https://doi.org/ 10.33472/AFJBS.6.Si3.2024.14-22

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Assessment of Nasopalatine Canal Anatomic Variations Using Cone Beam Computed Tomography in a sample of The Egyptian Population

Mayada Ghallab El-Saadi Abdelaal [a] E-mail: Mayada@dent.aun.edu.eg Tel:+201147799535
Mohamed Fouad Edrees [b] E-mail:MohamedEdrees.46@azhar.edu.eg Tel:+201002976098
Mahmoud Ahmed Mizar [b] E-mail: mahmoudmizar4@gmail.com Tel:+201005272005
*Ibrahim Hammad Ibrahim [b] E-mail: ibrahimhammad2017@yahoo.com Tel:+201065309956
Zein Abdou Shatat [a] E-mail: Zeinshatat@dent.aun.edu.eg Tel:+201014956999

***Corresponding author**:
Ibrahim Hammad Ibrahim, PhD, Department of Oral Medicine, Periodontology, Oral Diagnosis, and Dental Radiology, Faculty of Dental Medicine Al-Azhar University (Assiut), Egypt.
E-mail: ibrahimhammad2017@yahoo.com
Tel:+201065309956

Affiliation

[a] Department of Oral and Maxillofacial Radiology. Faculty of Dentistry, Assiut University, Assiut, Egypt.
[b] Department of Oral Medicine, Periodontology, Oral Diagnosis, and Dental Radiology, Faculty of Dental Medicine Al-Azhar University (Assiut), Egypt.

Article History
Volume 6,Issue Si3, 2024
Received:21 Mar 2024
Accepted : 08 May 2024
doi: 10.33472/AFJBS.6.Si3.2024.14-22

Abstract:

Background: This research was designed to assess the nasopalatine canal shape, size as well as anatomic variations according to age & gender in a sample of the Egyptian population utilising CBCT .

Material and Methods: This research was conducted on 100 CBCT scans belonging to 31 males & 69 women, with mean age of (35.8 ± 12.3) years. Inclusion and exclusion criteria as well as ethical issues were designed. CBCT scans were classified according to gender (male and female) and according to age (18-40 year and 41-61 year). All nasopalatine canals were evaluated to assess nasopalatine canal shape in coronal view and sagittal view as well as measurements of the nasopalatine canal in the sagittal & axial cross-section CBCT. The data were collected, computed, tabulated and statistically analyzed.

Results: Was observed no statistically substantial association amongst gender & NPC shape. Also, was noted no statistically substantial association amongst age group and NPC shape. Males showed statistically significantly higher mean diameter of incisive foramen and nasopalatine canal length than females. Subjects aged 18 – 40 years old showed statistically significantly lower mean antero-posterior diameter of nasal foramen, medio-lateral diameter of incisive foramen as well as canal diameter than those aged 41 – 61 years old.

Conclusions: The most frequent NPC shape in coronal view is variation of the Y-type of NPC in half of participants followed by single canal and the least was 2 parallel canals. The most frequent NPC shape in sagittal view is funnel shape (29%) followed by cylindrical shape (28%). The antero-posterior diameter of the incisive foramen & the nasopalatine canal length are higher in men than women. The antero-posterior diameter of the nasal foramen, the medio-lateral diameter of the IF and the NPC increase with aging.

Keywords: Nasopalatine canal , morphology of NPC, variations of NPC, Incisive foramen, Nasal foramen, CBCT.

Introduction

NPC , also referred to as the incisive canal , is a long, narrow structure bordered by thick cortical bone situated in the premaxilla, in the midline of the palate and posterior to the maxillary central incisors. The nasopalatine canal connects the nasal cavity via the nasopalatine foramina (also known as the Stenson's foramina) to the oral cavity via the incisive foramen found under the mucosal incisive papilla[1, 2].

On the basis of age, gender, and the evaluated population, prior researchers have identified numerous anatomic variations in the form & size of the NPC[3, 4].

