Assessment of root canal configuration of mandibular incisors using cone-beam computed tomography in a sample of Iraqi patient

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Abstract

Background and objectives: Mandibular incisors mostly have 1 root canal. The purpose of this study was to investigate the prevalence of root canals configurations in mandibular incisors and to investigate the gender prevalence. **Methods:** A total of 1200 patients' cone-beam computed tomography scans were screened and evaluated by two independent maxillofacial radiologists assessed the axial, sagittal, and coronal sections. Inclusion criteria applied to 429 patients; 200 females and 229 males, aged 14 to 75 years with total of 1716 mandibular incisors were evaluated. Inclusion criteria: Available Cone-beam computed tomography BCT images of mandibular anterior teeth with complete root formation, the presence of at least 1 central or lateral mandibular incisor in the scan, absence of root canal treatment, absence of coronal or post coronal restorations, absence of root resorption or periapical lesions and high-quality images. Canal configuration was classified according to the following criteria of Vertucci: type I, II, III, VI, V, VIII, VI, VII and VIII. The root canal morphology was recorded and analyzed. **Results:**The prevalence of type I root canal in mandibular incisors was found in 1360 teeth (79.254%), type III was found in 348 teeth (20.279%) and type II was found in 8 teeth (0.466%) while types VI, V, VIII, VI, VII and VIII were not detected. **Conclusions:**The occurrence of more than 1 root canal mandibular incisors is approximately 20% while single canal in mandibular incisors was (79 %), the difference in the canal types configurations and genders between the central and lateral incisors are non-significant.
Key words: Cone-beam computed tomography, Mandibular incisor, Root canal morphology.

Introduction

Understanding of root canal morphology and configuration showed an important role in the success of endodontic therapy. Many studies evaluating the configurations of root canals have been undertaken. Macroscopic sections, polyester resin impressions, transparent samples, and radiograph were used in both in vivo and in vitro studies[1,2].

It was first expected that mandibular incisors mostly had only a single root canal[3], Vertucci distinguished the complex root canal system and recognized 8 root canal configurations. He found that a single canal with 1 foramen was recognized in 70% of mandibular central incisors and in 75% of the mandibular lateral incisors[1].

Miyashita et al inspected the canal configuration of 1085 mandibular incisors. They observed 87.6% of single canals coronally to apically[4]. Green discovered that 79% of 500 central and lateral mandibular incisors had 1 major canal with 1 apical foramen[5].

Cone-beam computed tomography (CBCT) has become increasingly common in endodontic practice. Cone-beam computed tomography has been found to be useful for the diagnosis of root canal morphology[6,7] and for identifying additional canals and roots[8,9].

Based on CBCT scans, Shemesh found that 40.5% of central incisors and 37.9% of lateral incisors had more than 1 canal (type III was the predominant canal type)[10], high prevalence of 2 root canals in the mandibular anterior teeth of the studied Chinese and Turkish subpopulation showed 2 root canals in the lateral incisors was higher than that in the central incisors[11,12]. Conventional radiography is the most widely used method to distinguish tooth anatomy. Cone-beam computed tomography imaging is a noninvasive technique that was reported to be as accurate as the modified canal staining and clearing technique for evaluating root canal systems[13].

Periapical radiography provides a 2-dimensional image in which the canals may overlap with the surrounding tissue while CBCT scanning shows the sectional view[14].

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Cone-beam computed tomography scanning is an extra oral imaging system that produces 3-dimensional scans of the maxillofacial skeleton. The images obtained from the CBCT scanner are displayed in axial, sagittal, and coronal planes and minimize the superimposition of surrounding structures. Cone-beam computed tomography imaging, as a noninvasive tool, has been used to detect periapical lesions and root canal morphology[15].

The purpose of this study was to investigate the prevalence of canals configurations types in central and lateral mandibular incisors and its gender difference in Iraqi patient using CBCT.

Patients and methods

A total of 1200 patients' retrospective dental CBCT (The CBCT images were performed using NewTom GIANO CBCT Bologna, Italy, operating at high frequency 60-90KV;1-10 MA pulse mode and 0.5mm focal spot). All CBCT exposures were performed by an appropriately licensed radiologist.

