ORIGINAL RESEARCH

PREVALENCE OF MORE THAN ONE ROOT CANAL AND ITS VERTUCCI CONFIGURATION TYPE IN MANDIBULAR INCISORS:AN IN VITRO STUDY

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ABSTRACT

Aim: To evaluate the prevalence of more than one root canal and its Vertucci's configuration type in mandibular incisors using Spiral computed tomography (SCT).

Materials and Method: three hundred and fifty mandibular incisors were collected from various private dental clinics and academic institutions across the country. The teeth were disinfected with 0.5% sodium hypochlorite & mounted horizontally on wax sheet and scanned via spiral CT. The data was transferred to a software to evaluate the i) number of root canals and ii) Vertucci's configuration.

Results: The majority of mandibular incisors had a single canal (63.2% of teeth possessed a Type I canal system). Although 36.8% of the roots possessed two canals, only 2.6% had two separate apical foramina (Type- V canal system).

Conclusion: Spiral CT is a superior imaging technique for the identifying the variations in root canal systems. These data can help the clinician in selecting instrumentation systems and methods of obturation to be carried out during the treatment of central and lateral mandibular incisors.

Key words: Mandibular incisors, Spiral CT, Vertucci's configuration, root canals.

INTRODUCTION

The key factors for successful endodontic treatment are thorough debridement and obturation of the root canals. Therefore, the clinician must have in-depth knowledge of the root canal anatomy of the teeth [1]. Many issues encountered during root canal treatment happen due to the inadequate knowledge of the pulp space [2].Mandibular incisors commonlypossess one root and one canal. Studies have revealed that these teeth have two canals [3].Bifurcations of the root canal in mandibular incisors may give rise to complications or operative failure during endodontic treatment, as the clinician may fail to identify the presence of a second canal [4].

The root canal systems of mandibular incisors have been examined in various studies. There is no consistency in the prevalence and configuration of in mandibular incisors consisting of two canals, as observed in many studies. This difference may be attributed to study design (in vivo versus ex vivo), technique of canal identification or to racial divergence [5].Various studies have shown different trends in the number of root canals among different races. These variations seem to be genetically determined andplay an important role in detecting the racial origins of populations [2]. The prevalence of two canals in mandibular incisors was 11% in UK, 70% in Turkey [1] and 54.5% in Brazil [3].The prevalence of Vertucci's Type-I configuration was higher followed by Type-II, Type-III and Type-V canal configurations in the mandibular incisors.The prevalence of two canals in mandibular incisors was 36.25%in North-East Indian population [5].

Previously studies examining the internal anatomy of mandibular incisors employed conventional radiography, sectioning,and clearing-staining techniques.The more recent technique to study these variations in root canal anatomy includes Computed Tomography (CT) [6].An important diagnostic tool in Endodontics for assessing the canal configuration are conventional intra-oral periapical radiographsbut they are not completely reliable due to its innate limitations. Computed tomography has been valuable in overcoming the disadvantages of conventional radiography by producing a three-dimensional image and has emerged as a powerful tool for analysing the root canal configuration [7].

No study has been reported on prevalence of two canals and their canal configurationsin mandibular incisors using Spiral Computed Tomography in Indian population. The application of Spiral Computed Tomographic (SCT) scans in dentistry has increased enormously in the past 2 decades.The present study is conducted to determine the anatomical variations of root canals in mandibular incisors in vitro using Spiral Computed

Tomography because Spiral CT can achieve improved image resolution for a given radiation dose, compared to individual slice acquisition, hence, has the advantages of short scan time and improved image quality. Spiral computed tomography is useful in assessing the unusual root canal morphology when compared to routine intraoral periapical radiography and is an operator friendly software permitting the dentist to appraise the images in dental clinics.