The nasopalatine canal morphology in the coronal plane differs and is classified into three groups.: 1st group is single canal; 2nd group is 2 parallel canals; and the 3rd group is variations of the Y type canal[5]. The NPC's morphology in the sagittal plane varies greatly, with distinct populations displaying varying variations and forms. Previous studies have employed a variety of classifications to study the morphology of NPC. Hourglass, funnel, banana, and cylindrical are examples of the different shapes of sagittal NPC morphologies [6-8].

The radiographic imaging is a significant diagnostic tool for operations and post-operative evaluation. The description of differences, especially those concerning neurovascular morphology, is important to the surgical procedure. The premaxilla has a higher risk of problems because of its neurovascular component[9].

The premaxilla is usually exposed to trauma and loss of teeth more than other areas, the NPC is considered the most important landmark in the premaxilla. Surgical procedures for the premaxilla, such as implant surgery and operations for dentoalveolar fractures, may result in complications. Such as implant osseointegration failure, hemorrhage and NPC perforation during surgery, postoperative short-term sensory problems, and NPC cyst formation[2, 10].

Evaluation of the NPC and radiographic examination are deemed vital to avoid these complications. Two-dimensional radiographic techniques, as periapical and panoramic radiography, were used to evaluate the NPC, but The inherent flaws of these methods, such as overlapping, distortion, and magnification, make it impossible to see the NPC anatomic abnormalities clearly[11].

CBCT devices have lately been established for dentomaxillofacial imaging. CBCT, a volumetric imaging modality, improves visibility of the NPC due to its low radiation dose, accessibility, and ease of use. The dimensions & shape of the NPC can be accurately described with CBCT [1].

Materials and Methods

This study was done on randomly selected 100 CBCT scans (69 female and 31 male extended in age from 18 - 61 years with mean age of 35.8 ± 12.3 years). The CBCT scans were retrieved from the archives of the CBCT units, Faculties of Dental Medicine, Al-Azhar University (Assiut Branch) and Assiut University & several private radiology centers between "2021-2022".

Inclusion criteria included images for patients ≥18 years, the presence of upper incisors with no previous trauma or surgical treatment in the upper incisors, and images with high geometric resolution and the availability of precise information about patients' age and gender. The excluding criteria were predetermined as images with low quality, Images with pathologic abnormalities in the premaxilla, such as nasopalatine cysts, impacted teeth, tumors, and cleft lips and orthodontic cases with braces & other metal restorations in the area of the upper incisors.

Radiographic assessment:

Each (CBCT) image was extracted as Digital Imaging and Communications in Medicine files and imported to Blue Sky Plan program (Version 4.9.4).

All images were evaluated by 3 experienced radiologist observers. The orientation of the scan was such that the palatal plane [a line amongst the anterior nasal spine & the posterior nasal spine was

parallel to the ground, and both the sagittal and coronal planes were oriented to be perpendicular to the axial plane .

The NPC's anatomic variations in the shape and dimensions were evaluated and categorized according to gender (male and female) and age (less than and equal 40 years and more than 40 years).

All nasopalatine canals were observed to evaluate the following parameters:

1- Shape of the nasopalatine canal in coronal view

According to the description of **Bornstein et al**[12], The NPC morphology was grouped into three types in coronal view that included: type I has single canal, type II has 2 parallel canals, & type III exhibits variations of the Y-type of canal with one oral opening (incisive foramen) & two or more nasal openings (foramina of Stenson). Figure (1)

2- Shape of the nasopalatine canal in sagittal view

Considering the description of **Milanovic et al** [1], The NPC morphology was grouped into four shapes in sagittal cross-sections funnel like shape, hourglass, cylindrical and banana-shape. Figure (2)

3- Dimensions of the nasopalatine canal in the sagittal view

For all defined sagittal shapes of the NPC, the antero-posterior diameter **(A-P)** of the nasal foramen & incisive foramen, as well as the NPC length, were determined and measured in mm. Figure (3)

4- Dimensions of the nasopalatine canal in the axial cross-section

The medio-lateral diameter **(M-L)** of the incisive foramen as well as that of the NPC were determined and measured in mm. The medio-lateral diameter of the nasopalatine canal was measured at the most inferior, mid, and superior points. The average of the three measurements was calculated and recorded. Figure (4)

Statistical analysis :

After the data were collected, tabulated, & statistical analysis was carried out on them.

