

## A CONE-BEAM COMPUTED TOMOGRAPHY STUDY OF ROOT ANATOMY AND CANAL MORPHOLOGY OF MANDIBULAR INCISORS IN AN EGYPTIAN SUB-POPULATION

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### ABSTRACT

Endodontic treatment is basically dependent on knowledge of the root canal morphology. The purpose of this study was to analyze the root canal configuration of the mandibular incisor teeth in the Egyptian subpopulation using cone-beam computed tomographic (CBCT) imaging. A total of 1140 CBCT images of mandibular incisor teeth were obtained from 300 patients who were seeking to receive implant or orthodontic treatment and accepted CBCT projection. Vertucci's classification was used as a reference to correlate the analysis. The number of roots, number of canals, and root canal type were calculated and plotted. The results showed that all the mandibular incisors revealed one root. The analysis of root canal number irrespective to canal configuration type revealed single root canal (90.2%, n= 53) out of 592 central mandibular incisors and (81.38% n= 446) out of 548 lateral mandibular incisors. The prevalence of two root canals in mandibular lateral incisors (18.61%, n=102 out of 548) was significantly higher than that of mandibular central incisors (9.45% n=56 out of 592) ( $P < 0.5$ ). Within the limitations of this study, it has been concluded that CBCT is efficient tool for mapping root canal configuration. The majority of the Egyptian subpopulation have higher incidence of single canal in lower incisors. Most of two canal cases was type II.

### INTRODUCTION

Proper root canal disinfection and sealing is a mandatory requirement to regain the periapical tissue health<sup>(1)</sup>. Usually the most common misshape that causes failure is the incomplete instrumentation and faulty obturation<sup>(2)</sup>, which is a result of the lack of thorough knowledge about the anatomy of root canals and their variations and being technically unable to manage such variations. Different

methods were used in previous studies to examine root canal morphology. Most of them were performed on extracted teeth using canal and modified canal staining, tooth clearing techniques<sup>(3-9)</sup>, transverse cross-sectioning<sup>(10)</sup>, and conventional radiographs<sup>(8)</sup>. Recently, Cone-beam computed tomographic (CBCT) imaging has been used as an aid for mapping root canal morphology<sup>(11-17)</sup>. In contrary to periapical radiography, CBCT imaging can provide 3-dimensional (3D) images from 3 different views;

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the axial, sagittal, and coronal sections (Figure 1). In addition, it overcomes the difficulty caused by the superimposition of surrounding structures <sup>(18,19)</sup>. CBCT scans can better visualize additional canals compared to other radiographs and cross sectioning <sup>(20)</sup>. Furthermore, the low radiation dose, high-resolution image quality, and rapid scan time make CBCT imaging superior to conventional imaging radiographs <sup>(21)</sup>.

There is no large sample analysis of the root canal morphology of the mandibular incisors in the Egyptian subpopulation. From this point, the idea of this study is to have a solid base for the reference of the root canal morphology.

## MATERIALS AND METHODS

### Sample preparation

A total of 1140 CBCT images of mandibular incisor teeth were collected from 300 patients who accepted CBCT scanning as a preoperative evaluation for orthodontic and implant treatment at a private dental center (Shiny White Dental Center, Cairo, Egypt) between March 2016 and August 2017. The patients approved a written and verbal consent before proceeding any dental treatment.

### Imaging

The CBCT images were taken using Orthophos SL CBCT scanner (Sirona, Germany) operating at 85 kV and 35 mA with an exposure time of 2–6 seconds. The voxel size was 0.125 mm, and the slice thickness was 1.0 mm. CBCT Scans were performed according to the manufacturer's protocol recommendations with the minimum exposure required for adequate image resolution as well as the lowest radiation dosage. CBCT images obtained from subjects were screened using a CBCT scanner (Orthophos SL, Sirona, Germany), and the samples were selected according to the following criteria:

- Fully developed roots.

- Absence of any periapical lesions.
- Non endodontically treated canals.
- Absence of open apices.
- Absence of root resorption or calcification.
- Absence of artificial prothesis.

