Original Article

Study on Variations of Pulp Morphology in Normal Teeth

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Abstract

Background: Every tooth has a distinctive pulp and root morphology which varies from one segment to another. This myriad presentation of the pulp makes better understanding of pulp morphology mandatory to provide a successful endodontic treatment. Previously, extensive studies have been done on the morphology of the pulp. **Objective:** The present study was designed to study the pulpal morphology using the diaphanization technique. **Materials and Methods:** Fifty normally developed and erupted single-rooted and multi-rooted teeth were selected for the study, and the diaphanization technique was used to render them transparent. Methyl red/violet dyes were injected until it took up the entire pulp morphology, except for slight destruction in the crown portion due to the access preparation. The tooth model was then mounted vertically on to a sticky wax. **Results:** The lateral canals, apical foramina, furcations, and anastomoses of all the teeth were analyzed. **Conclusion:** The diaphanization technique helped in visualizing the pulp morphology of each tooth in a 3-dimensional aspect. It is an easier and inexpensive tool that provides better insight into understanding the pulp morphology *in vitro*. The models hence prepared can be used as teaching aid in preclinical studies for dental students to gain skills.

Keywords: *Diaphanization technique, pulpal morphology, Root canal*

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Introduction

Every tooth has a distinctive pulp and root morphology which varies from one segment to another. This myriad presentation of the pulp makes the better understanding of pulp morphology mandatory to provide a successful endodontic treatment. Various classifications to describe the pulp morphology have been proposed by authors such as Pineda and Kuttler[1] and Vertucci *et al*.[2] Over the years, numerous techniques have been suggested to view the pulp morphology, each with its own advantages and limitations. The longitudinal technique proposed by Sommer *et al*.[3] was unable to identify lateral canals and other techniques provided only a two-dimensional (2D) picture of the pulp.

The 3D view has an edge over the 2D methods. In 1969, Barker *et al*.[4] were the first to introduce the method of 3D view study. Recently, more sophisticated methodologies such as 3D rotatable scan[5] and microcomputed tomography have been used to assess pulpal morphology.[6] However, these were more technique sensitive and expensive.

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The diaphanization (transparent tooth technique) proposed by Maralingannavar[7] is a simple and inexpensive method for real-time visualization of the pulp. This technique has been employed to study the variations in the pulp morphology in Indian population. Although various techniques have been used to study and evaluate the canal morphology, it has been reported that the most detailed description can be obtained by demineralization and staining.[2] This is regarded as an excellent method to study the pulp canal morphology. Proper clearing and adequate penetration of the dye has been regarded as the finer method to visualize the intricate details of the canals. Therefore, in our current study, we had employed the diaphanization technique to visualize the pulp three-dimensionally and compared it with Vertucci's classification.

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Materials and Methods

Sample selection

The study consited of 50 extracted teeth obtained from both maxillary and mandibular arches of patients with no systemic disorder. From both the maxillary and mandibular dental arches. They were segregated into three groups: Group I included the anterior teeth, Group II – cuspids, and Group III – posteriors. The distribution of teeth in each group is summarized in Table 1. Only tooth eith intact crown and root morphology were included in the study. All the third molars, tooth with systemic disorders, and developmental disorders were excluded from the study.

Methodology

Fifty normally developed and erupted single-rooted and multi-rooted teeth were selected for the study.

Table 1: Distribution of teeth in each study group

Group-1 (anteriors - 15)	Group-2 (cuspids - 10)	Group-3 (posteriors - 25)
Maxillary centrals: 4	Maxillary canine: 1	Maxillary Molars: 13
Maxillary laterals: 3	Maxillary premolars: 5	Mandibular Molars: 12
Mandibular centrals: 5	Mandibular Canine: 2	
Mandibular laterals: 3	Mandibular premolars: 2	

The occlusal access opening was done using NSK Pana-Max high-speed air-turbine handpiece. Once the canals were located, minimal instrumentation such as files was used to prepare it. The prepared teeth were then placed overnight in 5.25% of sodium hypochlorite for debridement and cleansing followed by the next day in 100% of ethyl alcohol overnight for dehydration. The samples were then examined for the apical patency using jet stream. Those specimens that did not have apical patency were discarded. The samples were washed in distilled water and kept for 2–3 days in 10% of nitric acid for decalcification (the bulk teeth required a day more). Then, finally, the samples were placed in methyl salicylate until it turned transparent giving glass-like appearance. Later, the methyl red/violet dyes were injected drop by drop using a fine-needle syringe until it takes up the entire tooth morphology, except for slight destruction in the crown portion due to the access preparation. The tooth model is then mounted vertically on to a sticky wax.