In this presentation, qualitative data were presented in the form of frequencies & percentages. Mean, standard deviation (SD), 95% confidence interval , &range values were the formats that were used to show the quantitative data. When investigating the relationships between qualitative variables, the Chi-square test was used.

Tests of normalcy, such as the Kolmogorov-Smirnov & Shapiro-Wilk tests, were used in order to investigate the standard deviation of quantitative data. This was accomplished by examining the distribution of the data. There was a normal distribution (parametric) for all of the data. In order to make comparisons among men & females, as well as among the two age groups, the Student's t-test was used. At a significance level of $P < 0.05$, the level of significance was established.

IBM SPSS Statistics for Windows, Version 23.0 was used in order to carry out the statistical analysis. Armonk, NY: IBM Corp.

Figure (1): Coronal CBCT images showing types of NPC
I) single canal, II) 2 parallel canals & III) variations of the Y-type of canal

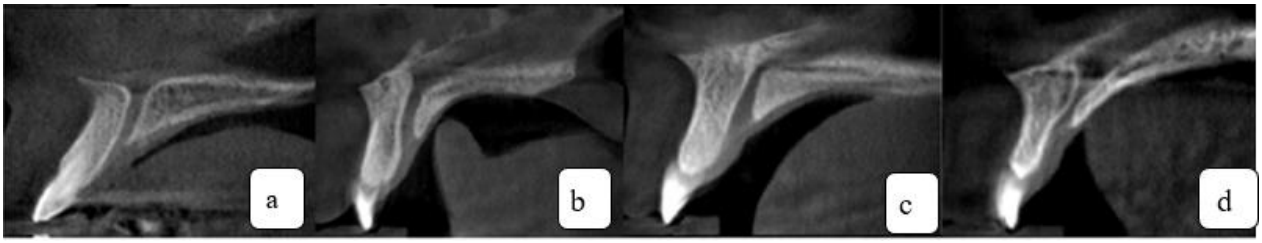

Figure (2): Sagittal CBCT images showing shapes of NPC
a) Cylindrical, b) Banana, c) Funnel, d) Hourglass

