Original Article

Evaluation Of Root Canal Morphology In Anterior Permanent Dentition Of Patients At University Hospital, Bbsr: An Analytical Review

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Abstract

Background: To perform a proper endodontic treatment, a clinician must have prior visualization and adequate knowledge of the root canal system.

Aims and Objectives: The present study is aimed to assess and evaluate the various root canal morphologies (in accordance with modified Vertucci's classification) in anterior permanent dentition of patients at university hospital, Bhubaneswar.

Methodology: An analytical, cross-sectional, radiographic evaluative study design was conducted to evaluate the various morphology patterns. Pilot study was done priorly. Descriptive statistics were calculated and presented.

Results: Genderwise, no statistical significant difference was found between each tooth type for mandibular anteriors. Class I morphology was found to be predominant in maxillary anterior types. Agewise, Class III was found to be predominant in mandibular central incisors and Class I in mandibular lateral incisors and canies.

Conclusion: The study indicates that in order to perform a fine root canal treatment procedure, CBCT should be used for a much better understanding of different root canal morphologies.

Keywords: Root canal morphology, anterior dentition, permanent dentition

Introduction

Successful endodontic treatment requires adequate knowledge of the root canal system [1]. Clinicians must be aware of multiple factors including detailed root canal configurations, along with the exact tooth morphology. In order to secure thorough chemo-mechanical instrumentation of all canals, the exact variations of the root canal morphology should be known. This would aid in improved root canal space filling in three dimensions [1,2]. Multiple factors have led to failures in root canal therapy including lack of information on the root morphology, directions of instrumentations, use of proper instrumentation methods, etc.

Even when the other canals have flawless obturation and filling, it is still important to have a thorough understanding of root and root canal morphological characteristics and likely variations in order to complete endodontic therapy successfully and prevent treatment failure [1,2,3]. The permanent mandibular anterior teeth contain additional roots or root canal alterations as compared to the maxillary anteriors. We should anticipate alterations in canal morphology in maxillary teeth having irregularities like the palato-gingival groove and also dens invaginatus. According to the literature, maxillary anterior teeth often had single roots and single canals, but mandibular anterior teeth typically had double canals. [5, 6]. Furthermore, differences in canal shape are influenced by people of various ethnic backgrounds [4]. Perlea et al. [7] reported that 81 percent of mandibular incisors teeth were with single canal, whereas the remaining 19 percent were bi-canaled, ranging from Weine's class 1 to 4 [7].

Additionally, research suggests that mandibular incisors are more likely to have two canals than other teeth [5, 8], with differences by age, gender, and ethnicity [9, 10]. A recent study in the Malaysian population showed that there are many different types of mandibular anterior canals, with age, sex, and ethnicity all having a significant influence on canal complexity [4]. According to several research conducted in Turkish, Chinese, Iranian, Jordanian, and American communities, there are changes in the root canal morphology of permanent anterior teeth. The complexity of the root canal morphology of anterior teeth differs depending on the community [11 to 16].

Staining, sectioning, decalcification and cleaning procedures, as well as conventional radiography, have all been employed to analyse the morphology of the root and canal [17,18,19,20]. Additionally, radiographic methods that provide 3D images, such as cone-beam computed tomography and micro-computed tomography (MicroCT), have been employed (CBCT). Multiple investigations have found inconsistencies in the classification of the internal architecture of different tooth kinds, such as maxillary premolar teeth with three canals. This variety was categorised as type VIII by Vertucci and Seelig [24], who described it as having three separate, distinct root canals that extend from the pulp chamber to the apex. The classification does not specify whether these canals are enclosed in single- or multiple-rooted teeth, though. Because of this, type VIII maxillary premolars with three canals are still referred to in the majority of studies [22, 25, 26]. Since it impacts the preparation of the access cavity, counting the number of roots rather than only the number of canals is obviously crucial for clinical treatment of teeth having root canal therapy.

