Root Canal Configuration of Mandibular Anterior Teeth in Baghdad City by Cone Beam Computed Tomography

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Abstract

Background Appropriate root canal morphology knowledge is vital for successful endodontic treatment. One of the main reasons for root canal treatment failure is the lack of knowledge of canal morphology, causing missed uncleaned and unshaped canals and compromising the favorable outcome. Objectives To investigate root canal morphology of mandibular anterior teeth by CBCT imaging in a sample of the Iraqi population in Baghdad city. Materials and Methods A total of 441 healthy, untreated fully erupted mandibular anterior teeth from 75 CBCT scans were examined and investigated for root canal morphology categorized by Vertucci classification. The entire root length was examined in the axial section with a slice thickness of half a millimetre. Results All examined teeth had single roots. Obtained data expressed as number and percentage of canal configuration. The chi-square test showed a non-significant difference between males and females. Type I configuration was the most common 80%, while type III accounted only for 17%. Conclusion Single rooted with Type I canal configuration is the most prevalent in mandibular anterior teeth in the Iraqi subpopulation. However, the incidence of more than one root canal with different canal configurations is also detected.

Keywords: Root canal morphology; mandibular anterior teeth; cone beam computed tomography; vertucci classification.

Introduction

To perform a successful root canal treatment, complete and accurate identification, thorough cleaning, and filling of the root canal system is crucial. Since unfilled canals are assumed to be a potential cause of infection and can lead to periapical pathosis after treatment, their accurate detection would be indispensable (Pattanshetti et al, 2008). The most common reason for endodontic failure is undoubtedly missed canal anatomy. The mandibular incisors are known to be the smallest adult human teeth. They are almost always single rooted but the internal root canal anatomy is prone to exhibit complex variations. As these teeth are usually radiographed only in one plane, they appear single-canaled and
more accessible than they are, and it may be complicated by the presence of second (bifurcated) canals, lateral canals and apical deltas. Adding to the difficulty while treating these teeth, the narrow crown offers a restricted area of access to the root canals (Prita et al, 2017). Root canal morphology varies among different ethnic and regional populations because it is thought to be racially and genetically determined. Many studies have revealed variations in morphology among individuals of Asian race. A smaller number of studies have analyzed African, Latin-American and Caucasian patients, but these also show morphological variations (Walker, 1988). Different morphological variations of root canal systems have been investigated and classified by several investigators, and the most widely used is Vertucci’s classification (Vertucci, 1984). Many studies have examined root and canal morphologies using various methods. The methods used in analyzing root canal morphology are sectioning (Weine et al, 1969), canal staining and tooth clearing techniques (Vertucci, 1984), conventional radiography techniques (Pineda and Kuttler, 1972), contrast medium enhanced radiography (Fan et al, 2008), modified canal staining and clearing, and computed tomography CT scanning (Zheng et al, 2010). The advent of cone-beam computed tomography (CBCT) had brought in a significant reduction in radiation exposure and affordability of CT in many dental institutions and practices (Scarfe et al, 2006). Cone beam CT (CBCT) scanning has been used in the field of endodontics since 1990 (Tachibana and Matsumoto, 1990). CBCT uses a cone-shaped beam of radiation to acquire data in a single 360° rotation, which reveals the internal structure of an object. Data obtained by CBCT can be analyzed using appropriate software three-dimensionally giving the dentist accurate information to explore the pulp chamber and identify all canals. This diagnostic aid reduces the risk of canal perforation, missed canal anatomy, or morphology and greatly increases the chances for endodontic success (Gaurav et al, 2013). When CBCT is compared with conventional CT, it provides improved accuracy, higher resolution, lower scan time, and radiation doses (Scarfe, 2005). CBCT can be used for diagnosis in endodontics due to its noninvasive nature. A study reported that CBCT was as precise as the modified canal staining and tooth-clearing method in determining root canal morphology (Winter et al, 2005). To the best of our knowledge, few studies have evaluated the root and canal morphology in the Iraqi population (Ranjdar Talabani, 2021; Azhin and Fareed, 2020). However, no data are available on the determination of root and canal morphology of the anterior teeth with CBCT in the Baghdad subpopulation.