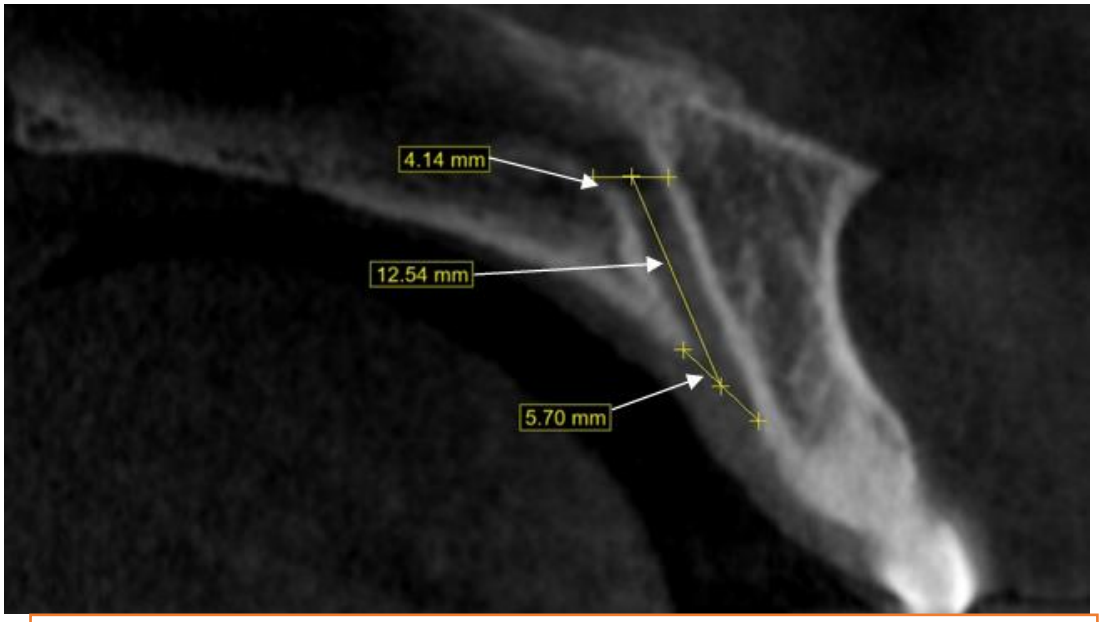

Figure (3) Sagittal CBCT image revealed dimensions of the NPC

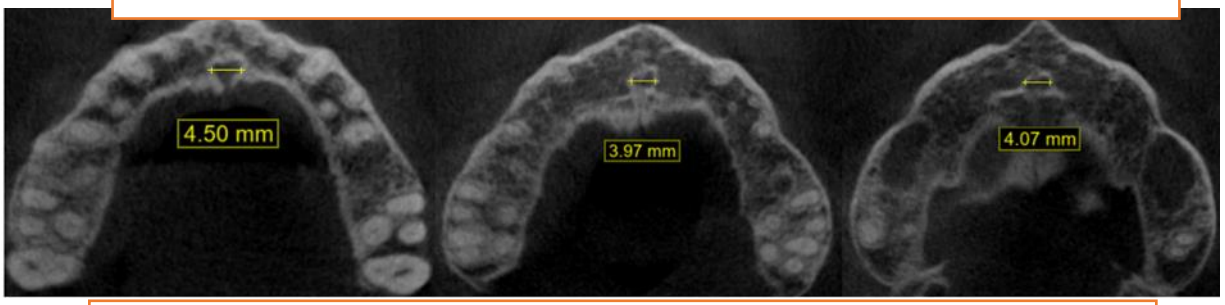

Figure (4) Axial CBCT images revealed Medio-lateral diameters (M-L) of NPC

Results

The selected CBCT images were evaluated, and the NPC's shapes were determined and categorized according to gender and age. (Table1)

Table1: Descriptive statistics & results of Chi-square test for the association of gender & age with different shapes of NPC in both coronal and sagittal planes.

Cross-section	NPC shape	Males	Females	*p-value*	18-40 years	41-61 years	*p-value*
coronal	Type I	16(51.6%)	26(37.7%)	0.426	25(39.1%)	17(47.2%)	0.123
	Type II	2(6.5%)	6(8.7%)		3(4.7%)	5(13.9%)	
	Type III	13(41.9%)	37(53.6%)		36(56.3%)	14(38.9%)	
sagittal	Funnel	8(25.8%)	21(30.4%)	0.426	19(29.7%)	10(27.8%)	0.430
	Cylindrical	6(19.4%)	22(31.9%)		21(32.8%)	7(19.4%)	
	Hourglass	9(29%)	14(20.3%)		13(20.3%)	10(27.8%)	
	Banana	8(25.8%)	12(17.4%)		11(17.2%)	9(25%)	

**: Significant at $P \leq 0.05$*

Was observed no statistically significant association presented amongst gender & nasopalatine canal shape. The percentage of type I is more common in males, while the percentage of type II and type III is more common in females without a statistically significant difference. The percentage of banana and hourglass shape is more common in males, while the percentage of funnel and cylindrical shape is more common in females without a statistically significant difference.

Was observed no statistically substantial association presented amongst the age groups & NPC shape. The percentage of type III is more common in (18 – 40 years) group, while the percentage of type I and type II is more common in (41 – 61 years) group without a statistically significant difference. The percentage of banana and hourglass shape is more common in old age group, while the percentage of funnel and cylindrical shape is more common in young age group without any statistically significant difference.