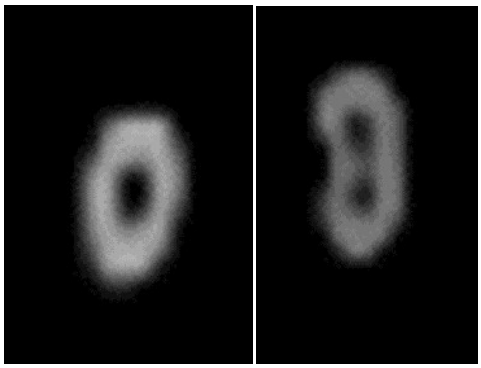
MATERIALS AND METHOD

The present study was conducted in post graduate Department of Conservative Dentistry and Endodontics, Institute of Dental Sciences and Department of Radiology, Rohilkhand Medical College and Hospital, Bareilly International University, Bareilly. The main purpose of this study was to evaluate the prevalence of more than one root canal and its Vertucci's configuration type in mandibular incisors.350 freshly extracted permanent mandibular central and lateral incisors were studied. Teeth were disinfected by overnight immersion in 5.25% NaOCl solution and any attached soft tissue and calculus was removed with an ultrasonic scaler. The samples were stored in 0.9% normal saline solution until the scanning procedure was performed.The storage and handling of teeth was performed as per Occupational safety and Health administration guidelines and regulation.The teeth were mounted horizontally on a modelling wax sheet and scanned using a GE Scanner Bright Speed LXI (16 Slice) CT scanner. They were then viewed both cross-sectionally and longitudinally with a constant thickness of 0.625mm/slice and a constant spiral or table speed of 5.62, pitch 0.56 and 120KVP. Subsequently, volume rendering and multiplanar volume reconstruction was performed to evaluate the criteria. The scanned data was then transferred to the RadiAntDicom viewer and evaluated in three views -Axial view to evaluate number of canals, Sagittal and coronal view to evaluate the bifurcation of the canals.

Vertucci's Classification of Root Canal Configuration

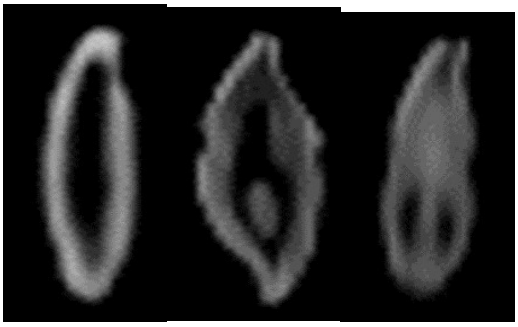
Type-I	Type-II	Type-III	Type-IV	Type-V	Type-VI	Type-VII	Type-VIII
1-1	2-1	1-2-1	2-2	1-2	2-1-2	1-2-1-2	3-3
							

RESULTS



A **B**

Figure 7 Axial view of mandibular incisors representing A) one canal B) Two canals.



A **B** **C**

Figure 8 Sagittal view of mandibular incisors representing

A) Vertucci'sType-I canal configuration,

B) Vertucci'sType-III canal configuration and

C) Vertucci'sType-V canal configuration

In the present study, maximum of 122 central incisors and 104 lateral incisors had one root canal. In 71 central incisors and 53 lateral incisors two canals were present.Type-I canal configuration was observed in maximum of 121 central incisors and 104 lateral incisors; Type-III canal configuration was observed in maximum of 67 central incisors and 52 lateral incisors; Type- V canal configuration was observed in 5 central incisors and 1 lateral incisor.The observations from the results were statistically analysed by two observers and kappa value was calculated to test interobserver reliability. Based on the results of the present study, statistically there was no significant difference (P=0.996) reported by two observers.

Table - Distribution of Number of Canals in Central Incisor

	Observer 1		Observer 2	
No. of Canals	**Number**	**Percentage (%)**	**Number**	**Percentage (%)**
One	122	63.2	121	62.7
Two	71	36.8	72	37.3
Total	193	100.0	193	100.0

X^2 – Value= 0.011, P-Value= 0.916 (not significant)

Out of 193 observer one found maximum one canals in 122(63.2%) and two canals in 71(36.8%) and observer two found maximum one canals in 121(62.7%) and two canals in 72(37.3%) in central incisorand there was no significant difference in observing of canals in central incisor in between observer one and observer two (p=0.916).

Table - Distribution ofVertucci's root canal configuration observed in Central Incisor.

	Observer 1		Observer 2	
Configuration	**Number**	**Percentage (%)**	**Number**	**Percentage (%)**
TYPE I	121	62.7	120	62.2
TYPE III	67	34.7	68	35.2
TYPE V	5	2.6	5	2.6
Total	193	100.0	193	100.0

X^2 – Value= 0.012, P-Value= 0.994 (not significant)

Table 5- Distribution of Number of Canals in Lateral Incisor.

