and 17.8 mm in female and male patients, respectively. In mandibular canines, these numbers were 14.9 mm for females and 16.3 mm for males (Table 1). The mean root length in maxillary and mandibular canines of male patients was significantly higher than female patients (P=0.0001). The root length was 16.6-17.2 mm and 15.2-15.8 mm in maxillary and mandibular canines, respectively (Table 2).

Table 1- Root length according to gender (mm)

Jaw	Gender	Number	Mean	SD
Maxilla	Male	44	17.8	1.4
	Female	82	16.4	1.7
Mandible	Male	53	16.3	1.7
	Female	72	14.9	1.1

Table 2- Root length according to age groups in mm

Jaw	Age group	Number	Mean	SD	Confidence Interval	
					Lower Bound	Upper Bound
Maxilla	13-25	6	17.9	0.6	17.3	18.6
	25-35	47	17.4	1.9	16.8	17.9
	35-45	35	16.8	1.6	16.2	17.4
	45-55	23	16.2	1.2	15.6	16.7
	55<	15	16.4	2.1	15.2	17.6
	total	126	16.9	1.7	16.6	17.2
Mandible	13-25	34	15.7	1.5	15.2	16.3
	25-35	29	15.6	1.8	14.9	16.3
	35-45	29	15.7	1.5	15.1	16.2
	45-55	18	15.0	1.4	14.3	15.7
	55<	15	15.1	1.0	14.5	15.7
	Total	125	15.5	1.5	15.2	15.8

Prevalence of root curvature:

Based on the multinomial regression model, in coronal view, most of the roots were straight (Table 3). The curvature of roots had no correlation with gender (p=0.414) but had a significant correlation with the jaw, as mandibular teeth showed higher frequency of curvatures (p=0.020). The prevalence of mesial and distal curvatures was 7.2% and 17.6% in mandibular teeth and 0.8% and 16.7% in maxillary teeth, respectively (Figure 1-B).

In the sagittal plane, most of the roots had no curvature (Table 4). The curvature of the roots had no correlation with the jaw (p=0.118) but had a significant correlation with gender, as females had higher frequency of root curvatures (p=0.012). The frequency of buccal and lingual curvatures

was 16.2% and 2.6% in female and 5.2% and 2.1% in male patients, respectively (Figure 1-A).

The most frequent root curvatures were towards the distal (17.1%) and buccal (12.0%). No significant difference was found in the root curvature between different age groups (p>0.05).

Number of roots:

All maxillary canines in male and female patients had one root; whereas, mandibular canines in 1.9% of males (one out of 53) and 1.4% of females (one out of 72) had two roots (Figure 1-C).

Canal number and pattern according to the Vertucci's classification:

Of 126 maxillary canines, 44 (34.9%) had two canals, and of 125 mandibular canines, 23 (18.4%) had two canals and the remaining had one canal (Table 5).

In the maxilla, 65.1% of teeth were type I (1-1) and 34.9% were type III (1-2-1) (Figure 2-A, B). In mandibular canines, type I (1-1) canal configuration was the most common (81.6%), followed by type III (1-2-1) (16.8%) and type V (1-2) (1.6%) (Figure 2-C, 2-D and Figure 3). Other types were not detected (Table 5). Type V canal configuration was reported in only two teeth. Thus, for analyzing the correlation between the type of canal, gender, jaw and age, Type V was excluded from the analysis (Table 6). According to multinomial regression model, significant differences were noted in terms of canal configuration regarding gender (p=0.008) and jaw (p=0.001), as higher frequency of type III canal configuration was reported in maxillary teeth and in male patients (Table 6). No significant difference was noted for canal number and pattern in different age groups (p=0.399).