Multiple studies have discovered discrepancies in how various tooth types, including maxillary premolar teeth with three canals, are classified based on their internal architecture. Vertucci and Seelig [24] classified this variety as type VIII and noted that it had three unique, discrete root canals that go from the pulp chamber to the apex. However, whether these canals are contained in single- or multiple-rooted teeth is not stated in the classification. As a result, studies continue to frequently make reference to type VIII maxillary premolars with three canals and one, two, or three roots. Quantifying the number of roots rather than merely the number of canals is undoubtedly important for clinical treatment of teeth undergoing root canal therapy since it impacts the preparation of the access cavity [22, 25, and 26]. In terms of clinical treatment of teeth having root canal therapy, quantifying the number of roots rather than just canals is unquestionably significant since it affects access cavity preparation. The purpose of the current study is to describe the morphology of the anterior tooth's root canals in an effort to help patients receive root canal treatments that are more successful.

Methodology

An analytical, cross-sectional, radiographic evaluative study design was taken up in the Department of Oral and Maxillofacial Radiology, KIIT University, Bhubaneswar. The study was conducted between the month of March

2022 and May 2022. Training and calibration of the investigator was done by the Departmental Head and Inter-examiner reliability statistics were calculated. The Cronbach's alpha value was calculated to be 0.7; which showed moderate acceptance. Pilot study was conducted on 10 subjects solely to understand the feasibility of the study.

Sample size derivation:

t tests - Correlation: Point biserial model

Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	Two
	Effect size |ρ|	=	0.35
	α err prob	=	0.05
	Power (1-β err prob)	=	0.95
Output:	Noncentrality parameter δ	=	3.6608345
	Critical t	=	1.9855234
	Df	=	94
	Total sample size	=	96
	Actual power	=	0.9518657

The present study considered 100 samples.

Eligibility Criteria: Vertuccii classification was used for classifying the teeth in the present study.

Han et al. [12] criteria were used to select the samples:

1. CBCT images of the anterior maxillary and mandibular teeth with complete root formation.

2. Tooth without root canal procedure;

3. No coronal or post-coronal restorations present;

4. No resorption of the roots or periapical lesions;

5. Presence of the investigating tooth in the field of examination.

Subjects not falling in the above criteria were excluded from the present study.

Method used:

The research required CBCT images of the central, lateral, and canine mandibular and maxillary anterior teeth. The study included photographs of healthy mandibular and maxillary anterior teeth, without radiographic abnormalities, with only minor caries or crown restorations. The following conditions were excluded from the study: root canal-treated teeth, post and core treated teeth, crowns, fractured maxillary and mandibular anterior teeth, resorbed teeth, teeth with abnormalities, calcification, along with those teeth that had crown and root anomalies.

Myray Hyperion X9 (Irys software, Italy) cone-beam computed tomography images were obtained, and source data (the original DICOM images) were imported into image-analysis software (CS 3D Imaging, v. 3.7.1.) and evaluated in the multiplanar reconstruction module of the 3D viewer. Two skilled investigators separately examined the roots and canals of mandibular anterior teeth. Each tooth was assessed independently. The tooth's long axis and two other lines perpendicular to the long axis were established when it was virtually isolated. The researchers employed 0.2–0.25 mm thick axial, sagittal, and cross-sectional slices. To guarantee appropriate visualisation, the programme was used to modify the contrast and brightness of the photographs (Figure 1, Figure 2).

Permissions: The ethical committee clearance was obtained from the Institutional Ethics committee. The mandate to obtain ethical clearance in a record based study included attaining informed consent of the patients who visited the institutional OPD between July 2021 and February 2022. The patients' age, gender, and ethnicity were recorded, and access to their data was authorized by the dean and hospital director.

Statistical Analysis: The sample collection was manually done and data was entered using the MS Office Excel version 2016. Categorical variables were presented in terms of Frequency and percentages while the continuous variables were presented as Mean and SD. Inferential statistics were calculated using Chi Square statistics. The degrees of freedom were kept at 2.

Results

The demographic characteristics were shown in Figure 3. More number of males was reported as compared to the females. Majority of the study population belonged to the age group of 41 to 65 years.

Gender-wise distribution of the root canal morphology for the maxillary anterior tooth has been represented in Table 1. Class 1 was predominant in Maxillary central and lateral incisors and canine.

Gender-wise distribution of the root canal morphology for the mandibular anterior tooth has been represented in Table 2. Class 1 was predominant in Tooth numbers 31, 32, 42; Class 3 was present in 41, 33 and 43. There was no statistically significant difference between the presentations of the groups for each tooth type.