	Observer 1		Observer 2	
No. of Canals	**Number**	**Percentage (%)**	**Number**	**Percentage (%)**
One	104	66.2	104	66.2
Two	53	33.8	53	33.8
Total	157	100.0	157	100.0

X^2 – Value= 0.000, P-Value= 1.000 (not significant)

Out of 157both observer one and two found maximum one canals in 104(66.2%) and two canals in 53(33.8%) in lateral incisor and there was no significant difference in observing of canals in lateral incisor in between observer one and observer two (p=1.000).

Table - Distribution ofVertucci's root canal configuration observed in Lateral Incisors

	Observer 1		Observer 2	
Configuration	**Number**	**Percentage (%)**	**Number**	**Percentage (%)**
TYPE I	104	66.2	104	66.2
TYPE III	52	33.1	52	33.1
TYPE V	1	0.7	1	0.7
Total	157	100.0	157	100.0

X^2 – Value= 0.000, P-Value= 1.000 (not significant)

Table 7-Interrater reliability the kappa statistic

Variables	Kappa Value	Level of agreement	% of data that are reliable
Number of Canals in Central Incisor	K=0.92	Almost perfect	82—100%
Configuration in Central Incisor	K=0.93	Almost perfect	82—100%
Number of Canals in Lateral Incisor	K=0.89	Strong	64—81%
Configuration in Lateral Incisor	K=0.89	Strong	64—81%

DISCUSSION

Various studies have revealed that anatomical variations can occur in all groups of teeth with inconsistent prevalence in different ethnic populations. Thus, an in-depth knowledge of the complexity of the root canal system is important for understanding the principles and problems of cleaning and shaping, and also for performing successful micro-endodontic procedures [8].

Different methods have been put forward to permit visualization of the root canal system as it is absolutely paramount to identify and manage root canal variations. The high variability in results can be attributed to the different methods used tostudythe root canal anatomy of the teeth. Earlier, histopathologicalstudies,intraoralperiapicalradiographs, clearing and demineralising methodand surgical operatingmicroscopy were used to study the root canal system.The main disadvantage of these methods was that the actual canal anatomy would have been altered because the majority of thesemethodsinvolveaninvasive procedure [8].

Intraoral radiographs provide only a two-dimensional image of a three-dimensional object and can conduce to superimposition of the root canals [9].The sectioning technique had the disadvantage of producing irreparable alterations to the studied samples. The tooth is composed of unique tissues with distinct radiographic densities and it lends itself to assessment to tomographic techniques. Recently,computed tomography has been used in various studies, which is a non-invasive technique and provides three-dimensional imaging. It is a non-destructive method, which allows for observation and analysis from any angle both in vitro and in vivo. The advent of this 3D imaging has provided the clinician with

sophisticated diagnostic tools for potent assessment of root canal anatomy that were not available before and facilitated interactive image manipulation and augmentation to visualize the area of interest.The results have been reported to be better with the use of computed tomography (CT) to evaluate the root canal anatomy than other methods such as radiographic imaging, tooth clearing and sectioning [10].

Both the lesion contrast and the degree of spatial separation of lesions observed depend on the relation of the commencement point of the scan series to the arbitrary spot of a lesion, in conventional CT. Spiral CT proffers uniform resolution due to its continuous scanning. The contrast for small lesion can be upgraded by a factor of 1.8 in comparison with conventional CT [11]. In Spiral CT there is simultaneous translation of the object through the x-ray source with continuous gyration of the source-detector assembly. Fresh computation data with a spiral sampling locus is acquired in a relatively short period. The data can then be viewed as conventional trans-axial images, as in multiplanar reconstructions, or three-dimensional reconstructions [12]. Hence, in the present study SCT was used to observe the prevalence of more than one canal in mandibular incisors. Samples in the present study were viewed under three sections that is axial, coronal and sagittal for convenience of the clinician.

In the present study, out of 193 mandibular central incisors, observers found maximum one canals in 122(63.2%) and two canals in 71(36.8%). Type-I canal configuration was seen in 121 (62.7%), Type-III canal configuration was seen in 67 (34.7%) and Type-V canal configuration was seen in 5 (2.6%) of the mandibular central incisors. Out of 157 mandibular lateral incisors, Observers found maximum one canals in 104(66.2%) and two canals in 53(33.8%) in lateral incisor.Type-I canal configuration was seen in 104 (66.2%), Type-III canal configuration was seen in 52 (33.1%), Type-V canal configuration was seen in 1 (0.7%) of the mandibular lateral incisors.