The selected CBCT images were evaluated and the dimensions of the nasopalatine canal were assessed, measured in mm, and categorized according to gender and age. (Table2)

Table 2: Descriptive statistics & results of Student's t-test for the association of gender and age with measurements (mm) of the Nasopalatine canal

Measurement	Males Mean ±SD	Females Mean ±SD	*p-value*	18-40 years Mean ±SD	41-61 years Mean ±SD	*p-value*
A-P diameter of nasal foramen	3.24 ± 0.9	2.99± 0.85	0.181	2.92±0.79	3.34±0.94	0.018*
A-P diameter of incisive foramen	5.33±0.86	4.87±0.86	0.015*	4.91±0.97	5.19±0.68	0.138

NPC length	1.46±12.02	10.4±1.57	<0.001*	10.71±1.78	11.26±1.5	0.120
M-L diameter of incisive foramen	4.44±0.97	4.08±0.82	0.061	4.01±0.83	4.51±0.88	0.006*
M-L diameter of NPC	4.21±1	3.88±0.8	0.075	3.79±0.72	4.32±1.02	0.003*

**: Significant at P ≤ 0.05*

Was noted statistically substantial association amongst males and females where males showed higher mean diameter of incisive foramen and nasopalatine canal length than females.
Subjects aged 18 – 40 years old showed statistically significantly lower mean A-P diameter of nasal foramen, M-L diameter of IF as well as canal diameter than those aged 41 – 61 years old.

Discussion

An anatomical feature identified as the nasopalatine canal is located on the midline of the maxilla & runs parallel to & amongst the upper central incisors & the palatal cortical plate along the maxillary jaw. [(13)].
The NPC is associated to a number of significant clinical issues. Specifically, the IF acts as a reference point for the incisive nerve block anesthetic technique; a helpful method for restorative dental interventions that can anaesthetize six maxillary anterior teeth. The oral cavity's most common non-odontogenic cyst, the nasopalatine cyst, is also connected to this canal. Planning surgical treatments involving the NPC area, such as insertion of dental implant or apical root excision are another clinical considerations[(14)].
The buccolingual thickness, the three-dimensional structure of the bone, and anatomical structures like the NPC cannot be clearly determined using conventional radiographic techniques, while the use of computed tomography (CT) requires the use of a high radiation dose[(15)].
The target of **this** research was to check out NPC size shape,as well as anatomic variations according to age and gender in a sample of the Egyptian population utilising CBCT . Many studies were performed on different populations that evaluating the NPC anatomic variations using CBCT, none of them carried out on Egyptian population.
Three skilled radiologists reviewed each image in a quite environment with standardized lighting and image size, the analysis was carried out[(16)].
Inclusion criteria involve patients ≥18 years of age as it is the time for complete ossification of skull base. The maxillary incisors presence with no history of trauma or surgical treatment with respect to the upper incisors to avoid bone resorption that may result from loss of one of the incisors causing change in NPC anatomy. The research did not include the following: cone-beam computed tomography images of patients with nasopalatine canal cysts, which could extremely affect the alveolar bone & NPC measurements; cases with developmental, metabolic, or inflammatory source jaw diseases; insufficient, unreliable, or unclear data about any variable; artifact images that could hinder the identification & evaluation of reference points.[(1)].
Two age groups (18–40 and 41–61) were used to categorize the age groups in the current study. The goal was to illustrate the impact of ageing on bone remodeling and dimensional changes in anatomical structures by including both younger and older age groups[(17)].
Upon examination of nasopalatine canal shape in coronal view, in the present the most frequent shape t study regardless gender and age of the cases was type III (variations of the Y-type of NPC) in half of participants (50%). This was followed by type I (single canal) (42%) while the least frequent type was Type II (2parallel canals) (8%). These findings were in accordance with previous results of Turkish researchers stated that; variations of the Y-type of NPC is the most common