Age wise distribution of the of the root canal morphology shows Class 1 was predominantly present in Maxillary central and lateral incisors and also canines.

Age wise distribution of the of the root canal morphology in the mandibular tooth shows Class 3 was predominantly present in mandibular central incisors. Class 1 was predominantly present in the mandibular lateral incisors and canines.

Discussion

Cleaning and filling the root canal system entirely is one of the most crucial factors affecting the outcome of root canal therapy. Due to the presence of additional, undetected canals at these sites, more periapical lesions have been seen following root canal procedures on anterior molars and maxillary molar teeth [11,12]. Because of this, efficient root canal therapy necessitates a careful analysis of root canal anatomy and variations [13]. Studies have evaluated root and canal morphology using techniques such histological section examinations, radiographic imaging assessments, and radiographic imaging evaluations [14]. Dental surgery microscopy, contrast-enhanced imaging, modified canal cleaning, and staining techniques were all utilised.

The bulk of these operations can change the canal's morphology and are invasive. Conventional radiography imaging is the two-dimensional representation of three-dimensional structures [18]. However, it does have limitations, including anatomical variations, tooth and surrounding tissue overlap, and interpretation. These difficulties can be overcome by using sophisticated three-dimensional radiographic imaging modalities, such as CT and CBCT, which offer detailed three-dimensional anatomical information and make abnormalities more visible [9]. CBCT is an excellent technique for evaluating variations in anatomy and is effectively employed in the examination of root and canal morphologies because it eliminates artefacts caused by overlapping anatomical components [19].

Cone-beam computed tomography is a technology that enables a thorough assessment of both the external and internal architecture of teeth, as well as a more accurate analysis of root canal systems. This approach allows for the simultaneous or separate study of the anatomy of the teeth. A greater comprehension of the tooth morphology is added by visualising various viewpoints by reconstructing observations in 3D planes, which improves the prognosis of the lesions. The benefit of CBCT is that it provides sagittal and horizontal views of the architecture of the teeth [21 to 26].

The current analysis demonstrates that Type I and Type III morphologies were the most prevalent. Although Yigit et al. and De Almeida et al. discovered the second-most type III morphology after Type I, Orhan et al. discovered the most type II morphology after type I. The variations in these results are explained by sample sizes and geographic factors [22,23,26]. According to Orhan et al. and Altunsoy et al. [22,27], women have two more canals than men do, and vice versa. In our investigation, there was no discernible difference in central and lateral incisor morphology between genders.

Conclusion

The present study infers that CBCT is a finer mode of understanding the tooth morphology. Root canal shaping and cleaning would be more conveniently done if there is an improvement in the understanding of the root canal morphology. Owing to the benefits of the CBCT radiographs; improving the availability of this method of radiography could improve the overall outcome of endodontic treatments.

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Tables

Table 1: Gender-wise distribution of the Root canal morphology in the maxillary anterior tooth

Tooth Number	Type	Male		Female		P Value
		N	%	N	%	
MAX_11	**Class 1**	53	100.0	47	100.0	-
MAX_21	**Class 1**	53	100.0	47	100.0	-
MAX_12	**Class 1**	53	100.0	47	100.0	-
MAX_22	**Class 1**	53	100.0	47	100.0	-
MAX_13	**Class 1**	53	100.0	45	95.7	0.132
	Class 2	0	0	2	4.3	
MAX_23	**Class 1**	53	100.0	46	97.9	0.291
	Class 2	0	0	1	2.1	

Table 2: Gender-wise distribution of the Root canal morphology in the mandibular anterior tooth

Tooth Number	Type	Male		Female		P Value
		N	%	N	%	
MAN_31	Class 1	18	34.0	23	48.9	0.939
	Class 2	8	15.1	6	12.8	
	Class 3	27	50.9	16	34.0	
	Additional Type	0	0	2	4.3	
MAN_41	Class 1	19	35.8	24	51.1	0.980
	Class 2	9	17.0	6	12.8	
	Class 3	25	47.2	15	31.9	
	Additional Type	0	0	2	4.3	
MAN_32	Class 1	26	49.1	22	46.8	0.134
	Class 2	4	7.5	3	6.4	
	Class 3	22	41.5	17	36.2	
	Additional Type	1	1.9	5	10.6	
MAN_42	Class 1	25	47.2	23	48.9	0.402
	Class 2	6	11.3	3	6.4	
	Class 3	21	39.6	18	38.3	
	Additional Type	1	1.9	3	6.4	
MAN_33	Class 1	46	86.8	40	85.1	0.304
	Class 2	5	9.4	3	6.4	
	Class 3	2	3.8	3	6.4	
	Additional Type	0	0	1	2.1	
MAN_43	Class 1	45	84.9	41	87.2	0.417
	Class 2	6	11.3	2	4.3	
	Class 3	2	3.8	3	6.4	
	Additional Type			1	2.1	