Two canals were prevalent in mandibular anterior teeth varying from 12.4% to 53% as reported by many authors. There is alikeness in the incidence of two canals between the mandibular centrals and laterals, which may be accredited to the sample size and the racial differences indicating that the location and place of the teeth did not influence this trait.

Different studies showed different trends in the number of root canals in mandibular incisors amongst different races. These variations come off as genetically determined, and may play an important role in tracing the racial origins of populations [2]. The prevalence of two canals in mandibular incisors was 36.25%in North-East Indian population[5], 11% in UK, 70% in Turkey [1] and 54.5% in Iran [3].The prevalence of Vertucci's Type-I configuration was

higher followed by Type-II, Type-III and Type-V canal configurations in the mandibular incisors.

In various studies, performed on mandibular incisors, the results showed that there were two canals in 11%-70% of these teeth and 0.3%-10% of these teeth had two distinct apical foramen. The differential results may be ascribed to diverseelements, one of them being the method used in the study. Low prevalence of two canals in incisors (1.3%-18.7%) was seen in studies conducted by using radiography. Nonetheless, whendifferent angulations were used in radiography, or by injecting radiopacifiersinto the canals or placing endodontic files in the canal before taking radiographs, the prevalence (30%-61.5%) of two canals in incisors were reported to be higher. The clearing and staining technique has also displayed high prevalence of two canals in incisors when used in various studies. Other elementslike distinct races and gender of the population studied may be accountable for the slender differences in the results [1].

The age of the patients is a predominantdetail that was not contemplated as a criterion in morphological studies. Deposition of secondary dentin may obscure the canals in elderly patient's teeth and consequently, the results were different in studies conducted on different age-groups. Conversely, mandibular incisors are the last teeth to be lost by the patients, in general and so it can be presumed that maximal samples could have been from older age-groups [1].

CLINICAL IMPLICATIONS OF TWO CANALS IN MANDIBULAR INCISORS

Root canal bifurcation in mandibular incisors play a major role in the endodontic treatment. In occasion of partial bifurcation, obturation of one root canal, usually the buccal, will accordingly seal the termination of the second canal. On the contrary, this will not happen when the root canal bifurcates totally that brings about two apical foramina, because the shortfall of treatment of the second canal will conduce failure of the endodontic therapy [13].

Clinicians, especially endodontists, should be able to envisage all root canals of a tooth to treat them appropriately. On this basis, professionals must be quite familiar with the internal anatomy of teeth and know the radiographic techniques and their modifications as well, to visualize the root canals perfectly [14].

It is imperative to evaluate two or more periapical radiographs carefully. These radiographs taken at different angulationscontribute to theintegral information about root canal anatomy. A rigorous clinical inspection of the tooth both internally and externally, accompanied by radiographs in different angulations aid in precise evaluation of the root canal system [8].

Inspection of the pulpal floor can divulgesigns of the orifice location and the type of canal system present. When there is only one canal, it is present in the centre of the access cavity. These orifices, especially if are oval shaped, must be explored scrupulously with small sized pre-curved K-files. If there is only one orifice and it is not in the centre of the root, it is probably due to the existence of another orifice, and the clinician should search for it on the opposite side. The connection of these two orifices is notable. The closer the canals are, the greater the chance they join at some point in the body of the root. As the distance between orifices in a root increases, the greater the chance that the canals remain separate. More the separation between orifices, less the degree of canal curvature. The direction of the file while placing into the orifice is also influential. If two canals are present, they will be smaller than a single canal, on any occasion,in a root with two canals that join to form one, basically the lingual/palatal canal is the one with direct access to the apex. A lingual shoulder must be eliminated for direct-line access while preparing the access cavity in mandibular incisors because this shoulder conceals the orifice of the second canal, if present, is found immediately beneath it. The outline of the pulpin mandibular incisors is wider labiolingually, at the CEJ it is oval, wider labiolingually than mesiodistally, in the mid-root region the canal outline is oval, but is more constricted and narrower labiolingually [15].

After the presence of separate canals is confirmed using different angulations,biomechanical preparation can be executed using conventional hand instruments. 2.5% of sodium hypochlorite and 17% EDTA can be used for irrigation. The canals should be rinsed with normal saline after every instrumentation and obturation can be done using lateral condensation technique. Radiographs are taken in multiple angulations (20 degree right and 30 degree left horizontal beam angulation) for better identification of two canals [4].Recently, thermo-plasticized injectable gutta percha techniques had a better filling ability than the lateral condensation technique [16].

