

Root canal anatomy and morphology of permanent maxillary canine teeth in an Iranian population

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Abstract

Thorough knowledge from anatomical characteristics of different teeth is a must, to achieve successful root canal, Orthodontic, surgical and other dental treatments on them. This cross-sectional study aimed to study the anatomy and morphology of permanent maxillary canine teeth in Kerman, a province in the southeast Islamic Republic of Iran. One hundred extracted permanent maxillary canines with intact apices were collected from five different dental centers within five different city districts in Kerman. The number of roots, the root curve direction and the length of each tooth was assigned by macroscopic observation and length measurement of each sample. Also, after staining, decalcification and clearing of each selected tooth the existence of lateral canals and their location was carefully evaluated under magnification. The results showed that all maxillary canine teeth had 1 root and one root canal in this study. The average length for this tooth was 27.31mm. The curve direction of the roots, in 32% of the cases was; distally, in 8%; buccally, in 4%; mesially and in 3%; palatally. 53% of the teeth had straight roots and root canals and, 25%, had lateral canals that in all of the cases were located in the apical third of the roots and were never observed in the middle and coronal thirds. As a conclusion, in this population, roots of maxillary canine teeth have straight roots in 53% of the cases, and in 25%, they have lateral canals that are usually located in the apical thirds.

Keywords

Anatomy, Canine, Maxillary, Morphology, Root canal.

Introduction

The canine teeth, also called cuspids, fangs, dog or eye teeth (in the maxillary jaws), are long pointed and in some cases, more flattened teeth which cause them to be similar to incisors and to be named, incisiforms. Their corner position, complements their major function in the mastication which is tearing of the food. Canines are the longest teeth in the mouth and also the only anterior teeth with one cusp. (Wikipedia. Accessed 2/05/2019).

The root canal space of this tooth is wider in the Labio-lingual than in the mesio-distal, in contrast with the other anterior teeth. Also, despite other anterior teeth, canine teeth don't have pulp horns.

Because of these differences, the outline form of the access cavity and also the instrumentation techniques in them is somehow different from other maxillary inci-

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isor teeth. The outline form of their access cavity is oval, in comparison with the Central maxillary incisors, which is triangular. (Hargreaves *et al.* 2016, Ash *et al.* 2007, Ingle *et al.* 2011, Seltzer *et al.* 1988)

Many studies in different parts of the world have shown that the anatomic characteristics along with the related root canal morphology of the teeth is various in different racial populations. (Cohen *et al.* 2016 Ingle *et al.* 2011) In the Caucasians only one root and one root canal configuration has been reported to exist in the maxillary canines, whereas in the Turkish populations an additional canal configuration has been reported in this tooth. (Vertucci *et al.* 1984 Caliskan *et al.* 1995 Sert *et al.* 2004) Studies on root canal anatomy and morphology of permanent canine teeth are limited. Therefore, this study was done to investigate the external and internal root canal anatomy of the extracted permanent maxillary canine teeth in an Iranian population using macroscopic observation along with the Staining, decalcification and clearing technique.

Materials and methods

With the approval of the University Ethics committee, approval code: K/90/19 100 permanent maxillary Canine teeth with completely formed apices which had been extracted because of different dental interventions such as progressive caries or periodontal diseases, complete or partial denture treatments and financially inability of the patients to treat the teeth were randomly collected from 5 dental centers within 5 different municipal districts of the city of Kerman, the capital city of the province; Kerman located in the southeast of the Islamic Republic of Iran. The side of the teeth, gender, and age of the patients had not been considered as a criterion. The attached soft tissues were removed from the surfaces of the extracted teeth by an ultrasonic scaler and then kept in 5.25% Sodium Hypochlorite (Samen-Mashad). The length of the teeth was measured from apex to the Cusp of the teeth, considering that in cases of root curvature this could underestimate root length up to 1mm. The direction of root curvature was also visually assessed and recorded in a table along with the length of the teeth. After determining macroscopic anatomical characteristics, the root canals of the teeth were stained, decalcified and finally cleared in order to study the internal anatomy of the samples.

For this purpose, access cavities to the pulp were prepared with a high-speed Turbine (Bien-Air, Swiss) and diamond burs, (Diatech-Germany). Then the organic pulp tissues of the samples were dissolved and removed by immersing the teeth in 5.25% Sodium Hypochlorite (Samen-Mashad) for nearly 12 hours. Finally, all samples were washed and dried in the room temperature. The locations of the apical foramina for all Canine teeth were determined by putting a no 10 K file (Maillefer-Swiss) inside the canal, until it reached to the root apex. India ink (Shimin-Tehran) was injected into the pulp chambers of the teeth by an irrigating syringe and a 27 Gauge needle. The ink was moved into the canal system by negative pressure to the apical end of the teeth with the use of a central suction system. Then the stained samples were dried and demineralized by immersion in 14% Nitric acid solution (Shimin - Tehran) for almost 10 days. The acid solution was changed daily and, was checked for enough demineralization of the teeth by taking frequent X-rays. after enough

demineralization the samples were dehydrated in Ethanol (Taghtir- Iran) for 12 hours and finally all teeth were made transparent by immersion inside 5% Methyl Salicylate(Merck-Germany). The teeth were maintained within this solution until they completely became transparent. The stained, decalcified and cleared canine teeth were carefully observed under the Stereomicroscope (Olympus- Japan) at $\times 2$ to $\times 3$ magnification. (Vertucci *et al.*1984 Caliskan *et al.* 1995 Sert *et al.*2004 Kuzekanani *et al.* 2015).

