

Root canal anatomy and morphology of permanent maxillary Lateral Incisors in an Iranian population

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Abstract

A meticulous knowledge of the root canal anatomy and morphology of the teeth is imperative to achieve successful root canal and also many other dental and surgical treatments on them. The purpose of this study was to study the root canal anatomy and morphology of permanent maxillary Lateral incisors in Kerman. 100 extracted intact permanent maxillary Lateral incisor teeth were collected from different dental clinics in Kerman. The anatomic and morphologic characteristics of the selected samples such as the number of roots, the apical root curve direction and the length of the teeth were determined by macroscopic evaluation and length assessment of each sample. After staining, decalcification and clearing of each tooth the existence and location of additional and lateral canals was also carefully explored by using magnifying tools. All maxillary Lateral incisors had just one root and one root canal and the average length for this tooth was 22.5 mms in this study. The curvature of the roots in 67% of the samples was distally, in 5%; buccally, in 2%; palatally and in 3%; mesially. 23% of the teeth had straight roots and root canals. Also, 29% of the teeth had lateral canals that in 89% of the cases were located in the apical thirds, in 11%; in the middle and in none of the cases in the coronal thirds. As a conclusion lateral canals and curved apex which are thorough challenges in dentistry are prevalent in maxillary lateral incisors among this south eastern Iranian population.

Keywords

Anatomy, lateral incisors, Maxillary, Morphology, Root canal.

Introduction

Maxillary Lateral Incisors are a pair of upper teeth that are located laterally from both maxillary central incisors and medially toward the midline of the face from the maxillary canines. Like all incisor teeth, their function is tearing and cutting food during mastication. These teeth generally have no cusp, but the rare condition known as the Talon cusp has been most, observed and reported in them. The surface of these teeth, which is used in mastication is called, incisal ridge or incisal edge.

The maxillary lateral incisor teeth resemble the maxillary central incisors from many aspects, but are smaller in all dimensions and the mesio-distal width of them is evidently smaller than that of the maxillary Centrals. These teeth have the most variability in crown shape within the dental arch after the maxillary third molars and it is possible to be congenitally missing bilaterally .(Wikipedia, accessed 01/03/2020).

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Disto-incisal angles of the maxillary lateral teeth are more rounded in comparison with those of the Central incisors and the root canal space of these teeth is wider in the mesio-distal than in the bucco-lingual, in contrast with the Canine teeth. Both maxillary Central and Lateral incisors have pulp horns and since the width of the incisal ridge, in the Lateral teeth is less than that of the Centrals the outline form of the access cavity to their pulp space is oval shape in comparison with the Central incisors which is triangular (Hargreaves *et al.* 2016, Nelson 2015, Ingle *et al.* 2011, Seltzer *et al.* 1988).

Previously it has been proven that the anatomic characteristics of the teeth and their related root canal morphology could follow many various patterns within different racial populations in different parts of the world (Hargreaves *et al.* 2016, Ingle *et al.* 2011).

Maxillary lateral incisors generally have a single root with a single canal but this generalization is not always true since a number of research and case report articles have described them to have two roots with two, three and even four root canals. Many anatomical anomalies and variations such as gemination, concrescence, fusion or dens invagination, have also been reported to happen in maxillary lateral incisors, since these teeth are located at a high prone to risk embryological position in the oral cavity (Lim *et al.* 2012, Mohan *et al.* 2012, Nosrat *et al.* 2015, Peix-Sánchez *et al.* 1999, Pereira *et al.* 2000, Shokouhinejad *et al.* 2009).

All maxillary incisors (Centrals, Laterals and Canines) may have various configurations of root canals in different racial groups and populations. (Vertucci *et al.* 1984, Caliskan *et al.* 1995, Sert *et al.* 2004) Because of these reported racial variations, current cross sectional study was carried out to study the external and internal root canal anatomy and morphology of the extracted permanent maxillary lateral incisor teeth in Kerman a city in the south east of Iran, using macroscopic observation along with staining, decalcification and clearing the selected samples.

Materials and methods

After, approval of the University research and the ethics in research committees;

Approval Code: K/90/18, 100 permanent maxillary Lateral incisors with intact and completely formed apices which had been extracted because of progressive caries, periodontal diseases, complete or partial denture treatment planning were randomly collected from 5 dental centers within 5 different municipal districts of the city of Kerman, without considering the side, age and gender as selective criterions

The attached periodontal ligament tissues were separated from the root surfaces by scaling instruments, then the samples were washed and brushed under distill water and were immersed and kept within 5.25% Sodium Hypochlorite solution (Shimin-Tehran). The length of the teeth was measured from apex to the incisal ridge considering that in cases with root curvature this measurement could underestimate root length up to 1 mm, also the apical root curvature directions of the samples were visually assessed and recorded in a table along with their measured lengths. After determining macroscopic anatomical characteristics, the root canals of the teeth were stained, decalcified and finally cleared in order to study the internal morphology of these teeth, for this purpose, access cavities to the pulp chambers were prepared

with a high-speed Turbine (Bien-Air, Swiss) and diamond burs, (Diatech-Germany). Then their organic pulp tissues were dissolved and removed by immersing the teeth in 5.25% Sodium Hypochlorite (Shimin-Tehran) for nearly 12 hours and finally were washed and dried in the room temperature. The locations of the apical foramina for all samples 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. Ink was moved into the canal systems by negative pressure to the apical end of the teeth from a central suction system. Afterwards 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 also 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 were made transparent by immersion inside 5% Methyl Salicylate (Merck-Germany). The teeth were maintained inside this solution until they completely became transparent. The stained, decalcified and cleared samples were finally carefully observed under the Stereomicroscope (Olympus-Japan) at $\times 2$ to $\times 3$ magnifications (Vertucci *et al.* 1984, Caliskan *et al.* 1995, Sert *et al.* 2004, Kuzekanani *et al.* 2019).