One of the chief causes for endodontic failure of mandibular incisor teeth is the inability to locate, debride, and obturate the second canal. Most of the examined specimens had only one main apical foramen. Because of which, clinician might expect that treating one canal would be adequate since the apical foramen would be sealed, yet, one would see more failure in these teeth. Although, it is not secure to treat only one canal since the second canal would become necrotic and liberate noxious by-products through the accessory and lateral canals into the periodontal ligament space or through the inadequate apical seal of root canal filling materials. It is foremost essence to be aware of the complexity of the root canal system that

are meant to undergo endodontic treatment. Even under the most difficult state of affairs the current methods of root canal therapy result in an exceptionally high rate of success [8].

CONCLUSION

It is mandatory to have knowledge of the anatomic variations of the central and lateral mandibular incisors for the treatment to be successful. The root canal system is complex and canals tend to bifurcate and re-join. These bifurcations may lead to complications or in operative failure during endodontic treatment, as the clinician may fail to recognize the existence of a second canal [4].Hence, the clinician must be familiar with the various root canal configurations and their characteristic features among racial groups [8].Usage of 3-dimensional scan has been advantageous in cases where conventional methods do not give desired results. Future of the radiological diagnosis lies in utilizing 3-dimensional imaging technique for clinical cases in regular Endodontic practice as well.

REFERENCES

1) Rahimi S, Milani AS, Shahi S. Prevalence of two root canals in human mandibular anterior teeth in an Iranian population. Indian J Dent Res. 2013;24(2):234-36.
2) Vaziri PB, Kasraee S, Abdolsamadi HR. Root canal configuration of one-rooted mandibular canine in an Iranian population: An in vitro study. J Dent Res Dent Clin Dent Prospects. 2008;2(1):28-30.
3) Saati S, Shokri A, Foroozandeh M. Root morphology and num er of canals in mandibular central and lateral incisors using cone-beam computed tomography. Braz. Dent. J. 2018;29(3):239-44.
4) Bhat SP, Sheth R, Kumar P. Root canal morphology and assessment of incidence, type and position of isthmus in permanent mandibular central incisors in North Indian population; An in vitro study. Endod. 2017;29(2):107-14.
5) Boruah LC, Bhuyan AC. Morphologic characteristics of root canal of mandibular incisors in North-East Indian population: An in vitro study. J Appl Oral Sci. 2009;17(3):234-39.
6) Kalaitzoglou ME, Knatilireaki E, Beltes C. Second root canal in mandibular incisors: An ex-vivo cone bean computed tomography study. Balk J Dent Med. 2018;15(3):38-42.
7) Nathani P, Naik Suresh, Singh MP. Endodontic applications of spiral computed tomography. J. Sci. Res. 2009;2(1):31-4.

8) Al-Fouzan KS, Almanee A, Jan J. Incidence of two canals in extracted mandibular incisor teeth of Saudi Arabian samples. Saudi Endod J. 2012;2(2):65-9.

9) Deepak BS, Subash TS, Narmatha VJ. Imaging techniques in Endodontics: An overview. J Clin Imaging Sci 2012;2(1):1-8.

10) Nair MK, Nair UP. Digital and advanced imaging in Endodontics: A Review. J. Endod2007;33:1-6.

11) Kalender WA, Polacin A. A comparison of conventional and spiral CT: An experimental study on the detection of spherical lesions. J. Comput. Assist. Tomogr. 1994;18:167-76.

12) Kalender WA, Seissler W, Klotz E, Vock P. Spiral volumetric CT with single-breath-hold technique, continuous transport and continuous scanner rotation. Radiol1990;176:181-3.

13) Kokane VB, Patil S, Gunwal M. Treatment of Two Canals in All Mandibular Incisor Teeth in the Same Patient. Case Rep Dent. 2014;7(2):1-4.

14) Yury S, Paul V. Endodontic treatment of mandibular incisors with two root canals: Report of two cases. AustEndod J 2007;33:27–31.

15) Cohen S, Hargreaves K. Pathways of pulp, 10th edition:136-50.

16) Kulkarni G. New Root Canal Obturation Techniques: A Review. EC Dent Sci 2017;11(2):68-76.