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Mandibular Anterior Root Morphology in an Indian Population: A Cone Beam Computed Tomographic Study

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ABSTRACT

Aim: The aim of this study was to ascertain the root canal morphology of the mandibular anterior teeth in an Indian (odisha) population by examining cone-beam computed tomography (CBCT) images.

Materials and Method: CBCT images of 240 females and 240 males with a mean age of ranging from 14 to 70 years were examined in this study. A total of 912 mandibular central incisors, 940 mandibular lateral incisors, and 808 mandibular canines were examined. The number of root canals and their canal configurations were determined and then were classified according to Vertucci's classification.

Statistical Analysis: The data were analyzed using Chi-square test (SPSS software ,Version 17.0; SPSS Inc., Chicago, IL, USA.)

Results: The Type 1 canal configuration was most prevalent (76.38-92.08 %) In the mandibular anterior teeth. The Types 2, 3, 4, and 5 canal configurations were observedwithin a range of 1.49-2.98%, 0.99-3.83%, 1.49-4.04% and 3.96- 14.69% respectively. The prevalence of two canals was higher in females than in males.

Conclusions: In the studied population of odisha (india), it was observed that the mandibular anterior teeth predominantly had type I root canal configuration and type V configuration predominantly in teeth with two canals. The chances of encountering two canals was higher in mandibular lateral incisors and in females though these results were not statistically significant.

Keywords: Mandibular anterior teeth, cone-beam computed tomography, endodontics, root canal morphology.

INTRODUCTION

The cardinal rule for predictable success in root canal treatment is to clean and seal the entire root canal system. Endodontic failure primarily occurs if there is presence of a variability in the root canal system that has missed the eye and thus has not been cleaned and sealed. The incidence of variable root canal morphology is gaining more prominence due to advances in diagnostic technology. It is presumed that single rooted teeth would have single canal, especially the anterior teeth but studies have shown contrary results[1]. The incidence of two canals in anteriors was first reported by Rankine and Henry in 1965[2]. Several studies since then have shown a range of 0.3% [3] to 55.9%[4] in the incidence of two canals in mandibular anteriors. This variability can be correlated to sex, ethnicity or race of the individual or population[5].

The means employed to assess the root canal morphology include - tooth sectioning, canal staining and tooth clearing technique, modified canal staining and tooth clearing technique, SEM

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examination, stereomicroscopic examination, In vivo examination of the pulpal floor with surgical microscope, conventional radiographic techniques and more recently the use of CBCT [1,6]. CBCT as a diagnostic tool is gaining impetus as majority of other diagnostic tools are destructive and the conventional radiographic techniques though are non invasive but still are a two dimensional representation of a three dimensional structure and thus might obscure certain details[5]. CBCT was introduced in 1990 and its growth in popularity is due to the high image resolution, low radiation dose as compared to conventional CT , ability to study the image in different angles and three dimensional reconstruction of the image[7,8].

Many studies have been conducted amongst various populations to study the root canal morphology of teeth using different methods[1,6]. A literature search revealed that a CBCT evaluation of the root canal morphology in an indian population has not been done. The purpose of the present study was to assess the root canal morphology of mandibular anterior teeth in an indian population using CBCT.

MATERIALS AND METHODS

Cone-beam computed tomography images using a CBCT imaging system (Myray, NNT software, Italy) at 90 kVp, 8 mA with an exposure time of 9 secs and voxel size of 0.3 mm were obtained from the department of Oral and Maxillofacial Radiology , Kalinga institute of dental sciences, Bhubaneswar, India between january 2014 and january 2015. CBCT images of 240 women and 240 men were examined with a mean age ranging from 14 to 70 years. A total of 912 mandibular central incisors, 940 mandibular lateral incisors, and 808 mandibular canines were analyzed from the database. Images of patients with fully erupted permanent mandibular anterior teeth or those containing at least one mandibular permanent incisor and with teeth having fully formed apices and no root canal fillings, posts, or crown restorations and no signs of root resorption were only selected. Tomography sections of 0.3 mm axial planes was obtained and the axial CBCT images were examined by carefully rolling the toolbar from the incisal edge to the root apex. Two examiners assessed all the images separately, and any disagreement between them was discussed until a consensus was reached. Examination of results was done using the Wilcoxon matched paired signed-rank test. The number of root canals and the canal configurations were classified according to Vertucci's classification. The data were analyzed with Chi-square test. All statistical analyses were performed using SPSS (Version 17.0; SPSS Inc., Chicago, IL, USA) software.