Results

All maxillary Lateral incisors had just 1 root and one root canal in this study. The assessed average length for this anterior tooth was 22.5 mms. The curvature of the roots in 67% of the samples was distally, in 5% buccally, in 2% palatally and in 3%; mesially, 23% of the teeth had straight roots and root canals. Also, 29% of the teeth had lateral canals that in 89% of the cases were located in the apical thirds, in 11% in middle thirds of the roots and in none in the coronal thirds.

Discussion

Many investigators and clinicians have reported more than one root and one root canal for the maxillary Lateral teeth in the literature and through the case reports. (Christie *et al.* 1981, Fabra 1985, Pecora *et al.* 1991, Caliskan *et al.* 1995, Walvekar *et al.* 1997, Peix- Sanchez *et al.* 1999, Collins 2001, Shokouhinejad *et al.* 2009, Sert *et al.* 2004, Kottoor *et al.* Mohan *et al.* 2009, 2012, Nosrat *et al.* 2015) in contrast, more than one root and one root canal was not observed among randomly selected extracted maxillary Lateral teeth in this study. In agreement with the results of current study, many other investigators have not found more than one root and one root canal for maxillary Lateral 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).

As, it has been mentioned before, results obtained from different studies on root canal anatomy and morphology of the teeth, are so much dependent on the methodology of the research (Kuzekanani *et al.* 2018, Kuzekanani *et al.* 2020). According to some recent valuable studies, no significant statistical difference has been found

between clearing of stained and decalcified teeth and the Cone beam Computed Tomography method in detecting additional canals in the extracted human teeth and these two methodologies currently are more approved than other methodologies for studying the root canal anatomy and morphology of the teeth (Neelakantan *et al.* 2010, Dalili Kajan *et al.* 2018).

Results of different studies on root canal morphology of the maxillary Lateral teeth along with the years and places of the research, also the used methodologies are summarized in the Table 1.

Table 1. Variations in root canal anatomy and morphology of Maxillary lateral incisors in different populations.

Author	Methodology/ year	Country	1 canal(%)	2 canals(%)	3 canals(%)	4 canals(%)
Caliskan et al	Clearing 1995	Turkey	95.1	4.9	----	----
Christie et al	Clinical Raiography 1981	Canada	----	Case report	----	----
Peix-Sánchez	Clinical Radiography 1999	Spain	----	----	Case report	----
Collins	Clinical Radiography 2001	Australia	----	Case report	----	----
Fabra-Campus	Clinical Radiography 1985	Spain	----	Case report	----	----
Pecora et al	Clinical Radiography 1991	Brazil	----	Case report	----	----
Pineda&Kuttler	Radiographic 1972	Mexico	100	----	----	----
Sert&Bayirli	Clearing 2004	Turkey	97	3	----	----
Thompson et al	Clinical 1985	USA	----	Case report	----	----
Vertucci	Clearing 1984	USA	100	----	----	----
Walvekar & Behbehani	Clinical Radiography 1997	Kuwait	----	----	Case report	----
Pereira	Clinical Radiography 2000	Brazil	----	Case report	----	----

Author	Methodology/ year	Country	1 canal(%)	2 canals(%)	3 canals(%)	4 canals(%)
Kottoor	Clinical (CBCT) 2012	India	----	----	----	Case report
Nosrat	Clinical CBCT) 2015	USA	---	---	---	Case report
Mohan	Radiographic 2012	India	---	Case report	---	---
Shokouhinejad	Clinical Radiography 2009	Iran	--	Case report	---	--

Considering that the variations in the external and internal anatomical and morphological features of the teeth influence the outcome of many dental treatments, all clinicians practicing in different dental disciplines must be attentive to possible complexities present. In root canal treatments most of iatrogenic procedural errors such as missed canals, canal transportations and also perforations arise from an insufficient knowledge of root canal anatomy and morphology of the teeth. (Pan *et al.* 2019) To avoid these procedural errors using the recently introduced facilities such as the CBCT, dental microscopes and loupes are highly recommended in complicated recognized cases on first common peri-Apical radiographs (Schwarze *et al.* 2002, Patel *et al.* 2007, Pan *et al.* 2019, Mashyakhi *et al.* 2019).

Conclusion

All maxillary Lateral incisors were single root and single canal in this Iranian population; in 67% of cases had distal curve and also in 29%, showed lateral canals that in 89% of the cases were located in the apical thirds, although many case report articles from different parts of the world and even in Iran have described maxillary lateral incisors to have one or two roots with, one, two, three and four root canals. By review of the literature it is concluded that, Turk, Asian and south(Latin) American populations are more probable to show additional roots and root canals than other racial groups in maxillary lateral incisors.

Conflicts of interests

Nothing to be declared.

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