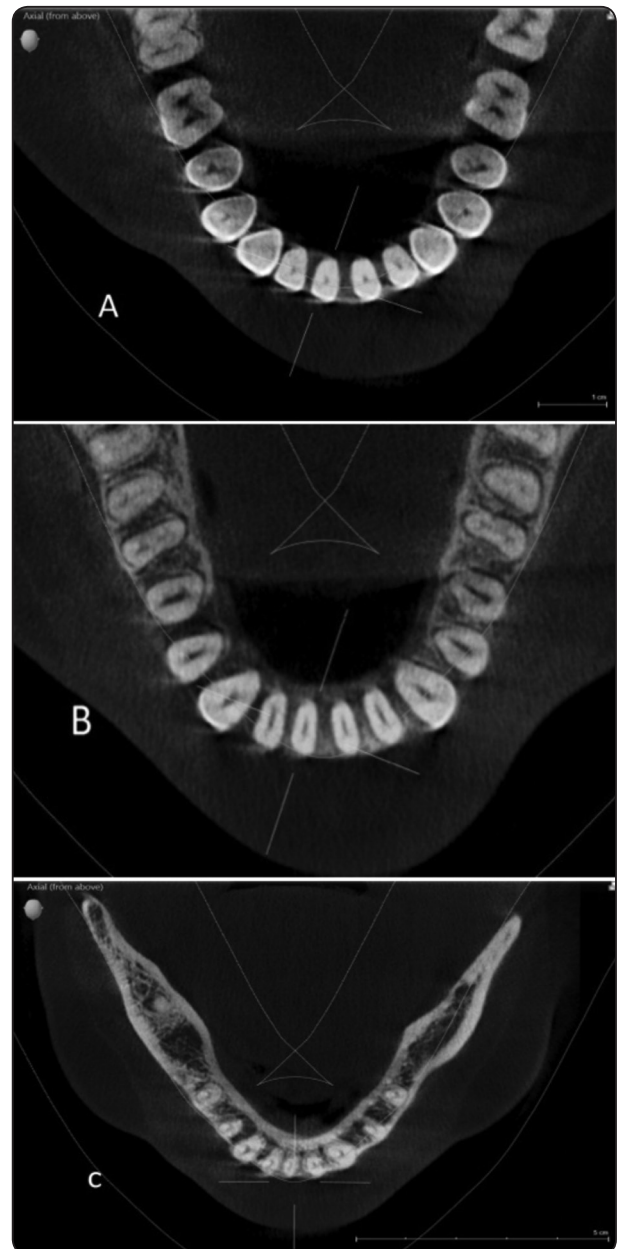


Fig. (1) The axial planes of CBCT scanning in the coronal (A), middle (B), and apical (C) thirds of the root displayed variations in canal morphology.

## Analysis

The CBCT images were viewed in three planes (axial, sagittal and coronal) and were analyzed with the built-in software package SIDEXIS XG V.4.1. If needed, images contrast and brightness were adjusted for optimal visualization. All the images were evaluated twice by two endodontists together with 3-weeks interval between the two evaluations.

The following information was recorded and analyzed:

1. Tooth position
2. The root and canal number for each tooth
3. The root canal type for each root

**Canal configuration was classified according to the following criteria of Vertucci<sup>(6)</sup> (Figure 2)**

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

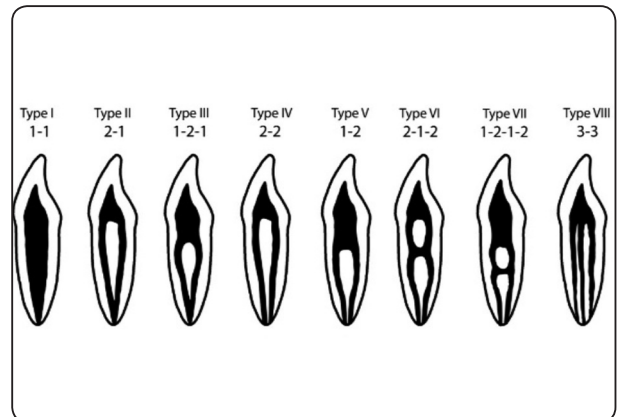


Fig. (2) Vertucci's (1984) classification of canal configuration.

## RESULTS

All the mandibular incisors revealed one root. The number of root canal was summarized in table 1.

The analysis of root canal number irrespective to canal configuration type revealed single root canal (90.2%, n= 534) out of 592 central mandibular incisors and (81.38% n= 446) out of 548 lateral mandibular incisors.