Table 3- Root curvature in coronal views according to gender and jaw (%)

Jaw	Gender	Without curvature	Mesial	Distal	Total
Maxilla	Male	40 (90.9)	0 (0.0)	4 (9.1)	44
	Female	64 (78.0)	1 (1.2)	17 (20.7)	82
	Total	104 (82.5)	1 (0.8)	21 (16.7)	126
Mandible	Male	39 (73.6)	5 (9.4)	9 (17.0)	53
	Female	55 (76.4)	4 (5.6)	13 (18.1)	72
	Total	94 (75.2)	9 (7.2)	22 (17.6)	125
Total	Male	78 (81.3)	5 (5.2)	13 (13.5)	96
	Female	119 (77.3)	5 (3.2)	30 (19.5)	154
	Total	198(78.9)	10 (4.0)	43 (17.1)	251

Table 4- Root curvature in sagittal views according to gender and jaw (%)

Jaw	**Gender**	**Without curvature**	**Buccal**	**Lingual**	**Total**
Maxilla	Male	42 (95.5)	2 (4.5)	0 (0.0)	44
	Female	71 (86.6)	9 (11.0)	2 (2.4)	82
	Total	113 (89.7)	11 (8.7)	2 (1.6)	126
Mandible	Male	48 (90.6)	3 (5.7)	2 (3.8)	53
	Female	54 (75.0)	16 (22.2)	2 (2.8)	72
	Total	102 (81.6)	19 (15.2)	4 (3.2)	125
Total	Male	90 (92.8)	5 (5.2)	2 (2.1)	97
	Female	125 (81.2)	25 (16.2)	4 (2.6)	154
	Total	215 (85.7)	30 (12,0)	6 (2,4)	251

Table 5- Number of canals and canal configurations according to gender

		Number of canals and canal configurations (%)			
Jaw	**Gender**	**One canal**	**Two canals**		**Total**
		Type I (1-1)	Type III (1-2-1)	Type V (1-2)	
Maxilla	Male	21 (47.7)	23 (52.3)	0 (0.0)	44
	Female	61 (74.4)	21 (25.6)	0 (0.0)	82
	Total	82 (65.1)	44 (34.9)	0 (0.0)	126
Mandible	Male	42 (79.2)	10 (18.9)	1 (1.9)	53
	Female	60 (83.3)	11 (15.3)	1 (1.4)	72
	Total	102 (81.6)	21 (16.8)	2 (1.6)	125

Table 6- Canal configurations according to gender and jaw

		Canal configuration, n (%)		**Total**
		Type I (1-1)	**Type III (1-2-1)**	
Gender	Male	63 (65.6)	33 (34.4)	96
	Female	121 (79.1)	32 (20.9)	153
Jaw	Maxilla	82 (65.1)	44 (34.9)	126
	Mandible	102 (82.9)	21 (17.1)	123

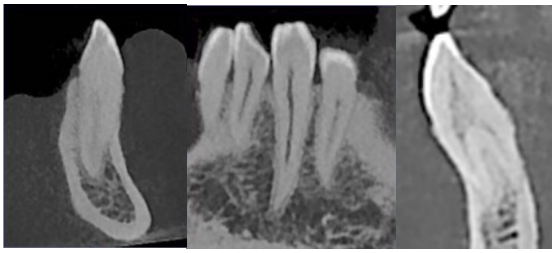

Figure 1- (A) Root curvature of mandibular canine teeth in the coronal plane (mesial); (B) sagittal view (buccal), (C) Two roots in a

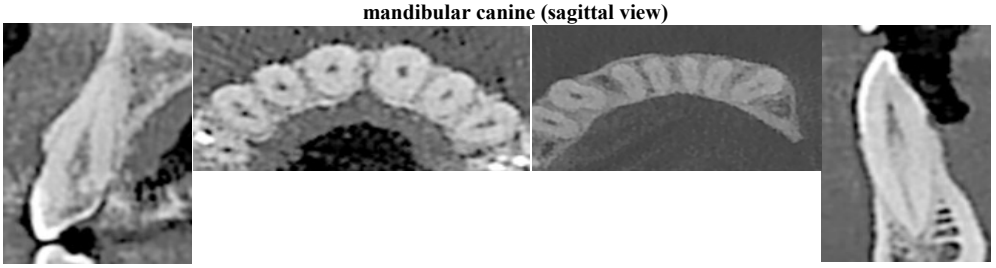

Figure 2- Type III canal configuration (A) in maxillary canine; sagittal, (B) axial view, (C) in mandibular canine; axial, (D) sagittal view

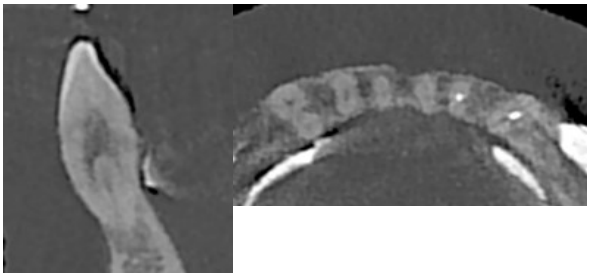

Figure 3- Type V canal configuration in mandibular canine: (A) sagittal, (B) axial view

Discussion

Thorough knowledge about the tooth morphology and careful interpretation of radiographs are essential for successful root canal treatment.[25] In this study, root canal anatomy of maxillary and mandibular canines of an Iranian population was evaluated using CBCT, in order to gain adequate knowledge for proper cleaning and shaping of these teeth.

