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ASSESSMENT OF INCISIVE CANAL MORPHOLOGY AND POSITION IN A SAMPLE OF EGYPTIAN POPULATION: A CONE BEAM COMPUTED TOMOGRAPHY STUDY

Hisham Elsheikh*, Caroline Maged Massieh**,
Magdy Fouad Youakim*** *and* Sherif Shafik El Bahnasy****

ABSTRACT

Several studies have highlighted the diversity in the anatomy of the incisive canal. Evaluation of incisive canal as well as its approximation to the maxillary incisor root is crucial before orthodontic treatment, implant placement and other surgical procedures in the anterior maxillary area. Cone-beam computed tomography (CBCT) provides detailed three-dimensional information and have been used to evaluate the nasopalatine region with high accuracy along with relative safety due to low radiation exposure.

Aim: The study aimed to provide analysis of the nasopalatine canal anatomy using cone-beam computed tomography (CBCT) in a sample of the Egyptian population.

Materials & methods: A retrospective study will conducted on 100 CBCT scan, 50 males and 50 females taken between years 2022 & 2024, for various purpose such as orthodontic treatment and implant surgeries. CBCT were randomly selected from archives of radiology department of the Faculty of Dentistry, The British University in Egypt. CBCT will obtained with Planmeca® Viso G7 machine (Planmeca Oy, Helsinki, Fin land). The acquisition parameters were as follow: field of view 25 x 25 cm, voxel size 200 μm, tube voltage 100 kV, and current 50 mA. Images were saved as digital imaging and communication in medicine (DICOM) files, and sagittal and horizontal views of those were extracted and evaluated using Planmeca Romexis® software (Version 6.3. Planmeca Oy Asentajankatu 6 FIN-00880 Helsinki, Finland). Images were viewed using Dell monitor (22'' Full HD 1920 × 1080 display) in dimmed light room.

KEYWORDS: CBCT, Incisive canal, Nasopalatine Canal, Three-dimensional detailed information

* Lecturer of Oral & Maxillofacial Radiology, Faculty of Dentistry, The British University in Egypt
** Lecturer of Oral Biology, Faculty of Dentistry, The British University in Egypt
*** Professor of Anatomy, Faculty of Medicine, Cairo University, Faculty of Dentistry, The British University in Egypt
**** Associate Professor of Oral & Maxillofacial Radiology, Faculty of Dentistry, The British University in Egypt.

INTRODUCTION

The incisive canal (nasopalatine canal) is a bony channel between nasal and oral cavities. It opens above into the nasal cavity, by two openings, one on each side of the nasal septum as nasopalatine foramina also called Stenson's foramina, which lie about 2 cm posterior to the nostril inner margin. Below it opens through incisive foramen into the floor of the incisive fossa which lies behind the central incisor teeth. [1, 2]

Having two superior endpoints and one end at the incisive fossa, the nasopalatine canal most frequently has a typical "Y" shape in 60% of the population. [3]

The nasopalatine canal works as a passage for the nasopalatine nerve. It also contains the anastomosis between sphenopalatine and greater palatine arteries. [4]

Several studies have highlighted the diversity in the anatomy of the nasopalatine canal. The shape, dimensions, angulation of the nasopalatine canal as well as thickness of anterior maxillary bone can vary based on sex, age, and ethnicity. In addition, periodontal diseases, teeth extraction, trauma and neoplasms may affect the maxillary bony architecture and alter nasopalatine morphology. Furthermore, certain systemic conditions like diabetes mellitus and osteoporosis, can alter bone morphology and influence canal size and position. [5-7]

Evaluation of incisive canal as well as its approximation to the maxillary incisor root is crucial before orthodontic treatment, implant placement and other surgical procedures in the anterior maxillary area. It bears great importance to prevent neurovascular injury of the nasopalatine nerve and its accompanying vessels which are liable to damage during dental practices, with the consequence of loss of sensation of the anterior palate as well as hemorrhage. [8, 9]

Incisive canal morphometric analysis of the by two-dimensional conventional X-ray imaging methods provides limited information and might not adequately show its anatomical variations. Analysis by cone-beam computed tomography (CBCT) offers three-dimensional detailed information. It has been used to evaluate the nasopalatine region with high accuracy along with relative safety due to low radiation exposure. [10, 11]

Though, the dimensions, angulation and location of the incisive canal often present a challenge during dental procedures, limited data is available on the anatomy of the canal in the Egyptian population.