coronal shape of the NPC[15, 16]. The same results were obtained in Iranian, German, and Spanish populations in multiple previous studies using CBCT [15, 18, 19].
The obtained results are in contrast to multiple studies carried out using MDCT and CBCT scans who reported that the most frequent coronal shape of the NPC is type I single canal [12, 14, 20].
Regarding the nasopalatine canal shape in sagittal view; the most frequent shape in the present research was funnel shape followed by cylindrical shape then hourglass shape & the least frequent was banana shape. These outcomes closely match the research findings of **Milanovic et al**[1] and **Arnaut et al**[3].
The most prominent shape was the funnel nasopalatine canals, which were followed by banana canals in another prospective research on Mediterranean Caucasian subjects who underwent CBCT study before implantology[21].
Furthermore; was noted no statistically substantial association presented amongst gender as well as age in nasopalatine canal shape in coronal and sagittal views in the present study. The current study's findings supported previous findings that reported no difference in the distribution of the coronal and sagittal NPC shape and gender [4, 8, 22].
Age does not significantly affect NPC morphology in either the coronal or sagittal planes, according to research done in Saudi Arabia utilizing archived CBCT records[17].
That is the current research the mean diameter of the nasal foramen not affected by gender but it increases by aging whereas the mean diameter of the IF has higher values in males & not affected by aging and this result is similar to a study about impact of gender[23]. Other studies were performed on Serbian and Sri Lankan populations demonstrated no substantial gender impact on A-P dimensions of the incisive & nasal foramina [4, 6].
Regarding the age, previous studies reported no significant differences in the A-P diameter of IF & that of the nasal foramen assessed with respect to age [14, 24, 25]. However, the present study provide increase in the mean diameter of nasal foramen by aging. In another study, it was reported that mean diameter of IF was positively correlated with the patients age which increased by aging while no effect of aging on mean diameter of nasal foramen[22].
In the current research NPC length is 10.9 mm ranges from approximately 7.26 to 14.9 mm. This finding is consistent with the findings of the earlier research conducted by **Milanovic et al** [1], who made the report that the mean diameter of the nasopalatine canal length was 10.26 mm ranged from approximately 8 to 16 mm. The same results were obtained in other previous studies [3, 12, 26] . However, another study findings revealed that the mean NPC length was actually longer than 18 mm and the authors explained that their results might be different due to variations in the anatomical features of the Indian population[27].
In the present study, males showed statistically significantly longer NPC than females that matches with other researchers' findings [12, 22, 24] . **Thakur et al** reported that, the difference in the size of the nasopalatine canal could be relative to the facial dimensions rather than absolute, and the longer nasopalatine canal in men could be attributed to the considerably greater cranio-caudal dimension of the face found in men versus females [26].
In the current research, there was no statistically substantial correlation amongst age & canal length as the same findings of other studies [14, 16]. But in contrast to the results reported that was observed a statistically substantial variance amongst age & nasopalatine canal length in the 1000 CBCT study on the Turkish population[15].
The findings of the current study also showed that the mean medio-lateral diameter of (M-L) of IF as well as mean M-L of NPC are 4.19mm and 3.98mm, respectively. In regard to the M-L diameter of IF, the findings are close to the mean M-L of IF (3.59 mm) measured by **Arnaut et al**[3].
Within the current research, was noted no statistically substantial association amongst gender & the M-L diameter of the IF as well as the M-L diameter of the NPC, while both increased with aging. In regard to the M-L diameter of incisive foramen, the findings mirrored to previous CBCT study concluded that, was observed no substantial variance amongst males & females while was

noted a statistically substantial variance between age & M-L diameter of incisive foramen as it increase with aging[27]

Conclusion

The current study concluded that the most frequent NPC shape in coronal view is the Y-type variations of NPC in half of participants followed by single canal while the least frequent type was 2 parallel canal type. Also, the most frequent NPC shape in sagittal view is funnel shape followed by cylindrical shape. The antero-posterior diameter of the IF & nasopalatine canal length are higher in men than women. The antero-posterior diameter of the nasal foramen, the medio-lateral diameter of the incisive foramen and the NPC increase with aging.