Radiographic CBCT records obtained from the referred patients to the radiographic clinic (Denta Radiologic center, Erbil, Kurdistan region, Iraq) between 2013 - 2017 regardless of age, thus characterizing a convenience sample, the samples were selected based on the following criteria: Available CBCT images of mandibular anterior teeth with complete root formation, the presence of at least 1 central or lateral mandibular incisor in the CBCT scan, absence of root canal treatment, absence of coronal or post coronal restorations, absence of root resorption or periapical lesions and high-quality CBCT images.

A total of 429 patients met the inclusion/exclusion criteria were analyzed with NNT software using a Dell Precision T5400 workstation (Dell, Round Rock, TX, USA).

Two independent maxillofacial radiologists assessed the axial, sagittal, and coronal sections to reach a consensus on the interpretation of the radiographic findings. In cases where a consensus was not reached, a third professional oral radiologist was asked to perform a decisive evaluation.

Canal configuration was classified according to the following criteria of Vertucci [1]

Type I: A single canal appears from the pulp chamber to the apex, type II: 2 separate canals leave the pulp chamber but merge into 1 to the exit, type III: 1 canal leaves the pulp chamber, divides into 2 within the root, and then merges to the exit, type IV: 2 distinctly separate canals are present from the pulp chamber to the apex, type V: A single canal leaves the pulp chamber but divides into 2, type VI: 2 separate canals leave the pulp chamber, join at the midpoint, and then divide again into 2 with 2 separate apical foramina, type VII: 1 canal leaves the pulp chamber, divides and then rejoins within the root, and finally re divides into 2 separate canals with 2 separate apical foramina and type VIII: 3 separate and distinct canals begin from the pulp chamber to the root apex, Figure (1).

The proposal of the study was approved by the ethical and scientific committee of the Kurdistan Higher Council of medical specialty.

The independent T-test was used to compare central and lateral incisors and between the two genders. Statistical analysis was performed by SPSS Ver. 18.0 software.

Results

A total of 429 patients (200 females and 229 male) aged 14 to 75 years were included in this study. Total of 1716 mandibular incisors were evaluated. Mandibular incisors, type I was found in 1360 teeth (79.254%), type III was found in 348 teeth (20.279%), Figure (2) and type II was found in 8 teeth (0.466%) while types VI, V, VIII, VI and VII were not detected.
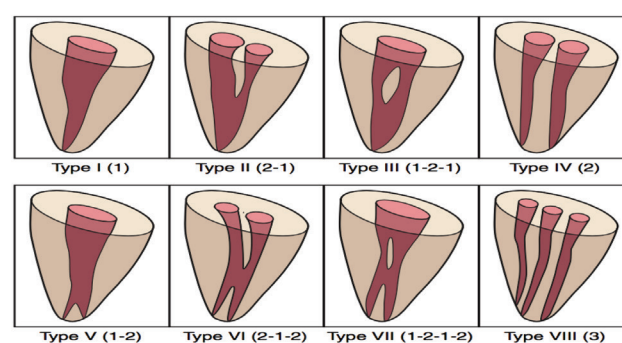
Figure (1): Vertucci Classification of Root Canal Systems (Types I–Type VIII)1.
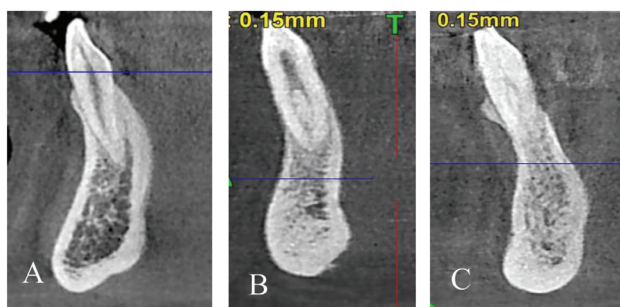
Figure (2): Cone-beam computed tomography images of mandibular incisors: (A) type I;
(B) type III; (C) type II.

Regarding the difference between male and female root canal configuration the paired t-test showed that there was non-significant difference in the canal types configurations between the male and lateral female p-value > 0.05, Table (1), while the difference between the central and lateral incisor root canal configuration the paired t-test showed that there was non-significant difference in the canal types configurations between the central and lateral incisors p-value > 0.05, Table (2).