AIM

The study aimed to provide analysis of the morphology of the incisive canal using CBCT in a sample of Egyptian population.

MATERIALS & METHODS

A retrospective study was conducted on 100 CBCT scan, 50 males and 50 females taken between years 2022 & 2024, for various purpose such as orthodontic treatment and implant surgeries. CBCT were randomly selected from archives of the radiology department of the Faculty of Dentistry. The British University in Egypt.

Inclusion criteria: Medically free Egyptian males and females with an age range of 20–40 years were included in the study.

Exclusion criteria: Missing or supernumerary maxillary incisors, midline deviation of maxillary incisors ≥2mm from the facial midline, history of orthodontic treatment, history of prosthodontic treatment, history of trauma to maxillary incisors, evident nasopalatine pathology (e.g., nasopalatine duct cysts), congenital anomalies (e.g., cleft lip and palate). Also, CBCT scans for individuals with any evident radiographic abnormality indicative of osteoporosis or other systemic diseases were excluded.

CBCT was obtained with Planmeca® Viso G7 machine (Planmeca Oy, Helsinki, Fin land). The acquisition parameters were as follow: field of view 25 x 25 cm, voxel size 200 μm, tube voltage 100 kV, and current 50 mA. Images were saved as digital imaging and communication in medicine (DICOM) files, and sagittal and horizontal views of those were extracted and evaluated using Planmeca Romexis® software (Version 6.3. Planmeca Oy Asentajankatu 6 FIN-00880 Helsinki, Finland). Images were viewed using Dell monitor (22" Full HD 1920 × 1080 display) in dimmed light room.

The following measurements were taken:

Incisive canal length from the upper opening to inferior opening. [20]

Incisive canal anteroposterior diameter at its middle. [21]

The angle between the incisive canal and the hard palate plane. [24]

The horizontal distance from the incisive canal at its middle and the facial surface of the buccal bone plate. Each measurement made in the corresponding view. Figure (1 & 2).

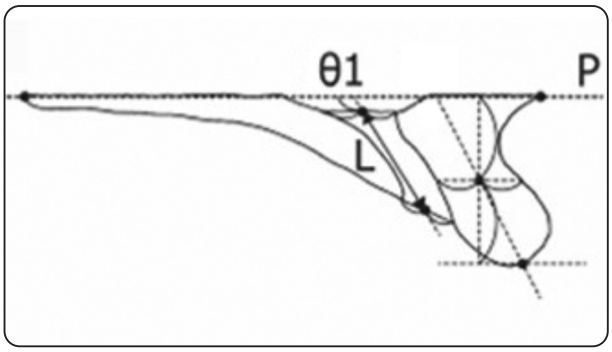


Fig. (1) Showing measurement of incisive canal length and the angle between base of hard palate and canal