Ethics Statement: The research protocol was permitted under the number of (AUAREC202200001-07) by the ethical committee, Faculty of Dental Medicine, Al- Azhar University (Assiut branch).

Availability of data and material: public available

Competing interests: It is declared by the authors that there are no potential conflicts of interest.

Funding: self-funded

Authors' contributions: Every single author made a contribution to the conceptualization & design of the investigation. The preparation of the materials, the collection of data, the analysis, & the writing of the article were all performed by all of the writers.

References

1. Milanovic P, Selakovic D, Vasiljevic M, Jovicic NU, Milovanović D, Vasovic M, et al (2021)Morphological Characteristics of the Nasopalatine Canal and the Relationship with the Anterior Maxillary Bone—A Cone Beam Computed Tomography Study. Diagnostics 11(5):915-927.
2. Da Costa ED, Nejaim Y, Martins LAC, Peyneau PD, Ambrosano GMB, Oliveira ML (2019)Morphological evaluation of the nasopalatine canal in patients with different facial profiles and ages. Journal of Oral and Maxillofacial Surgery 77(4):721-729.
3. Arnaut A, Milanovic P, Vasiljevic M, Jovicic N, Vojinovic R, Selakovic D, et al. (2021)The Shape of Nasopalatine Canal as a Determining Factor in Therapeutic Approach for Orthodontic Teeth Movement—A CBCT Study. Diagnostics 11(12):2345-2358.
4. Milanovic P, Vasiljevic M (2021)Gender Differences in the Morphological Characteristics of the Nasopalatine Canal and the Anterior Maxillary Bone-CBCT Study. Serbian Journal of Experimental and Clinical Research 0(0):29-39.
5. Al-Ghurabi ZH, Al-Bahrani ZM (2020) Radiographic assessment of nasopalatine canal using cone beam computed tomography. Journal of Craniofacial Surgery 31(1):e4-e6.
6. Jayasinghe R, Hettiarachchi P, Fonseka M, Nanayakkara D, Jayasighe R (2020) Morphometric analysis of nasopalatine foramen in Sri Lankan population using CBCT. Journal of Oral Biology and Craniofacial Research 10(2):238-240.
7. Etoz M, Sisman Y (2014) Evaluation of the nasopalatine canal and variations with cone-beam computed tomography. Surgical and Radiologic Anatomy 36(8):805-812
8. Güncü GN, Yıldırım YD, Yılmaz HG, Galindo-Moreno P, Velasco-Torres M, Al-Hezaimi K, et al (2013) Is there a gender difference in anatomic features of incisive canal and maxillary environmental bone? . Clinical oral implants research 24(9):1023-1026.
9. Görürgöz C, Öztaş B (2021) Anatomic characteristics and dimensions of the nasopalatine canal: a radiographic study using cone-beam computed tomography. Folia Morphologica 80(4):923-934.
10. Alkanderi A, Al Sakka Y, Koticha T, Li J, Masood F, Suárez-López del Amo F (2020) Incidence of nasopalatine canal perforation in relation to virtual implant placement: A cone beam computed tomography study. Clinical Implant Dentistry and Related Research 22(1):77-83.
11. Rao JB, Tatuskar P, Pulla A, Kumar N, Patil SC, Tiwari I (2018)Radiographic Assessment of Anatomy of Nasopalatine Canal for Dental Implant Placement: A Cone Beam Computed Tomographic Study. The journal of contemporary dental practice 19(3):301-305.
12. Bornstein MM, Balsiger R, Sendi P, Von Arx T (2011) Morphology of the nasopalatine canal and dental implant surgery: a radiographic analysis of 100 consecutive patients using limited cone-beam computed tomography. Clinical oral implants research 22(3):295-301.