Materials and Methods
Cone beam computed tomography images were obtained from Ghazi Al-Hariri surgical specialties hospital, Baghdad between December 2019 and September 2020. Subjects with fully erupted mandibular anterior teeth (centrals, laterals, and canines) were selected. Seventy-five CBCT images, 43 females and 32 males, from different age groups were examined. The CBCT images were obtained using the CBCT dental imaging system Kavo OP3D Pro operating at 66 Kvp, 10 mA, 10-second exposure time, slice thickness of 0.5 mm, the field of view (13 x Ø 15 cm), voxel size 330 µm. Images were evaluated by the use of Invivo 3D imaging software. Cone beam computed tomography scans of good diagnostic quality within the region of interest and free of distortion were examined by experienced dental radiologists. Examined CBCT scans included those with intact crowns, completely formed roots, with no root canal calcification, resorption or fracture, periapical lesions or previous
surgical or nonsurgical root canal treatment. 441 teeth were investigated for variable root canal morphology in axial sections along the entire root length from the cementoenamel junction to the root apex. The level at which the pulp chamber ends and the canal begins was at or just apical to the cementoenamel junction as this is generally considered. The observations recorded were the number of canals per root and canal configuration by Vertucci classification according to the following criteria:

Type I: A single canal from the pulp chamber to the apex.
Type II: Two separate canals leave the pulp chamber and join to form one canal at the apex.
Type III: One canal leaves the pulp chamber, and divides into two canals joining to form one canal at the apex.
Type IV: Two separate and distinct canals present from the pulp chamber to the apex.
Type V: One canal leaves the pulp chamber, and divides into two separate canals with two apical foramina.
Type VI: Two separate canals leave the pulp chamber, join at the midpoint, and then divide again into two with two separate apical foramina.
Type VII: One canal leaves the pulp chamber, divides and then rejoins within the root, and finally redivides into two separate canals with two separate apical foramina.
Type VIII: Three separate and distinct canals begin from the pulp chamber to the root apex.

All of the teeth examined from CBCT scans had only a single root. 75 scans, 43 were females, had 252 teeth distributed as 84 centrals, 86 laterals, and 82 canines. While 32 males, had 189 teeth distributed as: 64 centrals, 64 laterals, and 61 canines. Four scans presented asymmetrical canal configurations between the right and left sides, three in females and one in a male. A total of 49 scans, 28 females and 21 males, had a single canal in all of their six anterior teeth, about 65% in contrast to a total of 26 scans, 15 for females and 11 for males had more than one canal in some of them, about 35%. Canal configurations found in descending order according to Vertucci classification were type I, type III, type V, and type IV, while type II, type VI, type VII and type VIII were absent. The results are summarized in Figure (1). Type I configuration was the most prevalent 80%, followed by type III 17%, and type V with only 2% in all of the anterior teeth. Figure (2): shows the distribution and percentage of root canal configuration according to sex. The chi-square test showed a non-significant difference between males and females in all types of canal configurations, p-value > 0.05. Figure (3): shows the distribution and percentage of canal configuration according to tooth type and sex.

Statistical methods
The obtained results were expressed as a percentage of root canal configuration frequency and the Chi-square test was used to assess the differences between male and female categories in root canal configuration. The level of significance for the statistical tests was set at p-value < 0.05. The calculation for the Chi-Square test is made by an interactive calculation tool for Chi-square tests of goodness of fit and independence. Available from http://quantpsy.org.

