Uttar Pradesh Journal of Zoology

Volume 44, Issue 10, Page 73-82, 2023; Article no.UPJOZ.2593
ISSN: 0256-971X (P)

Assessment of Influence of Age and Gender on Morphological Variations of Nasopalatine Canal Using Cone Beam Computed Tomography: A Radiographic Observational Study

Niveditha Koppera [a++*], Reddy Sudhakara Reddy [a#], Geetanjali Darna [a†], Ramesh Tatapudi [a‡], Ramesh Kumar Budumuru [a++] and Vinutna Nanda Matta [a++]

[a] *Department of Oral Medicine and Radiology, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2023/v44i103508

Editor(s):
(1) Prof. Aurora Martínez Romero, Juarez University, Mexico.
Reviewers:
(1) Nishath Khanum, Jss Dental College and Hospital, India.
(2) Santosh Palla, India.

Original Research Article

Received: 18/03/2023
Accepted: 23/05/2023
Published: 06/06/2023

[++] *Post-Graduate;*
[#] *Professor and Head of the Department;*
[†] *Assistant Professor;*
[‡] *Professor;*
**Corresponding author: Email: knivedithа94@gmail.com;*

ABSTRACT

Aim: To assess the shape of the nasopalatine canal in the sagittal plane, coronal plane and axial plane. To assess the length of the nasopalatine canal in the sagittal plane and to assess the Influence of age and gender on these parameters of nasopalatine canal.
Methodology: A sample of 90 subjects were taken. Shape of nasopalatine canal in sagittal plane is assessed in males and females and all the age groups and classified as cylindrical, funnel, hourglass and spindle shape. The shape of the NPC in the coronal plane is classified according to Bornstein as Single (type A), double (type B), Y shaped (type C). The shape of the NPC at the mid-level was assessed in the axial plane and classified as oval, round, heart and triangular shape. The length of the nasopalatine canal is measured in the sagittal plane.
Results: The results showed cylindrical shape was most common in sagittal plane which showed statistical significance. Results showed males have significant longer canals than females. In coronal plane, Y shape was prevalent, but no significant results were observed. In the axial plane, in males and females was heart shape and round shape were prevalent respectively. In the axial plane, the most common shape of NPC was heart shape in group I and group III, round shape in group II. No statistically significant results observed.
Conclusion: The present study concluded there were significant morphological variations of NPC in males and females in different age groups. These morphological variations may cause complications during different treatment procedures. Assessment of the NPC using CBCT helps in implant rehabilitation and surgical treatment planning.

Keywords: Nasopalatine canal; influence of age and gender; morphological variations; CBCT; complications; implant planning.

1. INTRODUCTION

The nasopalatine canal (NPC) is an intraosseous conduit that is present in the midline of anterior maxilla that connects oral cavity with nasal cavity. The nasopalatine canal has two openings, the superior opening which ends as two openings in nasal cavity is Stenson's foramen whereas inferior opening that ends as a single entity in oral cavity which opens beneath the incisive papilla is incisive foramen. The nasopalatine canal is also known as incisive canal or anterior palatal canal [1,2].

The nasopalatine canal serves as a passage to nasopalatine nerve, vascular anastomosis between greater palatine artery and sphenopalatine artery, connective tissue, adipose tissue and minor salivary glands traversing the length of the canal. Nasopalatine canal is an important landmark in anterior maxilla because of its contents that include vital structures. Certain surgical, pathological, restorative and local anesthesia procedures that include surgeries in anterior maxilla region, nasopalatine cyst and implant placement may intervene with the vital structures of NPC resulting in complications like implant failure, hematoma, source of bleeding and infection and sensory dysfunction [2-5].

Several case reports with varied NPC morphology have been reported in literature and studies are being done to assess the morphological variations. Few authors have described the morphological variations of the NPC; they concern the shape, the length, number of openings at the level of nasal fossa, incisive foramen location and diameter. 2D imaging doesn't reveals much however 3D imaging modality like CBCT documents better visualization of the morphological structure of NPC in all the orthogonal planes. Assessment of morphology of NPC using CBCT can avert complications during surgical procedures, implant placement. As few authors have stated morphological variations of NPC in different genders, this study also determines the influence of genderand age on nasopalatine canal.

Though there is adequate literature regarding the morphological variations of NPC, there is paucity regarding establishing criteria to choose CBCT as the imaging modality. Hence the present research was done to evaluate and assess the morphological variations in males and females and in diverse age groups, thus enabling the indication of the CBCT scan in high-risk cases only. Previous studies have proposed that the risk factors for failure of Osseo-integration of implant, complications like profuse bleeding were due to involvement of nerve and artery which are

the contents of NPC. There was a dearth of research in assessing the morphometric variations of NPC in females and males among different age groups which was determined in this research work. This cross-sectional study aimed to assess the morphometric variations of the NPC in females and males among different age groups.

2. MATERIALS AND METHODS

A total of 90 CBCT images of 45 male and 45 female subjects aged between 21-65 years fulfilling the inclusion and exclusion criteria were selected and informed consent was obtained. Subjects with long standing edentulous maxillary anterior region, history of trauma in the maxillary anterior region, developmental anomalies, fractures, pathology or any chronic systemic disease that alters the bone morphology were excludedfrom the study.