13. Ongprakobkul N, Ishida Y, Petdachai S, Ishizaki A, Shimizu C, Techalertpaisarn P, et al (2023) Morphometric and volumetric analysis of the proximity between the incisive canal and maxillary central incisors during anterior retraction: a retrospective cone-beam computed tomography study. The Angle Orthodontist 93(2):159-167.
14. Khan M, Habib S, Ghafoor R (2022) Evaluation of the nasopalatine canal (NPC) in a subset of Pakistani population, using cone beam computed tomography (CBCT). Journal of Pakistan Medical Association 73(1):49-53.
15. Keşkek CÖ, Aytuğar E, Çene E (2022) Retrospective Assessment of the Anatomy and Dimensions of Nasopalatine Canal with Cone-Beam Computed Tomography. Journal of Oral & Maxillofacial Research 13(2):1-11.
16. Bahşi I, Orhan M, Kervancıoğlu P, Yalçın ED, Aktan AM (2019) Anatomical evaluation of nasopalatine canal on cone beam computed tomography images. Folia morphologica 78(1):153-162.
17. Linjawi A, Othman M, Dirham A, Ghoneim S, Aljohani S, Dause R, et al (2021) Morphological evaluation of the incisive canal with reference to gender and age: A cone-beam computed tomography study. Nigerian Journal of Clinical Practice 24(11):1596-1601.
18. Fernández-Alonso A, Suárez-Quintanilla J, Muinelo-Lorenzo J, Bornstein MM, Blanco-Carrión A, Suárez-Cunqueiro M (2014) Three-dimensional study of nasopalatine canal morphology: a descriptive retrospective analysis using cone-beam computed tomography. Surgical and radiologic anatomy 36(9):895-905.
19. Friedrich RE, Laumann F, Zrnc T, Assaf AT (2015) The nasopalatine canal in adults on cone beam computed tomograms–A clinical study and Review of the literature. in vivo 29(4):467-486.
20. Gönül Y, Bucak A, Atalay Y, Beker-Acay M, Çalişkan A, Sakarya G, et al (2016) MDCT evaluation of nasopalatine canal morphometry and variations: An analysis of 100 patients. Diagnostic and interventional imaging 97(11):1165-1172.
21. Gil-Marques B, Sanchis-Gimeno JA, Brizuela-Velasco A, Perez-Bermejo M, Larrazábal-Morón C (2020) Differences in the shape and direction-course of the nasopalatine canal among dentate, partially edentulous and completely edentulous subjects. Anatomical science international 95(1):76-84.
22. Khojastepour L, Haghnegahdar A, Keshtkar M (2017) Morphology and dimensions of nasopalatine canal: a radiographic analysis using cone beam computed tomography. Journal of Dentistry 18(4):244-250.
23. Kajan ZD, Kia J, Motevasseli S, Rezaian SR (2015)Evaluation of the nasopalatine canal with cone-beam computed tomography in an Iranian population. Dental research journal 12(1):14-19.
24. Safi Y, Moshfeghi M, Rahimian S, Kheirkhahi M, Manouchehri ME (2017) Assessment of nasopalatine canal anatomic variations using cone beam computed tomography in a group of Iranian population. Iranian Journal of Radiology 14(1):1-9.
25. Tözüm TF, Güncü GN, Yıldırım YD, Yılmaz HG, Galindo-Moreno P, Velasco-Torres M, et al (2012) Evaluation of maxillary incisive canal characteristics related to dental implant treatment with computerized tomography: a clinical multicenter study. Journal of periodontology 83(3):337-343.
26. Thakur AR, Burde K, Guttal K, Naikmasur VG (2013)Anatomy and morphology of the nasopalatine canal using cone-beam computed tomography. Imaging science in dentistry 43(4):273-281.
27. Soumya P, Koppolu P, Pathakota KR, Chappidi V (2019) Maxillary incisive canal characteristics: a radiographic study using cone beam computerized tomography. Radiology Research and Practice 2019:1-5.