

## Evaluation of Root Canal Morphology of Lower Lateral Incisors using Cone Beam Computed Tomography in an Indian Subpopulation

Research Article

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### Abstract

**Aim:** To aim of the current study was to evaluate the root canal morphology of lower lateral incisors in an Indian subpopulation using Cone-Beam computed tomography.

**Material and Methods:** The CBCT images of 256 patients were obtained from the Department of Oral Medicine and Radiology of the University. Various parameters such as number of roots, number of root canal and canal configuration were evaluated and recorded and then classified according to Vertucci's classification of root canals.

**Results:** The most common root canal morphology is for Vertucci's Type 1 which is 40.2%, and Type 2 being 33.6%. The other types being Type 3(11.4%), Type 4(6.3%), Type 5(1.9%), Type 7(4.7%) and Type 8(1.9%).

**Conclusion:** From the assessed data it was seen the root canal morphology of lower lateral incisors exhibited a higher incidence of Vertucci's Type 1 and Type 2 and other configurations being Type 3, Type 4, Type 7, Type 5, Type 8. Type 6 was not to be seen in the assessed sample. The variation in the root canal morphology was seen most commonly in the male population than in female population.

**Keywords:** Lower Lateral Incisors; Root Canal Morphology; Cone Beam Computed Tomography; Vertucci's Classification.

### Introduction

Endodontic treatment is a complex process which requires the practitioners to study the root canal morphology in tremendous detail. Accurate diagnosis of the root canal morphology is of very high significance since it can lead to a successful endodontic treatment [1]. Root canal therapy involves shaping and cleaning of root canal system followed by filling with an inert restorative material. Presence of untreated canal is said to be a major cause of endodontic failure [2]. Different radiographic methods are used for endodontic diagnosis of root canal morphology such as tooth staining and colouring, conventional radiographs, digital medium advanced radiographic techniques and the more recent computed tomography techniques [3].

Cone beam computed tomography or CBCT is a method introduced for diagnostic application in endodontic clinical practice. It is used for different applications such as assessment of endodontic trauma, diagnosis of radiographic signs of periapical lesions, confirmation of nonodontogenic causes of pathosis, assessment of complex root canal systems prior to endodontic management, assessment of endodontic treatment complications or for management of root resorption [4]. CBCT is said to be used initially for angiography to assess the blood patterns and has paved its way into various medical applications in different fields. Its mechanism is said to be acquire individual image slices which are reconstructed and made into a single image. CBCT is said to obtain a single field of view (FOV) in an arc manner of planar image projection [5]. The smaller the FOV the less the radiation exposure seen to the patient. Another advantage of CBCT over conventional CT is the decreased scan time ranging from 10-40 secs and in current

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advanced systems ranging from 5- 8 seconds [6].

Various retrospective studies [7-9] have been done which aims at evaluating the different root canal morphology in different sub-population but none of the studies have been done to evaluate the root canal variations of lower lateral incisors using Cone-beam computed tomography in an Indian subpopulation. The current study aims to evaluate the root canal morphology of lower lateral incisors in an Indian subpopulation (Chennai) using cone beam computed tomography data.

**Materials and Methods**

The CBCT images were obtained from Dentsply Sirona 3D unit (Orthophos XG 3D) with operating parameters (3-6 mA and 60-90 kV, Exposure time - 5.1 seconds). The smallest possible field of view (FOV) was used (8 × 8 cm) and isotropic voxel size was 0.16 mm. The effective dose was between 14 μsv-166 μsv. All CBCT scans were performed with the minimum exposure necessary for adequate image quality. The as low as reasonably achievable (ALARA) protocol was strictly followed. The patient was made to position parallel to the emitter beam with horizontal axis towards the alveolar process, and the teeth under examination were placed in the centre of the volume. Vertucci's classification (1-8) was used as mode of classification to determine the number of canals [10].

