ROOT CANAL MORPHOLOGY OF MANDIBULAR CENTRAL INCISORS IN A SOUTH-EASTERN ROMANIAN POPULATION: ENDODONTIC AND PERIODONTAL IMPLICATIONS

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ABSTRACT

A good knowledge of the anatomy of root canal systems is important to negotiate the canals and to carry out the root canal shaping. Such knowledge could help set the location and negotiation of canals and their subsequent management. The purpose of the present research is to assess the root canal morphology of mandibular central incisors in a South-Eastern Romanian population. Thirty-two extracted mandibular incisors were studied. Radiographs were taken in advance. The teeth were measured using a digital pakimeter. It was noticed that all examined teeth presented a single root. The internal anatomy was studied using a color detector and a tooth-clearing technique. The following landmarks were observed: external anatomy of the root (shape and size), apex angularity, and internal morphology. The mean length of roots was 13.05 mm. According to Vertucci’s classification, the majority of roots displayed a type I-root canal configuration (65.6%), type III was found in 25% cases, type II in 6.3 % and type VII in 3.1% of cases. Four teeth presented lateral canals and three teeth presented apical deltas. It was concluded that the variation in root canal morphology of mandibular incisors in the sample is fairly high, which may explain the fact that the endodontic treatment of the central mandibular incisors has a high failure rate and the periodontal status of these teeth may be affected. Therefore, the investigational use of an operating microscope as a complementary clinical device, which additionally can lead to an improvement of the sealing ability of the root canal filling during vertical condensation, is strongly recommended.

Keywords: root canals, apical foramen, morphology, southeastern Europe

INTRODUCTION

The success of the root canal treatment depends on the accurate knowledge of the anatomy of root canal systems. Thus, failure in root canal preparation of mandibular incisors occurs mostly because dentists miss the presence of second and/or lateral canals. Up-to-date, several researchers have examined the root canal systems of mandibular incisors. Vertucci studied the root canal morphology of 300 extracted lower incisors and showed that two canals were present in 30% of mandibular central incisors. Pecora et al. assessed the prevalence of mandibular anterior...
teeth with two canals. This situation was encountered in 29.7% of 300 lower central incisors. Mauger et al. assessed the canal anatomy at different root levels in 100 lower incisors and reported that 98–100% of the teeth had one canal in the area situated 1–3 mm above the apex. It has been reported that root canal systems may vary according to race. However, there are no published reports on the root canal morphology of mandibular incisors in the Romanian population.

The aim of the present study was to examine the root and canal morphology of the inferior incisors in a South-Eastern Romanian population and to assess their potential clinical implications.

MATERIAL AND METHODS

The study was performed at the Faculty of Dentistry of the Carol Davila University of Medicine and Pharmacy, Bucharest. Thirty-two freshly extracted mandibular central incisors were collected from the Oral Surgery Department of the Faculty of Dental Medicine, and from private dental practitioners in Bucharest, Romania. The teeth were cleaned using a curette to remove all traces of hard and soft tissue and then placed in a solution of 3.25% sodium hypochlorite for approximately one day. Following the cleaning procedure, the topographic dimensions of the teeth were observed and recorded.

External measurements were performed by using a digital pakimeter. The measurements were made in duplicate and the mean value was calculated. The following data were recorded: the length of the teeth, crowns and roots (on the buccal aspect); the presence or absence of proximal grooves in the cervical, middle and distal third on the external radicular aspects; the buccal-lingual and mesio-distal diameters of the cervical, middle and distal third; the apex orientation.

The teeth underwent radiographic examinations under two incidences: buccal-lingual and mesio-distal. The internal anatomy was studied as follows: the mandibular incisors were prepared for surgical access to the pulp chamber, according to Ingle, using a high-speed round diamond bur with a size proportional to the crown. The canals were located using a Maillefer Kerr file (size 10). The pulp tissue was removed by overnight immersion in 3.25% sodium hypochlorite, followed by ultrasonication. The teeth were then rinsed in running tap water for two hours and dried overnight. An endodontic irrigation syringe with a gauge 27 needle (BU Kwang Medical Inc., Seoul, Korea) was used to inject Indian ink (Sanford Rotring GmbH, Hamburg, Germany) into the root canal system, assisted by vacuum suction apically. After overnight drying, the teeth were demineralised by immersion in 10% nitric acid for 20 hours at room temperature (21°C). The acid solution was changed every six hours. The teeth were washed under the running tap water for four hours, dried and dehydrated using gradually increasing concentrations of ethanol (70%, 96% and 99%) for 12 h each. Finally, the dehydrated teeth were placed in methyl salicylate, which rendered them transparent after about two hours. The transparent specimens were examined by naked eye and, with the aid of radiographic findings, the following data were recorded: the number and type of root canals; the presence and location of lateral canals; the location and frequency of apical foramina.