The results of root length assessment of maxillary canines revealed a mean length of 16.4 mm and 17.8 mm for female and male patients, respectively. The anatomical literature shows a mean root length of 16.5 mm for maxillary canines without mentioning the effect of gender.[26] This value was 14.9 mm for females and 16.3 mm for males in mandibular canines, which was in agreement with the mean root length of 15.9 mm stated in the literature without mentioning the effect of gender[26] and in an Iranian study by Soleymani et al.[23] But the results of another Iranian study showed somehow different results from our study[22] with a slightly higher mean root length in these teeth, which may be due to different ethnicities from different parts of the country. The mean root length of both canines of male patients was significantly higher than female patients which was in line with the findings of other studies.[2, 22, 23]

In the coronal and sagittal views, most of the roots were straight similar to other studies.[20, 23, 26]

The curvature of the roots had no significant correlation with gender in the coronal view (p=0.414), but it had a significant correlation in the sagittal plane (p=0.012). Other studies found no significant difference between male and female patients in mandibular canine teeth in both planes.[20, 23] The current study found the most prevalent root curvature to be towards distal and buccal, which was in agreement with other studies.[20, 23, 27]

All maxillary canines had one root; whereas 1.6% of mandibular canines had two roots. The prevalence of double-rooted mandibular canines in the present study was in accordance with the results obtained from previous studies (0.3% to 4.7%).[20, 22, 23]

In the present study, high frequency of two canals was reported for canine teeth (34.9% of maxillary and 18.4% of mandibular teeth) with type III canal configuration as the most prevalent type of two canals (34.9% of maxillary and 16.8% of mandibular canine teeth). For maxillary canine teeth, a range of 1.4%-17.2% of two canals was reported in other studies, while some of them claimed type III canals to be the most prevalent type after type I canal configuration (11.6%).[28-31] The range of two canals reported for mandibular canine teeth is 3%-33% with different prevalence of canal configurations.[20, 22, 23, 30-33] Amardeep et al.[30] reported 17.2% and 20.4% prevalence of two canals in maxillary and mandibular canines, respectively with type III canal as the most prevalent configuration (11.6% and 13.6% of maxillary and mandibular teeth, respectively).[30] Two Iranian studies showed type III canal as the highest percentage of two canals in mandibular canine teeth.[23, 34] All the above-mentioned studies confirm the results of the present study. Higher percentage of two canals and type III canal configuration in this study may be due to the selected population and shows the need for more attention during root canal treatment of canine teeth in the Iranian population.

In this study, significant differences were noted in terms of the number and pattern of root canals regarding gender (p=0.008) and jaw (p=0.001). Nikkerdar et al.[24] found a significant correlation between gender and type of canal of maxillary canines (P=0.005) (24) although Aminsobhani et al,[20] and Soleymani et al.[23] did not find any significant difference between male and female patients in terms of

canal type (p>0.05).

Age had no significant correlation with root length, root curvature, number of roots and canals, and pattern of root canal system (p>0.05), which was consistent with the results obtained in previous studies.[2, 22, 35]

Conclusion

High percentage of type III canal configuration in canine teeth requires more attention in access cavity preparation and locating the canals, especially in maxillary canines and male patients. Higher frequency of root curvature in mandibular teeth and female patients highlights the need for higher precision in cleaning and shaping of the root canals.