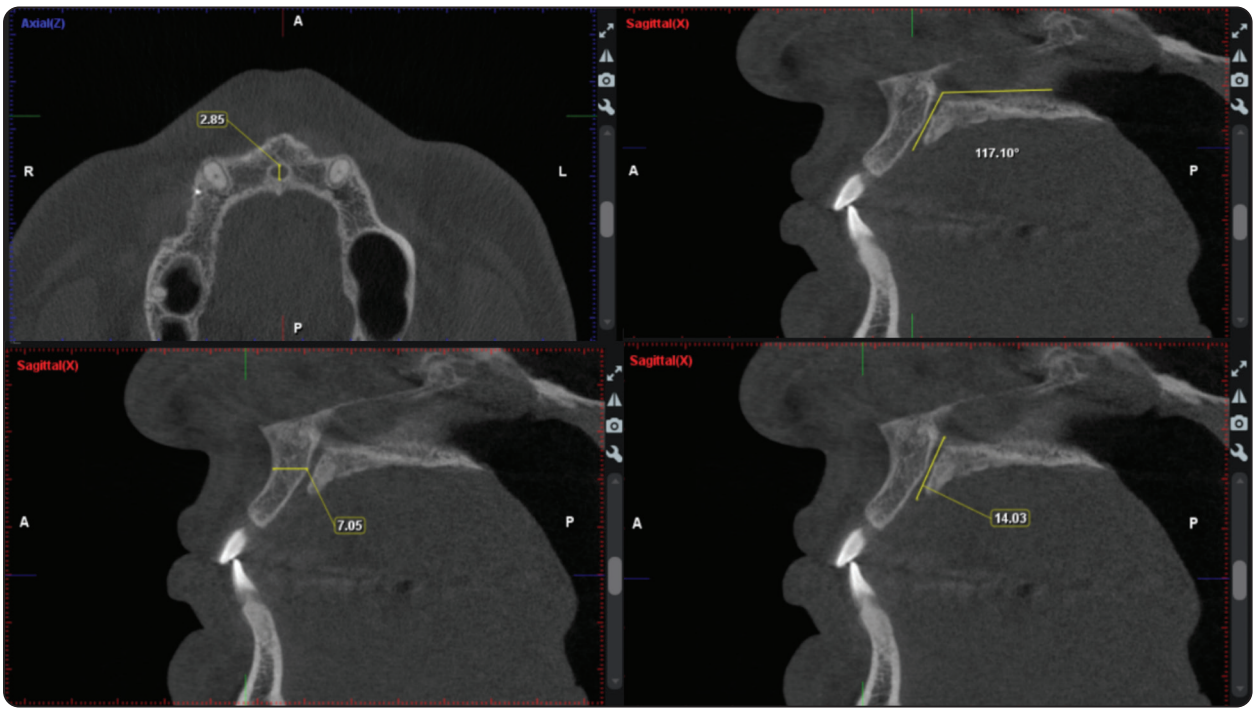


Fig. (2) Showing measurement of buccolingual diameter of incisive canal at the middle, canal length, angle between canal and hard palate, thickness of bone from buccal cortical plate to canal wall at middle level

Statistical analysis:

The Shapiro–Wilk test was applied to assess the normality of all sample sets. Data analysis was then conducted using unpaired t-test to compare between the male and female groups, with statistical significance set at $p<0.05$. GraphPad Prism 9.0 (GraphPad Software, San Diego, CA, USA) was the software used for these statistical analyses. All results are expressed as mean ± standard deviation (SD).

Sample Size Calculation:

A power analysis was conducted using G*Power 3.1.9.7 to determine the minimum required sample size for detecting sex-based differences in the morphometric characteristics of the incisive canal. Based on effect sizes reported in prior studies for canal length differences between males and females (e.g., Cohen's $d \approx 0.8$ for large effects) (29, 30), and using a significance level of $\alpha = 0.05$ with a power of 0.95 (95%), it was estimated that a minimum of 42 participants per group (total = 84) would be required to detect statistically significant differences using independent samples *t*-test. To increase the robustness of the analysis and account for potential data exclusion, a total sample of 100 CBCT scans (50 males and 50 females) was included.

RESULTS

A total of 100 patients, 50 males and 50 females CBCT were included in this study.

We examined morphological characteristics of the nasopalatine canal including its length, diameter, angulation as well as and the thickness of the buccal bone plate.

The mean canal length was 12.49 mm in males and 10.4 mm in females, Table1, Graph 1.

The mean canal width was 3.46 mm in males and 2.53 mm in females, Table 2, Graph 2.

The mean canal angle was 112.2° in males and 103.5° in females, Table 3, Graph 3.

The mean distance between the incisive canal at its middle and the facial surface of the buccal bone plate was 8.5 mm in males and 6.3 mm in females, Table 4, Graph 4.