Table 3: Age wise distribution of the Root canal morphology in the maxillary anterior tooth

Tooth Number	Type	11 to 18years		19 to 40 years		41 to 65 years		>65 years		P Value
		N	%	N	%	N	%	N	%	
MAX_11	Class 1	5	100.0	21	100.0	51	100.0	23	100.0	-
MAX_21	Class 1	5	100.0	21	100.0	51	100.0	23	100.0	-
MAX_12	Class 1	5	100.0	21	100.0	51	100.0	23	100.0	-
MAX_22	Class 1	5	100.0	21	100.0	51	100.0	23	100.0	-
MAX_13	Class 1	5	100.0	19	90.5	51	100.0	23	100.0	0.052
	Class 2	0	0	2	9.5	0	0	0	0	
MAX_23	Class 1	5	100.0	20	95.2	51	100.0	23	100.0	0.291
	Class 2	0	0	1	4.8	0	0	0	0	

Table 4: Age-wise distribution of the Root canal morphology in the mandibular anterior tooth

Tooth Number	Type	11 to 18years		19 to 40 years		41 to 65 years		>65 years		P Value
		N	%	N	%	N	%	N	%	
MAN_31	Class 1	1	20.0	7	33.3	25	49.0	8	34.8	0.979
	Class 2	1	20.0	3	14.3	6	11.8	4	17.4	
	Class 3	3	60.0	11	52.4	18	35.3	11	47.8	
	Additional Type	0	0	0	0	2	3.9	0	0	
MAN_41	Class 1	1	20.0	7	33.3	24	47.1	11	47.8	0.782
	Class 2	1	20.0	3	14.3	7	13.7	4	17.4	
	Class 3	3	60.0	11	52.4	18	35.3	8	34.8	
	Additional Type	0	0	0	0	2	3.9	0	0	
MAN_32	Class 1	3	60.0	10	47.6	26	51.0	9	39.1	0.634
	Class 2	1	20.0	1	4.8	4	7.8	1	4.3	
	Class 3	1	20.0	10	47.6	16	31.4	12	52.2	
	Additional Type	0	0	0	0	5	9.8	1	4.3	
MAN_42	Class 1	3	60.0	10	47.6	25	49.0	10	43.5	0.767
	Class 2	1	20.0	1	4.8	6	11.8	1	4.3	
	Class 3	1	20.0	10	47.6	17	33.3	11	47.8	
	Additional Type	0	0	0	0	3	5.9	1	4.3	
MAN_33	Class 1	5	100.0	16	76.2	45	88.2	20	87.0	0.816
	Class 2	0	0	2	9.5	4	7.8	2	8.7	
	Class 3	0	0	3	14.3	1	2.0	1	4.3	
	Additional Type	0	0	0	0	1	2.0	0	0	
MAN_43	Class 1	5	100.0	16	76.2	45	88.2	20	87.0	0.678
	Class 2	0	0	1	4.8	4	7.8	3	13.0	
	Class 3	0	0	4	19.0	1	2.0	0	0	