A total CBCT data from the time frame April 2019 to September 2019 consisting of 256 patients were collected from the Department of Radiology, out of the 256 patients CBCT data assessed 41 patients CBCT data was excluded. The acquisition process was performed by an experienced radiologist. The data was taken based on the inclusion/exclusion criteria:

**Inclusion criteria**

- Permanent mandibular lateral incisors which were fully developed
- Absence of root canal treatment
- Absence of post and core restorations
- Absence of large metallic restorations which may interfere image analysis
- Absence of root resorption or periapical lesions

- No previous root amputation or hemi section
- Presence of high-quality CBCT images in which canal orifice and root canal configuration could be recognized.

**Exclusion criteria**

- Distorted CBCT images
- Edentulous ridges
- Patients below the age of 18 years and above the age of 60 years
- Missing lower anterior
- Patients undergoing orthodontic treatment.

The data was collected interpreted digitally using Galaxis Galileo's Viewer 1.9 (Sirona Dental Systems, SICAT GmbH & Co. KG, USA). The following information was recorded:

- The number of roots
- The root canal configuration the results were acquired, analysed and interpreted according to Vertucci's Classification.

An experienced endodontist was made to assess the CBCT images independently and could scroll through axial, coronal and sagittal views of each tooth. In case of disagreement, the case was made to discuss with another fellow endodontist until a consensus was reached.

**Statistical Analysis**

The statistical analysis was done using SPSS 21.0 (IBM Corp, Armonk, USA). Descriptive Analysis was conducted following by which a chi square analysis was conducted on the acquired data among the same patient. A p value less than 0.05 was considered to be statistically significant.

**Results**

From the analysed 214 samples, 125 samples belonged to the male population and 90 samples belonged to the female population. All the analysed images showed a single root configuration. The incidence of canal variation was seen to be around 60% from the total assessed samples. Table 1 denotes the frequency of canal variation from the assessed samples. Vertucci's Type 1 was seen

**Table 1. Frequency of distribution seen in the assessed CBCT images.**

		Tooth Number		Total	Chi square	p value		
		32	42					
Observer	Type 1	N	76	96	172	20.16	0.003*	
		%	35.50%	44.90%	40.20%			
	Type 2	N	87	57	144			
		%	40.70%	26.60%	33.60%			
	Type 3	N	19	30	49			
		%	8.90%	14.00%	11.40%			
	Type 4	N	17	10	27			
		%	7.90%	4.70%	6.30%			
	Type 5	N	1	7	8			
		%	0.50%	3.30%	1.90%			
	Type 7	N	8	12	20			
		%	3.70%	5.60%	4.70%			
	Type 8	N	6	2	8			
		%	2.80%	0.90%	1.90%			
	Total		N	214	214			428
			%	100.00%	100.00%			100.00%

to 35.5% in tooth 32 and 44.9% in tooth 42, Vertucci's Type 2 was seen to be second highest in 32(40.7%) and 42(26.6%). A total variation canal variation was seen of 33.6%. Vertucci's Type 3 was seen to be the next most commonly seen with 32(8.9%) and 42(14.0%). Vertucci's Type 4 was seen to be 6.3%, Vertucci's Type 5 was seen to be 1.9%, Vertucci's Type 7 was seen to 4.7% and Vertucci's Type 8 was seen to 1.9% respectively. A Chi-square test between the analysed samples showed a significant correlation between the assessed samples ( $p < 0.05$ ).

## Discussion

The current study aims to assess the diverse root canal morphology in an Indian subpopulation. Mandibular lateral incisors are one of the most common teeth present in the oral cavity shown to have a high degree of root canal morphology variations and has proven to be clinically challenging for various practitioners. The incidence of second canal is seen more than 40% with more than 1% having a separate foramen [5]. Numerous studies have shown the presence of varied root canal morphology for lower anterior [11, 12]. It is seen that root canal morphology variation is seen among different racial population as well with the results varying among different population. This could possibly be due to genetic diversity playing a role in the variation of the canals. CBCT is an effective tool which can be used for the endodontic practice for locating additional canals or varied tooth morphology. Different scenarios are seen in which the mandibular lateral incisor exhibit varied root canal morphology. CBCT imaging is a non-invasive technique that was reported to be as accurate as the modified canal staining and clearing technique for evaluating root canal systems [13]. Root canal variation is one of the factors seen with studies showing the incidence of anatomical variation being more common in males than in females [14]. The current study also correlates with the existing literature of the canal variation being more diverse in male population than in female population.