The canal configurations were categorized according to Vertucci’s classification, as follows: type I: a single canal extends from the pulp chamber to the apex; type II: two separate canals leave the pulp chamber and join short of the apex to form one canal; type III: one canal leaves the pulp chamber and divides into two within the root; the two then merge to exit as one canal; type IV: two separate, distinct canals extend from the pulp chamber to the apex; type V: one canal leaves the pulp chamber and divides short of the apex into two separate, distinct canals with separate apical foramina; type VI: two separate canals leave the pulp chamber, merge in the body of the root, and redivide short of the apex to exit as two distinct canals; type VII: one canal leaves the pulp chamber, divides and then rejoins in the body of the root, and finally redivides into two distinct canals short of the apex; type VIII: three separate, distinct, canals extend from the pulp chamber to the apex.

Data were expressed as ranges, means, standard deviations and prevalences, as appropriate.

RESULTS

External morphology of mandibular incisors

All teeth within the examined sample presented a single root.

The mean length and standard deviation of the central incisors crowns were 6.97 ± 0.95 mm. The mean length and standard deviation of the central incisors roots were 13.05 ± 1.76 mm.

The presence of a proximal groove was recorded on the mesial aspect of 13 roots; in most of the cases (10) the groove was situated in the middle third. Ten roots exhibited a proximal groove on the distal aspect, its situation being recorded mostly (eight cases) in the middle third, too. The rest of the grooves were recorded in the coronal third, this finding having periodontal implications.
Twenty-one teeth (65.6%) presented a single canal (Vertucci type I). The prevalence of type II configuration was 6.3%. Twenty-five percent of the teeth presented type III configuration. One root (3.1%) had type VII morphology.

Four roots presented lateral canals and all of them were located in the apical third. A lateral canal in the apical third is shown in Fig. 2. The position of apical foramina was central in 24 teeth (75%), while a lateral location was found in five teeth (15%). Three teeth presented apical deltas, as illustrated in Fig. 2.

**DISCUSSION AND CONCLUSIONS**

The present study aimed to assess the internal and external morphology of extracted mandibular incisors in a South-Eastern Romanian sample population. Several techniques have been used to study root canal morphology, such as the radiographic examination, the root sectioning (splitting), and staining - clearing techniques. The last method was used in the present study. This method of staining and clearing proved to be very useful for the tridimensional evaluation of the root canal morphology. It has been stated that examination of details, such as lateral canals, requires adequate penetration of the ink. Nevertheless, the high quality of clarification was sufficient in order to observe the above mentioned details, although the staining was not optimal.

The external morphology data showed that the average length of the teeth was similar to that reported by Cohen. This finding may be of significance in choosing the appropriate root canal instruments and establishing the working length. As expected, values of the buccal-lingual and mesio-distal diameters were found to be the highest in the cervical radicular third, except for five teeth which had the first diameter larger in the middle third. Their measurements coincided with Vertucci canal type III configuration.

The presence of proximal grooves on the lateral radicular aspects is important for the occurrence of periodontal lesions. Longitudinal grooves account for the bacterial biofilm formation and its apical advancement, which, in turn, develop into localized periodontal pockets.

Twenty-three roots had the apex oriented either mesially or distally and 75% were found to have the apical foramen at the apical tip. Precurved files should be used for the scouting and instrumentation of these curved canals.

The internal morphology results showed that only 65.6% of the mandibular incisors presented a single canal, whilst the rest contained two canals in different
configurations. Our results present a higher frequency in occurrence of a second canal than that reported by previous studies.\textsuperscript{13,15-18} Lack of detection of the second canal usually leads to failure in endodontic treatment as periapical lesions and combined endodontic-periodontal lesions. The access cavity should therefore be extended in a cervical direction, in order to expose the lingual canal orifice, and the scouting should be made in both vestibular and lingual direction.

The Vertucci type III configuration was the most prevalent among roots with two canals, followed by types II and VII, respectively. Root canal instrumentation and filling are relatively accessible in type II morphology canals because each canal emerges distinctly from the pulp chamber and can be located distinctively with the aid of the operating microscope. The types III and VII present different situations, as the canals share the same space in some radicular areas and split in other zones. This requires adjustment and individualization of root canal preparation and filling, in order to obtain the best results in endodontic treatment.

Lateral canals were observed in 12.5% of the teeth, in the apical radicular third. From the clinician’s point of view, permeable lateral canals may raise many problems, as they may be potential pathways for dissemination of bacteria and toxins between pulp and periodontium.\textsuperscript{19} Fortunately, techniques as the dynamic irrigations and the gutta-percha condensation techniques make the overcome of most of treatment difficulties possible.

The variation in root canal morphology of mandibular incisors in the studied South-Eastern Romanian sample is fairly high, which may explain the fact that the endodontic treatment of the central mandibular incisors has a high failure rate. Therefore, the investigational use of an operating microscope as a complementary clinical device, which additionally can lead to an improvement of the sealing ability of the root canal filling during vertical condensation, is strongly recommended.

ACKNOWLEDGEMENTS

This research was supported by a grant of the National Center of Programs Management CNMP (contract 41-034/2007).

REFERENCES