RESULTS

The number of teeth evaluated are shown in table 1.The prevalence of the number of root canals in mandibular anterior teeth are shown in Table 2. The most prevalent root canal morphology in the mandibular anterior teeth was a single canal (75.74 - 94.55%) , followed by two canals (5.45-24.26%). The prevalence of two canals was higher in females than in males though the difference was not statistically significant. the mandibular lateral incisors showed highest prevalence of two canals(24.26%) and mandibular canine showed the least (5.45%). Table 3 shows the prevalence of the different canal configurations according to vertucci's classification of root canal morphology in the mandibular anterior teeth. The Type 1 canal configuration was the most prevalent (76.38-92.08 %). The Type 2 canal configuration was observed within the range of 1.49-2.98 %. The Type 3 canal configuration was observed within the range of 0.99-3.83 %. The Type 4 canal configuration was observed within the range of 1.49-4.04%, and the Type 5 canal configuration was observed within the range of 3.96- 14.69%. Type 6,7 and 8 canal configuration was not observed in the sample examined.

Table 1: Number of teeth evaluated

	Male	Female	Total
Central incisor	452	460	912
Lateral incisor	468	472	940
Canine	398	410	808
Total	1318	1342	2660
Chi-square=0.0492 P = 0.9769			

Table 2 : Root canal number of the mandibular anterior teeth *n* (%)

	No of canals	Male	%	Female	%	Total	%
Central incisor	1	368	81.42	354	76.96	722	79.17
	2	84	18.58	106	23.04	190	20.83
	Total	452	100.00	460	100.00	912	100.00
Chi-square= 2.7493 P = 0.0972							
Lateral incisor	1	350	74.79	362	76.69	712	75.74
	2	118	25.21	110	23.31	228	24.26
	Total	468	100.00	472	100.00	940	100.00
Chi-square= 0.4663 P = 0.4954							
Canine	1	380	95.48	384	93.66	764	94.55
	2	18	4.52	26	6.34	44	5.45
	Total	398	100.00	410	100.00	808	100.00
Chi-square= 1.2986 P = 0.2554							
Total	1	1098	83.31	1100	81.97	2198	82.63
	2	220	16.69	242	18.03	462	17.37
	Total	1318	100.00	1342	100.00	2660	100.00
Chi-square= 0.8333 P = 0.3614							

Table 3 : Root canal configurations of the mandibular anterior teeth *n* (%)

	Canal configurations	Male	%	Female	%	Total	%
Central incisor	1	364	80.53	348	75.65	712	78.07
	2	10	2.21	16	3.48	26	2.85
	3	8	1.77	12	2.61	20	2.19
	4	6	1.33	14	3.04	20	2.19
	5	64	14.16	70	15.22	134	14.69
Chi-square= 5.9433 P = 0.2036							
Lateral incisor	1	348	74.36	370	78.39	718	76.38
	2	12	2.56	16	3.39	28	2.98
	3	24	5.13	12	2.54	36	3.83
	4	18	3.85	20	4.24	38	4.04
	5	66	14.10	54	11.44	120	12.77
Chi-square= 6.5334 P = 0.1634							
Canine	1	374	93.97	370	90.24	744	92.08
	2	6	1.51	6	1.46	12	1.49
	3	4	1.01	4	0.98	8	0.99
	4	4	1.01	8	1.95	12	1.49
	5	10	2.51	22	5.37	32	3.96
Chi-square= 5.6783 P = 0.2254							

DISCUSSION

This study provides information on the root canal morphology of permanent mandibular anterior teeth in an indian subpopulation (odisha) using CBCT. Traditional In vivo diagnostic tool for evaluation of root canal morphology is the conventional periapical radiography technique. The major limitations that question the reliability of this technique include superimposition of bony and dental structures and distortion[1,5].Technological advancements have revolutionised diagnostic and imaging techniques[1]. CBCT is one such advancement. CBCT is now routinely used in oral and maxillofacial surgery , implantology and in endodontics, it is used in diagnosis in cases requiring surgery and for evaluating root canal treatment quality and for identification of canal morphology[5]. Modified canal staining and tooth clearing method is deemed the gold standard in determining root canal morphology a recent study showed that CBCT was as precise as that technique[5,9]. The CBCT imaging advantages include its non-destructive diagnostic nature , the 3D reconstruction and visualization of the internal and external anatomy of teeth and surrounding bony structures , its higher accuracy as the measurements are geometrically accurate because the CBCT voxels (3D pixels containing data) are isotropic, its significantly lower radiation dose, the short exposure time (2–5 seconds) and its lower cost compared to conventional CT[10-13].