Results

The results of the study are summarized in Tables 2 and 3.

The pulp morphology was observed and compared with Vertucci's classification.

Table 2: The morphological variations in maxillary teeth

Tooth	Number of teeth	Root	Lateral Canals	Apical foramina	Furcations	Anastomoses
Centrals	5	Single	Nil	Central	Nil	Nil
Laterals	3	Single	Nil	Central	Nil	Nil
Canines	1	Single	Nil	Central	Nil	Nil
First premolar	1	Single	Middle	Lateral	Present	Absent
Second premolar	1	Single	Apical	Lateral	Nil	Absent
First molars	5	Buccal	Apical	Lateral	Nil	Middle
		Palatal	Apical	Lateral	Present	
Second molars	5	Buccal	Apical	Lateral		Lateral
		Palatal			Present	

Table 3: Morphology of mandibular teeth

Tooth	Root	Number of teeth	Lateral canals	Apical foramina	Furcations	Anastomoses
Centrals	Single	5	Nil	Central	Nil	Nil
Laterals	Single	5	Nil	Central	Nil	Nil
Canines	Single	1	Nil	Central	Nil	Nil
First premolar	Double	1	Middle	Lateral	Nil	Present
Second premolar	Single	1	Apical	Lateral	Nil	Absent
First molars	MB	5	Apical	Lateral	Nil	Middle
	DB		Apical	Lateral	Present	
	P		Apical	Lateral		
Second molars	MB	5	Apical	Lateral		Lateral
	DB				Present	
	P					

Discussion

The present study showed predominantly a single-rooted presentation of mandibular incisors. Maxillary second premolars exhibited a more complex picture with Vertucci's type II classification with two separate canals merging into a single apical foramen.[2] The technique helped us in better visualization of both the canals in a 3D view. The mandibular first premolars showed the most common type 1 root canal morphology (based on Vertucci's classification).[2] Our study also showed the occurrence of a single canal in the mandibular second premolar. The present study validates the use of the diaphanization technique to provide a 3D view of the pulpal morphology. The major advantages of this method are the speed with which it can be done (5–7 days), simplicity of the technique, necessity of minimal equipment, and use of relatively less toxic chemicals as against numerous sophisticated and expensive methodologies.

Understanding the pulp morphology is essential so as to prepare the dental students to appreciate the varied normal morphology and be prepared for any unexpected presentations. Therefore, a precise assessment of the dental tooth anatomy is of extreme importance as it would help us in better treatment planning. The root canal system has a myriad of shapes, configurations, and patterns. Varieties of techniques have been used to study the root canal morphology using transparent tooth study model. The clearing study technique considered in this study gives a 3D view of the pulp morphology, in relation to the exterior of the tooth. In addition, instruments were not used to enter the canal; hence, the pulp morphology is preserved and the exact anatomical structure is maintained. The major advantages of this procedure are the period (5–7 days), the simplicity and the minimal toxic chemicals compared to the other procedures, and the cost. Not much significant variations of the pulp morphology are detailed. The knowledge obtained in this simple technique helps in well appreciating the pulp chambers and canal.

The other uses of transparent tooth model systems include (i) to study the root canal morphology of the pulp, (ii) preclinical teaching aid in an oral anatomy, (iii) provides 3D view of the root canal system, (iv) preclinical endodontic teaching aid, (v) to demonstrate the root canal treatment model to patients, (vi) improvement of endodontic skills in dental students, and (vii) assessment of endodontic material.

Conclusion

The diaphanization technique helped in visualizing the pulp morphology of each tooth in a 3D aspect. Although numerous *in vivo* studies involving radiographs are available, they have their limitations such as radiation exposure, 2D representation, and imaging artifacts. In contrast, the current study is an easier and inexpensive tool that provides a better insight into understanding the pulp morphology *in vitro*. The models hence prepared can be used as teaching aid in preclinical studies for dental students to gain skills. It may also be used to explain the endodontic procedures and visualize complex pulp morphology.

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Conflicts of interest

There are no conflicts of interest.

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