Conflict of Interest

None Declared ■

References

1. Sert S, Bayirli GS. Evaluation of the root canal configurations of the mandibular and maxillary permanent teeth by gender in the Turkish population. Journal of endodontics. 2004 Jun;30(6):391-8.
2. Naseri M, Safi Y, Baghban AA, Khayat A, Eftekhar L. Survey of anatomy and root canal morphology of maxillary first molars regarding age and gender in an Iranian population using cone-beam computed tomography. Iranian endodontic journal. 2016 Fall;11(4):298.
3. Trope M, Elfenbein L, Tronstad L. Mandibular premolars with more than one root canal in different race groups. Journal of Endodontics. 1986 Aug;12(8):343-5.
4. Weine FS, Healey HJ, Gerstein H, Evanson L. Canal configuration in the mesiobuccal root of the maxillary first molar and its endodontic significance. Oral Surgery, Oral Medicine, Oral Pathology. 1969 Sep;28(3):419-25.
5. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral surgery, oral medicine, oral pathology. 1984 Nov;58(5):589-99.
6. Kuzekanani M, Haghani J, Nosrati H. Root and canal morphology of mandibular third molars in an Iranian population. Journal of dental research, dental clinics, dental prospects. 2012 Summer;6(3):85.
7. Pineda F, Kuttler Y. Mesiodistal and buccolingual roentgenographic investigation of 7,275 root canals. Oral Surgery, Oral Medicine, Oral Pathology. 1972 Jan;33(1):101-10.
8. Fan B, Gao Y, Fan W, Gutmann JL. Identification of a C-shaped canal system in mandibular second molars—part ii: the effect of bone image superimposition and intraradicular contrast medium on radiograph interpretation. Journal of endodontics. 2008 Feb;34(2):160-5.
9. Zheng Q-h, Wang Y, Zhou X-d, Wang Q, Zheng G-n, Huang D-m. A cone-beam computed tomography study of maxillary first permanent molar root and canal morphology in a Chinese population. Journal of endodontics. 2010 Sep;36(9):1480-4.
10. Plascencia H, Cruz Á, Palafox-Sánchez C-A, Díaz M, López C, Bramante C-M, et al. Micro-CT study of the root canal anatomy of maxillary canines. Journal of clinical and experimental dentistry. 2017 Oct;9(10):e1230.
11. Kiarudi AH, Eghbal MJ, Safi Y, Aghdasi MM, Fazlyab M. The applications of cone-beam computed tomography in endodontics: a review of literature. Iranian endodontic journal. 2015 Winter;10(1):16.
12. Durack C, Patel S. Cone beam computed tomography in endodontics. Brazilian dental journal. 2012;23(3):179-91.
13. Patel S, Durack C, Abella F, Shemesh H, Roig M, Lemberg K. Cone beam computed tomography in endodontics–a review. International endodontic journal. 2015 Jan;48(1):3-15.
14. Naseri M, Ahangari Z, Bagheri N, Jabbari S, Gohari A. Comparative accuracy of cone-beam computed tomography and clearing technique in studying root canal and apical morphology of mandibular canines. Iranian Endodontic Journal. 2019;14(4):271-7.
15. Vier-Pelisser FV, Dummer PMH, Bryant S, Marca C, Só MVR, Figueiredo JAPd. The anatomy of the root canal system of three-rooted maxillary premolars analysed using high-resolution computed tomography. International endodontic journal. 2010 Aug;43(12):1122-31.
16. Domark JD, Hatton JF, Benison RP, Hildebolt CF. An ex vivo comparison of digital radiography and cone-beam and micro computed tomography in the detection of the number of canals in the mesiobuccal roots of maxillary molars. Journal of endodontics. 2013 Jul;39(7):901-5.
17. Zhang D, Chen J, Lan G, Li M, An J, Wen X, et al. The root canal morphology in mandibular first premolars: a comparative evaluation of cone-beam computed tomography and micro-computed tomography. Clinical oral investigations. 2017 May;21(4):1007-12.
18. Ash M, Nelson S. The permanent canines: maxillary and mandibular. Wheeler's Dental Anatomy, Physiology, and Occlusion. 2007:191-214.
19. Versiani M, Pécora J, Sousa-Neto M. Microcomputed tomography analysis of the root canal morphology of single-rooted mandibular canines. International Endodontic Journal. 2013 Sep;46(9):800-7.
20. Aminsobhani M, Sadegh M, Meraji N, Razmi H, Kharazifard MJ. Evaluation of the root and canal morphology of mandibular permanent anterior teeth in an Iranian population by cone-beam computed tomography. Journal of Dentistry (Tehran, Iran). 2013 May;10(4):358.
21. Martins JN, Marques D, Silva EJNL, Caramês J, Versiani MA. Prevalence Studies on Root Canal Anatomy Using Cone-beam Computed Tomographic Imaging: A Systematic Review. Journal of endodontics. 2019 Apr;45(4):372-386.e4.
22. Haghanifar S, Moudi E, Bijani A, Ghanbarabadi MK. Morphologic assessment of mandibular anterior teeth root canal using CBCT. Acta medica academica. 2017 Nov;46(2).
23. Soleymani A, Namaryan N, Moudi E, Gholinia A. Root canal morphology of mandibular canine in an Iranian population: a CBCT assessment. Iranian endodontic journal. 2017 Winter;12(1):78.
24. Nikkerdar N, Asnaashari M, Karimi A, Araghi S, Seifitabar S, Golshah A. Root and Canal Morphology of Maxillary Teeth in an Iranian Subpopulation Residing in Western Iran Using Cone-beam Computed Tomography. Iranian Endodontic Journal. 2020 Winter;15(1):31-7.
25. Vertucci FJ, Haddix JE. Tooth morphology and access cavity preparation. In Cohen's pathways of the pulp 2011 Jan 1 (pp. 136-222). Mosby.
26. Versiani MA, Pereira MR, Pécora JD, Sousa-Neto MD. Root Canal Anatomy of Maxillary and Mandibular Teeth. The Root Canal Anatomy in Permanent Dentition: 2019 Springer. p. 181-239.
27. Versiani MA, Carvalho KK, Mazzi-Chaves JF, Sousa-Neto MD. Micro–computed Tomographic Evaluation of the Shaping Ability of XP-endo Shaper, iRaCe, and EdgeFile Systems in Long Oval-shaped Canals. Journal of endodontics. 2018 Mar;44(3):489-95.
28. Martins J, Marques D, Mata A, Caramês J. Root and root canal morphology of the permanent dentition in a Caucasian population: a cone-beam computed tomography study. International endodontic journal. 2017 Nov;50(11):1013-26.
29. Jain P, Balasubramanian S, Sundaramurthy J, Natanasabapathy V. A cone beam computed tomography of the root canal morphology of maxillary anterior teeth in an institutional-based study in Chennai urban population: an in vitro study. Journal of