Results

All maxillary canine teeth had 1 root and one root canal and the average length for this tooth was 27.31 mm in this study. The curvature of the roots and related root canals in 32% of the cases was distally, in 8%: buccally, in 4%: mesially and in 3%: palatally. 53% of the teeth had straight roots and root canals. 25% of the teeth had lateral canals which in all of the cases were located in the apical thirds and were not observed in any sample in the middle and coronal thirds of the roots.

Discussion

There are several different techniques which help us to study the root canal anatomy and morphology of the teeth. Each technique has some advantages and some disadvantages.

Some of the most efficient and practical techniques for this purpose are: 1 preparing access cavities, putting files inside the diagnosed canals and taking radiographs. 2-Studying stained cross sections of different parts of the root canals under magnifications. 3- Studying the stained, decalcified and cleared (transparent) root canals and 4-Cone Beam Computed Tomography (CBCT). In this research we performed the third method which can detect and stain some areas of the root canals that are complex and not reachable and diagnosed by the files and other endodontic instruments, and be diagnosed on the simple radiographs. In a recent study, no significant statistical difference has been reported between the accuracy of the CBCT and the staining, decalcification and clearing methods in revealing the number and the morphology of the roots and root canals. (Dalili Kajan *et al.*, 2018) The clearing technique is more applicable than the CBCT method to study the root canal morphology of the teeth in experimental studies, but in the clinical studies and also clinical practice finding the additional canals and detecting morphological and anatomical variations and even canal obstructions, using the efficient CBCT technology is highly recommended. (Patel *et al.*, 2007, Versiani *et al.*, 2013, Kuzekanani *et al.*, 2017, Kuzekanani *et al.*, 2018, Mashyakh, 2018, Mashyakh, 2019)

Canine teeth are bulkier and more calcified in comparison with other anterior teeth. so more volume and higher concentration of the Nitric acid solution and also more time was needed for becoming decalcified .In our Study the average length of the Canines was 27.31 which is longer than the average international records which is 26.5 mms.(Hargreaves *et al.* 2016) Many investigators and clinicians have reported more than one root canal for the canine teeth in the literature and through the case

Table 1. Variations in root canal anatomy and morphology of Maxillary canine Teeth in different populations.

Author/year	Methodology	Country	No of samples	1 root and 1 canal	Accessory canals
Green/1956	Cross section/in vitro	USA	50	100%	---
Chapman/1969	Cross section/in vitro	UK	20	100%	12(60%)
Pindea/1972	Radiography/in vitro	Mexico	260	100%	77(29%)
De Deus/1975	Staining and clearing/in vitro	Brazil	73	100%	12(16.5%)
Vertucci/1984	Staining and clearing/in vitro	USA	100	100%	27(27%)
Caliskan/1995	SEM(Scanning Electrone Mycroscope)/in vitro	Turkey	100	93.5%	45.5%
Sert/2004	Staining and clearing/in vitro	Turkey	200	94%	57(28.5%)
Weng/2009	Staining and clearing/in vitro	China	65	75.5%	30(37.5%)
Uchiyama/2011	Staining and clearing/in vitro	Japan	250	98.5%	92(37%)
Somalinga/2014	CBCT/in vitro	India	250	81.6%	30(12%)
Plascencia/2017	CBCT/in vitro	Mexico	32	93.7%	43.7%

reports, (Caliskan *et al.*1995 Sert *et al.* 2004Alapati *et al.*2006 Onay *et al.*2008 Weng *et al.* 2009 Uchiyama *et al.* .2011 Somalinga *et al.* 2014 Plascencia *et al.* 2017) in contrast, more than one root and one root canal was not observed among randomly selected extracted canine teeth in this study. In agreement with the results of our study, many other investigators have not found more than one root and one root canals for Canine teeth in different parts of the world.(Green *et al.* 1956 Chapman *et al.* 1969 Pindea *et al.*1972 Dedeus *et al.*1975 Vertucci *et al.*1984) The results of the studies on the anatomic characteristics and the root canal morphology of the maxillary Canine teeth, along with the used techniques in different parts of the world has been summarized in the Table 1. Furthermore most of the studies and the texts report that distally curved roots are more prevalent in Canines,(Amin sobhani *et al.* 2013Vertucci *et al.* 2005) also in contrast most of the cases, (53%) had straight roots and root canals ,followed by distally(32%), buccally(8%), mesially(4%) and palatally curved roots(3%) in this study. Any additional canal was not recognized for these teeth in this study, instead 25% of the samples had lateral canals which are a thorough challenge in Endodontics because they cannot be bypassed by endodontic instruments and sometimes they may need apical surgeries to be sealed by retrograde material fillings such as amalgam, MTA and other retrofil materials and special care should be focused on chemical cleaning of these teeth while cleaning and shaping procedure. Also vertical compactions of warm and softened Guttapercha is a promising method to obturate and seal these lateral canals.(Hargreaves *et al.* 2016).

Conclusion

Based on the results of the current study all maxillary canine teeth had 1 root and one root canal.

The average length for this tooth was 27.31 mms. The curve of the roots in 32% of the cases was, distally, in 8%: buccally, in 4%: mesially and in 3%: palatally. 53% of the teeth had straight roots and root canals. 25% of the teeth had lateral canals which in all cases were located in apical thirds and were not observed in any case in the middle and coronal thirds of the roots.

Conflicts of interests

The authors have no conflicts of interests to be declared.

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