Results

Figure (1): Chart column showing the number and percentage of root canal configuration according to Vertucci classification.
Discussion

Vertucci classification was used to evaluate the root canal configuration as it seems to be the most frequently used classification. The root canal configuration of mandibular anterior teeth has been extensively studied by CBCT. In the present study, only Vertucci type I, type III, type IV, and type V were identified. Type 1 configuration was the most prevalent configuration which was by previous studies by Basha, (2018); Verma et al, (2017); Mashyakhy, (2017); Da Silva et al, (2016); Ying et al, (2014). Type IV canal configuration was the least prevalent type 0.2%, found only in canines, which is in contrast with Haghanifar et al, (2017) and Doumani et al, (2020), who found the least was type V. There is disagreement with the findings of Aminsobhani et al, (2013), who found that type IV accounts for 12.8%, 15.4%, and 7.7% in canine, lateral and central incisors respectively. Type II was absent in this study which agrees with Mashyakhy, (2017); Ying et al (2014); Basha, (2018), and Da Silva et al, (2016). There is disagreement with the findings of the Valenti-Obino et al, (2019) study in Italy which found the highest incidence of type II in 34% of incisors, and Baxter et al, (2020) in Germany which found type II in 22% of incisors and no type III configuration. Results showed there was a non-significant difference between genders. This finding is opposite to the studies of (Sert and Bayirli, (2004); Altunsoy et al, (2014); Lin et al, 2014), who reported a statistically significant difference between genders for the incisors. In two recent studies performed in Iraqi Kurdistan by Ranjdar Talabani, (2021) and Goran and Rofoo (2020), there was no gender significant difference identified except for centrals in the first study. Type I was the most prevalent configuration in both, followed by type II in the first and type III in the second study. The incidence of type I canal in central and lateral incisors was 77% and 74% respectively which was much higher than the result of Sert et al, (2004) in the Turkish population, Valenti-Obino et al, (2019); Da Silva et al, (2016) less than Ying et al, (2014); Basha, (2018). The second most common canal type in the present study was Type III which agrees and is close to the findings of Popovic et al, (2017); Da Silva et al, (2016); Mashyakhy, (2017). While type V in this study was less than that of Da Silva et al, (2016) et al, and Goran and Rofoo, (2020). The incidence of the second canal in mandibular incisors in this study was about 25%, which was lower than the finding of Çalışkan et al, (2016) 31.37% in Turkey, and Rahimi et al, (2013) 36.62% in Iran. These data are close to those of Vertucci, (1984) at 27.5% in the USA and Al-Qudah and Awawde, (2006) in Jordan at 26.2%, and higher than Liu et al, (2014) in China at 13.2%, Miyashita et al, (1997) in Japan at 12.4% and Madeira and Hetem, (1973) in Brazil at 11.6%, and lower than
those of Kartal and Yanikogulu, (1992) at 45% and Sert et al., (2004) at 65.3% in Turkey. The incidence of the second canal in mandibular canines in the present study was 9%, which was similar to Soleymani et al. in Iran at 9.4%, higher than the results of Altunsoy et al., (2014) in Turkey at 4.4%, Ying et al., (2014) in China 2.97%, and Rahimi et al., (2013). in Iran at 8.4%, and lower than the findings of Çalışkan et al., (2016) at 19.6%, Sert and Bayirli, (2014) at 23.5% in Turkey, and Aminsobhani et al., (2013) in Iran at 28.7%. Factors contributing to the difference in results with other studies may be due to ethnic, and racial variations, variations in sample size, and age differences. Mandibular anterior teeth are considered to last longer in older individuals and secondary dentin deposition contributes to canal obliteration.

Conclusions
Under the limitations of this study, CBCT imaging is an excellent method of root canal configuration detection of mandibular anterior teeth and the obtained findings emphasize the importance of knowledge of variations in root canal morphology. Canal configuration is subjected to racial and ethnic variations and studying it may help clinicians to overcome problems associated with shaping and cleaning procedures because the existence of a second canal is rarely apparent on periapical radiographs, and routine endodontic procedures from the lingual approach fails to reveal the presence of the second canal, increasing the chance of compromised outcome. More studies are needed to further define variations of canal configurations in mandibular anterior teeth in the Iraqi population.

Conflict of interest
We the author’s (Hanan Jawad Kadhim, Ali Hassan Abdul Ghani and Soran Kahtan Mohammedsaleh) state that the manuscript for this paper is original, and it has not been published previously (or part of an MSc. dissertation or PhD thesis) and is not under consideration for publication elsewhere and that the final version has been seen and approved by all authors.

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