International Society of Preventive & Community Dentistry. 2017 Oct;7(Suppl 2):S68.
30. Somalinga Amardeep N, Raghu S, Natanasabapathy V. Root canal morphology of permanent maxillary and mandibular canines in Indian population using cone beam computed tomography. Anatomy research international. 2014;2014.
31. Altunsoy M, Ok E, Nur BG, Aglarci OS, Gungor E, Colak M. A cone-beam computed tomography study of the root canal morphology of anterior teeth in a Turkish population. European journal of dentistry. 2014 Jul;8(3):302.
32. Zhao Y, Dong Y, Wang X, Wang Z, Li G, Liu M, et al. Cone-beam computed tomography analysis of root canal configuration of 4 674 mandibular anterior teeth. Beijing da xue xue bao Yi xue ban= Journal of Peking University Health sciences. 2014 Feb;46(1):95-9.
33. Beshkenadze E, Chipashvili N. Anatomo-morphological features of the root canal system in Georgian population–cone-beam computed tomography study. Georgian Med News. 2015 Oct;247:7-14.
34. Vaziri PB, Kasraee S, Abdolsamadi HR, Abdollahzadeh S, Esmaeili F, Nazari S, et al. Root canal configuration of one-rooted mandibular canine in an Iranian population: An in vitro study. Journal of dental research, dental clinics, dental prospects. 2008 Winter;2(1):28.
35. Schroeder H. Age-related changes in the pulp chamber and its wall in human canine teeth. Schweizer Monatsschrift fur Zahnmedizin= Revue mensuelle suisse d'odonto-stomatologie= Rivista mensile svizzera di odontologia e stomatologia. 1993;103(2):141-9.

How to cite:
Mandana Naseri, Nazanin Zargar, Alireza Akbarzadeh Baghban, Yaser Safi, Sepideh Rahimian, Zahra Rayeiji, Fatemeh Soltaninejad. Cone Beam Computed Tomography Study of the Root and Canal Morphology of Maxillary and Mandibular Canines Regarding Gender and Age in an Iranian Population. J Dent Sch 2019;37(4):131-136.