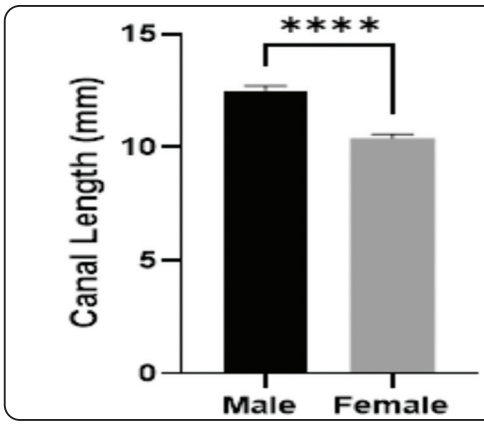
Values of all parameters measured were found to be statistically significantly higher in males than in females, Graphs 1-4.

TABLE (1)

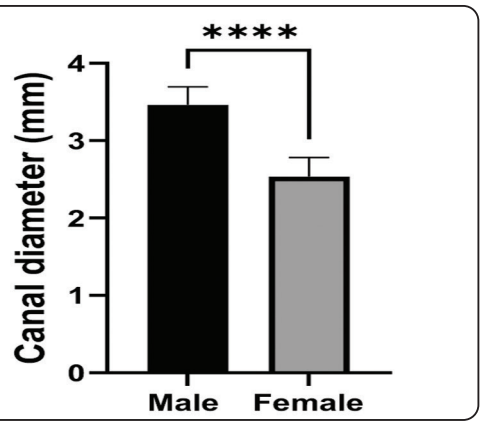
Canal Length:	Male	Female
Mean	12.49 mm	10.4 mm
Std. Deviation	0.2144	0.1727

TABLE (2)

Canal diameter:	Male	Female
Mean	3.462 mm	2.534 mm
Std. Deviation	0.233	0.2494



Graph 1: Canal length:



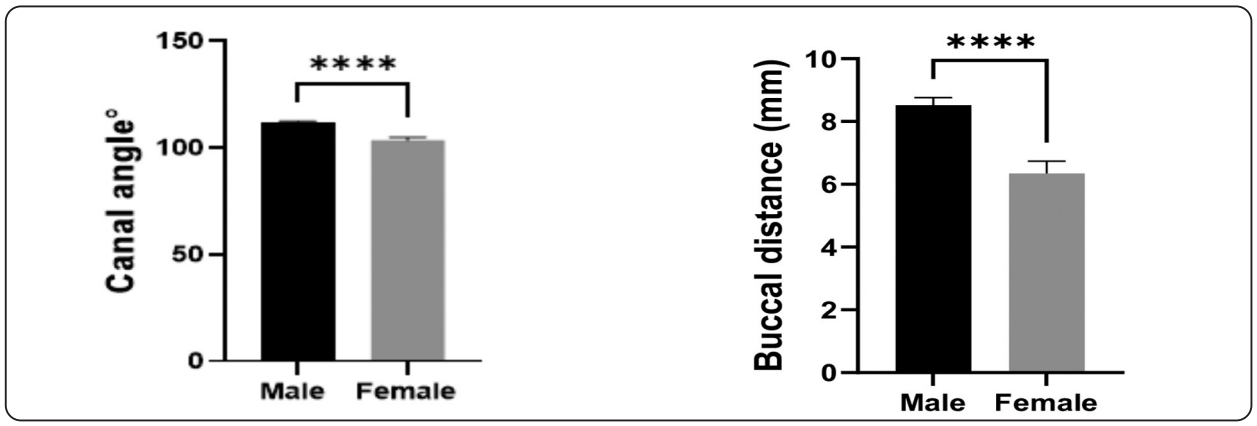
Graph 2: Canal diameter:

TABLE (3)

Canal angle:	Male	Female
Mean	112.2°	103.5°
Std. Deviation	0.2811	1.416

TABLE (4)

Buccal distance:	Male	Female
Mean	8.517 mm	6.348 mm
Std. Deviation	0.2449	0.3868



Graph 3: Canal angle:

Graph 4: Buccal distance:

DISCUSSION

The incisive canal is a conduit present in the midsagittal plane of the maxilla between the nasal floor to the hard palate. It extends from the Stenson foramina above to the incisive foramen below, which lies beneath the incisive papilla. [12]

The canal has shown large inter-individual variability. Morphometric differences vary according to sex, age and ethnicity. [13, 14]

The anatomical location and contents of the incisive foramen often present a challenge during procedures such as orthodontics, dental implants, surgical extraction of impacted teeth, and administration of local anesthesia in this region. Morphometric evaluation of incisive canal, understanding the size and position, before performing these procedures has high clinical significance in dentistry. [15, 16]

Various studies have been conducted to evaluate the incisive canal region. CBCT is considered the best method to evaluate the incisive canal offering high-resolution images, highly accurate three-dimensional measurements alongside with less radiation exposure. [17, 18]

Comparing our results with some values obtained by other authors, the mean canal length in the present research was 12.49 mm in males and 10.4 mm in females.

Matsumura et al found that the mean canal length is 13.8 mm in males and 12.2 mm in females. [19]

Firincioglulari M. and Orhan K. observed that mean canal length is 13.48 mm in males and 11.79 mm in females. [20]

Bermúdez-Pérez et al noticed that mean canal length is 11.87 mm in males and in female 9.96 mm in females. [21]

In accordance with our findings Bornstein et al. and Liang et al. showed that males have statistically significantly longer canals than females. (22, 23)

In the current study the mean diameter of the canal was 3.46 mm in male and 2.53 mm in females. Bermúdez-Pérez et al found that mean diameter at the middle of the canal is 2.24 mm in males and 2.12 mm in females. [21]

Regarding the angle, we found that angle between the palatal plane and the incisive canal was 112.2° in male and 103.5° in females. Vaishnavi D, et al. stated that the mean canal angle 108°, however in this study patients CBCT were not subdivided into males and females. [24]

Finally, concerning the mean buccal bone thickness, our work showed that it was 8.5 mm in male and 6.3 mm in females. Firincioglulari M. and Orhan K. found that mean bone thickness is 7.59 mm in males and 7.35 mm in females. [20]. Taking into account the various races and nationalities examined in previous studies, we may observe some discrepancies in measurement values between our research and those articles.

Our study helps better understanding of the anatomy of the incisive canal. This is important in several clinical aspects in dentistry including nerve block, orthodontics planning and implants placement in the anterior maxillary region.

Neurovascular structures passing through the canal include the nasopalatine nerve delivering sensory input from hard palate mucosa and from incisors and canine teeth gingiva. Nasopalatine nerve block at the canal is effective for incisor teeth extractions, however, proper anesthetic technique is required is important to the area to reduce bleeding. [25]

Furthermore, for successful orthodontic treatment, it is important to confirm the precise position of the maxillary incisors and that of the incisive canal as well as to verify the alveolar bone morphology. (26)

In addition, during immediate implant placement, the position of the incisive canal may interfere due to its proximity to the central incisor. Penetration of the incisive foramen during implant placement can lead to complications such as sensation loss, hematoma in addition to failure to osseointegrate. Therefore, evaluation of the central incisor-incisive canal relationship allows the clinician to determine if additional surgical measures are required. [22, 27]

Likewise, incisive canal anatomy is also important for ENT surgeons, since the nasopalatine canal contains the vascular anastomosis between sphenopalatine and greater palatine arteries. Eighty percent of nose bleeds occur in Little's area which confines anastomosis between sphenopalatine artery and superior labial artery. Endoscopic endonasal artery cauterization while entering the nasopalatine canal is considered an alternative to stop epistaxis. [28]

CONCLUSION

Our study highlights nasopalatine canal anatomical variations, it gives an idea about incisive canal length, diameter, angulation as well as covering bone thickness in a sample of Egyptian population using CBCT, stressing on the importance of presurgical planning in the administration of local anesthesia, orthodontic planning and placement of dental implants in the anterior maxillary region.

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