	Additional Type	0	0	0	0	1	2.0	0	0	

Figure 1: CBCT Image of the maxillary anterior tooth

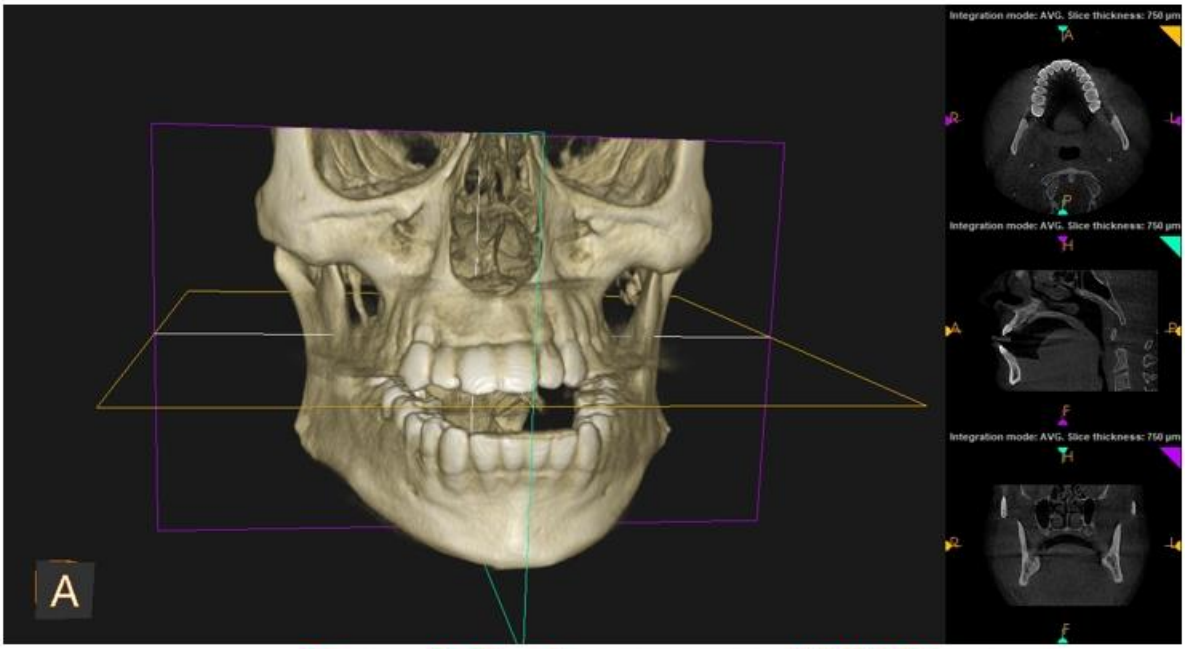

Figure 2: Tracing process of CBCT images

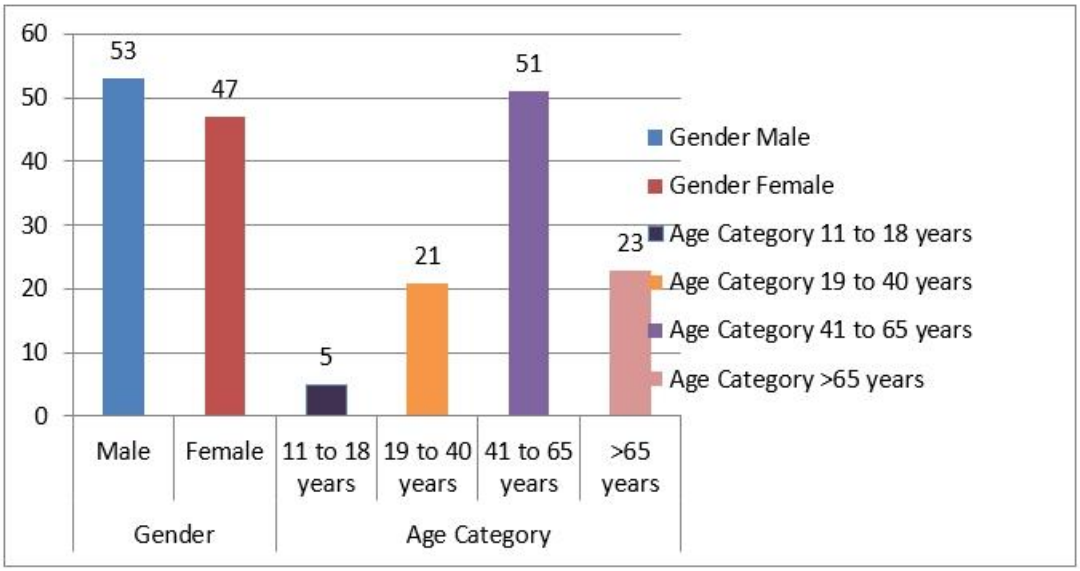

Figure 3: Demographic characteristics of the study population

Legends of figures and tables

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