The incidence of second canal in mandibular central incisors in this study was 20.83% which is similar to the results of Han et al (21.55%)[14], Al - Qudah et al(26.2%)[15],vertucci (27.5%)[16], Aminsobhani et al (27.3%)[17]. The results of this study was lower than results of kartal and yanikoglu (45%)[18], Benjamin and Dowson (41.4%)[19], Sert et al (65.3%)[20], Rahim et al (36.62%)[21] and caliskan et al (31.37%)[22] but higher than those of liu et al (13.2%)[23], Miyashita et al (12.4%)[24] and Madeira and Hetem (11.6%)[3]. In most of the previously mentioned studies, mandibular lateral incisors had similar incidence of second canal as the mandibular centrals which is in accordance to this study also (24.26%) but Han et al observed second canal to be more prevalent in mandibular laterals (27.36%) than centrals (15.71%)[14].

The incidence of a second canal in mandibular canines in this study was 5.45% which was similar to the findings of han et al (6.27%)[14], Rahimi et al (8.4%)[21],Pecora et al (10.6%)[25] but lower than findings of Aminsobhani et al (28.2%)[17], Sert et al (24%)[20],Vertucci (22%)[16],Caliskan et al (19.61%)[22]and Amardeep NS et al(20.4%)[26]. In this study, with respect to the mandibular centrals , laterals and canine the incidence of type I canal configuration was the highest (78.07 % ,76.38% and 92.08%) with canine showing the highest incidence. The second most prevalent canal configuration was type v for all (14.69% , 12.77% and 3.96%) . The next prevalent canal configuration was type II for centrals (2.85%) ,type II and IV for canines (1.49%) and type IV for laterals (4.04%) . The least prevalent was type III and IV for centrals (2.19%), type II for laterals (2.98%) and type III for canines (1.49%). Any other canal configuration was not detected in this study sample. Altunsoy et al in their study also showed similar results with type I configuration being most prevalent followed by type V and type III being least prevalent[6]. Zengyan et al[5] also found type I canal morphology to be most prevalent but in their study type III canal was the second most prevalent configuration which is different from this study. Aminsobhani et al[17] also showed type I configuration to be most prevalent but showed type II in centrals and type IV in laterals and canines to be the next most prevalent canal configuration and type V was the least prevalent configuration this result was dissimilar to our findings. Amardeep NS et al[26] in their study of mandibular canals showed type I canal configuration to be the most prevalent (79.6%) which is similar to this study but the incidence was lesser compared to the this study. The next most prevalent canal configuration in their study was type III and least prevalent was type V which was dissimilar to this study.

Taking gender into account, in this study the prevalence of two canals was higher in females than in males though the difference was not statistically significant which is dissimilar to the previous studies by Altunsoy et al[6]and Sert and Bayirli[27] that evaluated gender as a parameter in which the prevalence of two canals was higher in males. In morphological studies the difference in findings can be attributed to the various methods of sample examination, sample size, ethnic

background of the study sample and its geographical location[6].

Amongst the various methods to evaluate root canal morphology, CBCT has proved to be the gold standard for non destructive in vivo examination comparable to the modified canal staining and tooth clearing technique[14]. Micro CT compared to CBCT provides a more precise information on the root canal anatomy but they can be used only on extracted tooth[14].

CONCLUSION

In the studied population of odisha (india) and with the limitations of this study it was observed that the mandibular anterior teeth predominantly had type I root canal configuration and type V configuration predominantly in teeth with two canals. The chances of encountering two canals was higher in mandibular lateral incisors and in females though these results were not statistically significant. The present data may provide information to practicing clinicians in odisha regarding the root morphology of mandibular anteriors.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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