Several studies have used other different methods for the examination of root canal morphology which are use of polyester resins, creating transparent angles and use of 2D radiographs [15]. In clinical practice the use of roentogram is said to have severe limitations due to fact that it is 2-dimensional in nature which limits the clinician's ability to detect any additional canals. Currently with the introduction of CBCT the clinician can visualize the tooth in a 3-dimensional view which helps them to acquire the image. In contrast to traditional radiography, CBCT scanning provides 3-dimensional images in axial, sagittal, and coronal sections that could avoid geometric distortion and anatomic super imposition. However, the cost of CBCT scanning compared with periapical radiography hinder its clinical application in developing countries. A case report published by Reeh et al, has seen the incidence of fusion of the mandibular lateral incisor and seen varied apices with some being more than one [16]. One of the main failures of endodontic treatment is the missed root canal system this is seen due to the anatomical variation in the root canal system [17]. A study done by Boruah et al., [18] in which the incidence of type 1 root canal morphology is 63.5%, another study done by Wu et al., [19] for the Taiwanese population had seen similar results with Vertucci's type 1 being 75% and type 3 being 23%. The present study shows a slight variation in the results obtained in which Vertucci's Type 1 (40.2%), Type 2 (33.6%), Type 3(11.4%), Type 4(6.3%), Type 5(1.9%), Type 7(4.7%) and Type 8(1.9%). The in-

cidence of a type 6 canal configuration was seen to nil from the assessed samples.

Previously, various methods were advocated for the examination of root canal morphology. The most primitive method used were to section the tooth, this was discontinued due to fact that it does not allow a continuous view of the root canal system and also irreversibly changing the morphology [20]. Another method given by Robertson et al. which was used for a short amount of time is the clearing technique in which India ink was used as for the identification of the root canal system [21]. Ground sectioning of the apices has also been done by various authors to study the root canal morphology. In the recent times scanning electron microscopy or SEM is another method used to for the study of root canal morphology but clinically impossible have not been able to use [22]. With the advent of cone beam computed tomography, the clinician can evaluate and plan the data with considerable detail the mechanism of CBCT being a fan shaped beam which is exposed to the target structure which is simulated to multiple exposure in a single field of view and involving the sectioning of the tooth in three planar direction that is axial, coronal and sagittal direction [23]. The mechanism of CBCT radiographs is very much similar to conventional OPG but unlike the conventional orthopanthograph which is taken in a 2-dimensional image CBCT acquires the image in 3-dimensional in which a gantry is used to acquire slices of images which are compiled together digitally to produce a single image. Hundreds of planar projection images are acquired in the field of view which ranges at 180 degree [24].

Multiple studies are performed among different ethnic population to determine the root canal morphology. In Iranian population it was seen that the population has Type 1 having 70.6% for permanent lateral incisors compared to other types [13]. A study done by Altunsoy et al., for the Turkish population had seen that Type 5 was one of the frequently observed root canal configurations [25]. In the Chinese population a study conducted by Liu et al., had seen that males had 14.6% and females had 11.9% incidence of second canal [26]. Micro CT is another method which can be used for evaluation of the root canal morphology which is able to provide much accurate information about root canal morphology than the CBCT but its indicative purpose in clinical practice is not applicable, but they can only be used on extracted teeth. In clinical situations conventional radiography is the most commonly used method to distinguish tooth anatomy.

One of the limitations of the present study, is to not use an advanced diagnostic method such as micro CT for the evaluation of root canal morphology. Though micro CT is shown to be much effective in analysing root canal morphology the excessive cost for analysis and its clinical application is seen to negligible the usage of CBCT is still preferred for cone beam computed tomography analysis.

## Conclusion

Within the limitations of the present study, it can be concluded that most of the tooth examined had Type 1 root canal morphology of mandibular incisors. In tooth exhibiting more than single canal, the Type II canal configuration was the most prevalent followed by Type III, Type IV configuration based on the Vertucci's Classification. The least exhibited root canal morphology being

additional type 6. Gender variation as also seen in a factor for the variation in root canal morphology with the incidence of second canal being more common in males than in female population.

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