Table (1): Comparison between genders.

Gender	Mean± SD	Standard Error of Mean	95% CI of the Difference Upper	Lower	p-value
Male - female	6.0E1± 36.76955	26.0	-270.36	390.36	0.26

Table (2): Comparison between Central and Lateral .incisors

Incisors	Mean± SD	Standard Error of Mean	95% CI of the Difference Upper	Lower	p-value
Central- lateral incisor	2.8E1± 36.76	26.0	-302.36	358.36	0.47

Discussion

The root canal configuration of central and lateral mandibular incisors was investigated using various methods; the study examined 500 central and lateral mandibular incisors by grinding the root and staining the canals. It found that 21% of the central and lateral mandibular incisors had 1 major canal with 1 apical foramen[4].

Vertucci studied 200 central and lateral mandibular incisors by decalcification, and hematoxylin dye was injected into the pulp cavities. He found that a single canal with 1 foramen was identified in 70% of the mandibular central incisors, 27% had 2 canals with 1 apical foramen, and 3% had 2 canals with 2 apical foramina. Approximately 75% of mandibular lateral incisors had a single canal with 1 foramen, 23% had 2 canals with 1 apical foramen, and 2% had 2 canals with 2 apical foramina[1].

Most of these studies have used the classification system by Vertucci[1]. However, in these morphological studies, gender has not been taken as a parameter. Sert et al investigated 400 extracted central and lateral mandibular incisors using a demineralization and staining technique it showed that 67.5% of central mandibular incisors and 63.0% of lateral mandibular incisors had more than a single canal[12].

Cone-beam computed tomography is a radiographic examination that provides 3-dimensional observations of roots, root canals, and adjacent structures. CBCT has been found to be useful for the diagnosis of root canal morphology[6,7] and for identifying additional canals and roots[8,9].

Han et al examined more than 1200 CBCT scans of central and lateral mandibular incisors in a Chinese subpopulation showed that 15.71% of central mandibular incisors and 27.36% of lateral mandibular incisors had 2 canals[11].

Shemesh et al investigated the root canal configuration of 1472 central mandibular incisors and 1508 lateral mandibular incisors utilizing CBCT images and showed that 59.5% of central mandibular incisors and 62.1% of lateral mandibular incisors had a single canal[10]. In the present study examined root canal morphology of 1716 mandibular incisors using CBCT, revealed that 79.254% had a single canal.

The incidence of a second canal in mandibular incisors in the present study was 20.279% , which was in accord with the findings of Vertucci (27.5%)[1] and Al-Qudah and Awawdeh (26.2%)[17], These data were clearly higher than those of Miyashita et al (12.4%)[3], and Liu et al (13.2%)[16] and lower than those, Caliskan et al (31.37%)[18], Sert et al (65.3%)[12], and Rahimi et al (36.62%)[19].

In most of these existing studies, the incidence of a second canal was relatively similar for mandibular central and lateral teeth as in Shamsh el al10 found no significant difference between central and lateral mandibular incisors (p-value > 0.05). The bilateral incidence of more than 1 root canal (type II–type VIII) in central and lateral

mandibular incisors was 69.8% and 68.7%, respectively[10]. In the present study no significant difference between central and lateral incisors (p-value >0.05), whereas this incidence was utterly different in Han et al[11] findings in which the mandibular lateral incisors had more double canals (27.36%) than did central incisors (15.71%) (p-value < .05).

Regarding the gender in the present study there was non-significant difference in the canal configuration between genders p-value > 0.05 and same finding was reported that there were no significant differences were noticed between male and female patients regarding canal configuration (p-value >0.05)[12,21,22], while the incidence by Arsalan et al [20] the difference of the canal configurations was higher in males than in females (p-value < 0.001)[20].

Conclusions

Knowledge of the anatomic variations of the central and lateral mandibular incisors is essential for successful treatment. In the present study, based on CBCT scans, 20.279% of mandibular incisors had more than 1 canal (type III) and no significant difference in the canal types configurations and genders between the central and lateral incisors p-value > 0.05. These data can help the clinician in choosing instrumentation systems and obturation methods during the treatment of central and lateral mandibular incisors.

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