The prevalence of two root canals in lateral mandibular incisors (18.61%, n=102 out of 548) was significantly higher than that of central mandibular incisors (9.45% n=56 out of 592) ( $P < 0.5$ ).

The analysis of the prevalence of root canal type according to Vertucci's classification was summarized in table 2.

The most common morphology in all mandibular incisors was type I root canal configuration. Mandibular central incisors revealed type I canal type in (90.2%, n= 534) of the cases while mandibular lateral incisors revealed the same root canal type in (81.83%, n= 446) of the cases.

Type II canal is the most common root canal type in 2-canal incisors ([4.39%, n = 26] and [12.95%, n = 71] in central and lateral mandibular incisors, respectively.

TABLE (1) Number of canals in mandibular central and lateral incisors

Tooth type	Single root canal	Two root canals	Total
Central mandibular incisors	534 (90.2%)	56 (9.45%)	592 (100%)
Lateral mandibular incisors	446 (81.38%)	102 (18.61%)	548 (100%)

TABLE (2) Canal type of mandibular central and lateral incisors based on Vertucci's classification

Canal type	Type I	Type II	Type III	Others
Central mandibular incisors	534 (90.2%)	26 (4.39%)	18 (3.04%)	14 (2.36%)
Lateral mandibular incisors	446 (81.38%)	71 (12.95%)	19 (3.46%)	12 (2.18%)

The prevalence of the other configuration types was as follows:

- *Type III* occurred in (3.04%, n = 18) of central mandibular incisors cases and in (3.46%, n = 19) of lateral mandibular incisors cases.
- Other root canal types were also found in mandibular incisors with relatively less frequency.

## DISCUSSION

The CBCT scanning has been used as a tool to examine root canal morphology in different subpopulations.

It is non invasive method and a practical way to examine root canal morphology. It provides 3-dimensional images in axial, sagittal, and coronal sections that could avoid geometric distortion and anatomic superimposition<sup>(18,19)</sup>.

The prevalence of complex root canals in mandibular incisors based on a survey of available studies in last four years was summarized in table 3.

This study focused on the evaluation of the root canal morphology of mandibular incisors in the Egyptian subpopulation.

A total of 1140 CBCT images of mandibular incisor teeth from 300 cases were evaluated, including 592 central incisors and 548 lateral incisors.

One of the interesting findings of the Egyptian subpopulation within the limitation of the sample size selected was the prevalence of single canal in most of the cases. It reached up to 90.2% and 81.83% in central and lateral incisors respectively. This incidence was in agreement with Chinese subpopulation, *Liu J., et al*<sup>(15)</sup> and *Han T. et al*<sup>(11)</sup> and in Iranian subpopulation *Saati S., et al*<sup>(13)</sup> who all revealed 86.8%, 78.44% and 81.4% respectively type I root canal morphology of their selected case. While it was in different coincidence with Turkish subpopulation *Arslan H. et al*<sup>(12)</sup> and Isralian subpopulation *Shemesh M., et al*<sup>(14)</sup> who revealed lower incidence 52.4% and 39.61% type I root canal morphology respectively.

The majority of two canals in the rest of the sample selected for this retrospective study showed type II configuration in the two canal morphology.

The study used CBCT scanning to examine the root canal morphology of mandibular incisor teeth in an Egyptian subpopulation. Yet, limited data was available on the root canal system of mandibular incisors using CBCT with this sample size for the Egyptian subpopulation. Therefore, this study can be helpful for mapping of root canal configuration as a supplemental information for mandibular incisors in Egyptian subpopulation.

TABLE (3) Prevalence of complex root canals in mandibular incisors based on a survey of available studies in last four years

Author	Method	Year	Population	Total number of incisors	Percent of single canal	Percent of more than one canal
Han T. et al	CBCT	2014	Chinese	2580	78.44%	21.55%
Arslan H. et al	CBCT	2015	Turkish	374	52.4%	19.13%
Liu J., et al	CBCT	2014	Chinese	1553	86.8%	13.2%
Shemesh M., et al	CBCT	2018	Israeli	2980	39.61%	60.39%
Saati S., et al	CBCT	2018	Iranian	414	81.40%	18.59%

## CONCLUSION

Within the limitations of this study, it can be concluded that CBCT is a valuable aid for mapping root canal morphology. The majority of the Egyptian subpopulation have high incidence of single canal in lower incisors. Most of two canal cases was type II.

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