The CBCT images were taken and viewed using Cranex 3d Soredex (Finalnd) and Scanora imaging software 5.2 version with exposure parameters set at 10mA, 90kVp and 4.9 seconds to obtain the image with 6 x 8 field of view (FOV). The morphological variations of NPC were studied in all the orthogonal planes i.e., sagittal, coronal and axial sections. The parameters observed were length and shape of the nasopalatine canal in sagittal plane, shape of the nasopalatine canal in axial and coronal planes in different age groups and in males and females respectively. Subjects were divided into three age groups - group I (21-35 years) group II (36-50 years) and group III (51-65 years).

The length of the nasopalatine canal in sagittal plane was considered as the distance between level of the nasal fossa and the level of the hard palate along the long axis of the canal [6]. The shape of the nasopalatine canal in sagittal plane were grouped into cylindrical (Fig. 1), spindle, funnel (Fig. 2) and hourglass (Fig. 3) shapes [7]. The shape of the nasopalatine canal in coronal plane were grouped into single (Fig. 4), double and Y shaped (Fig. 5) canals according to Bornstein et al. [8]. The shape of the nasopalatine canal in axial shape is assessed at the mid-level of the nasopalatine canal and grouped into four different shapes i.e., oval (Fig. 6), round (Fig. 7), heart (Fig. 8) and triangular (Fig. 9) [6].

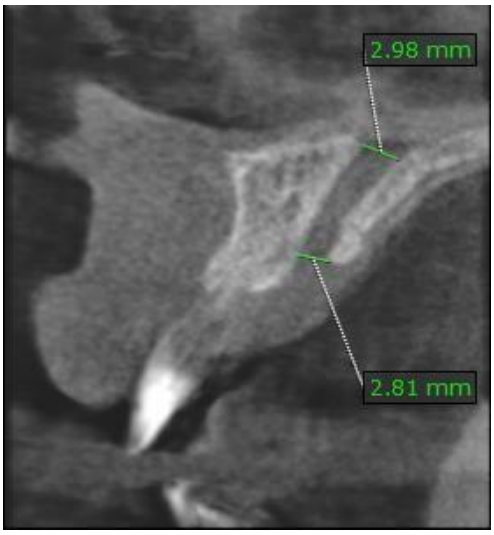


Fig. 1. Cylindrical shape

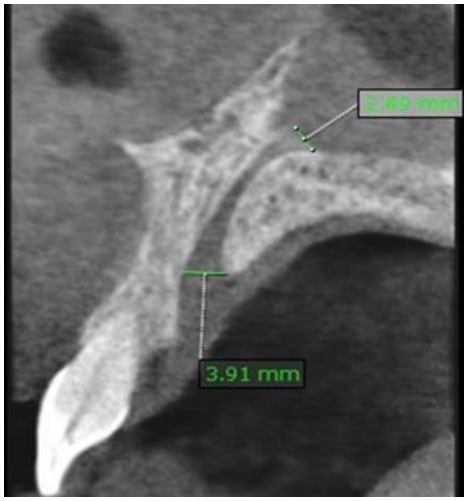


Fig. 2. Funnel shape

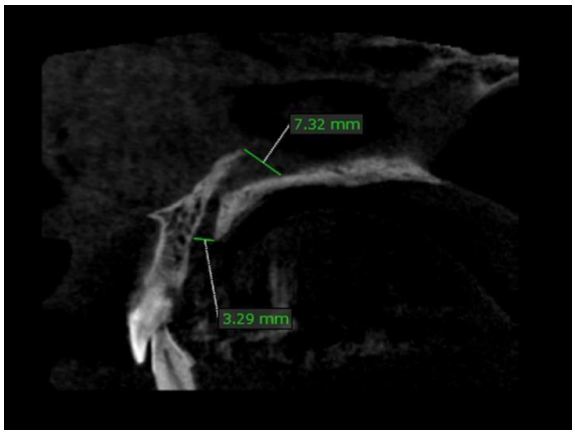


Fig. 3. Hourglass shape

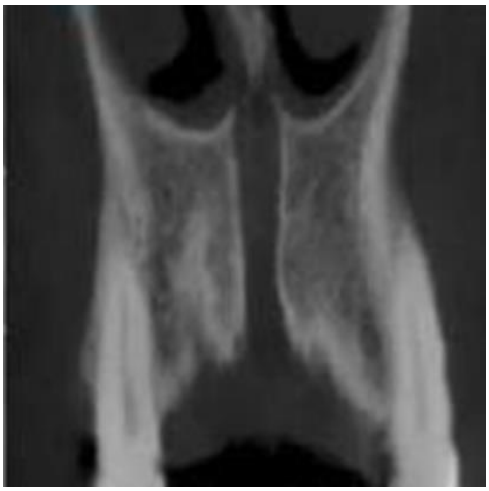


Fig. 4. Single canal

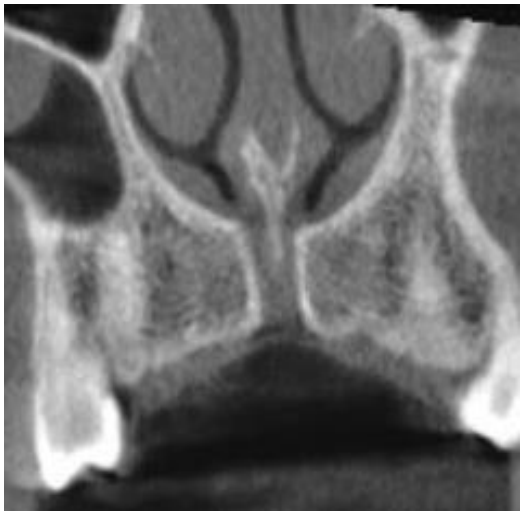


Fig. 5. Y shape canal

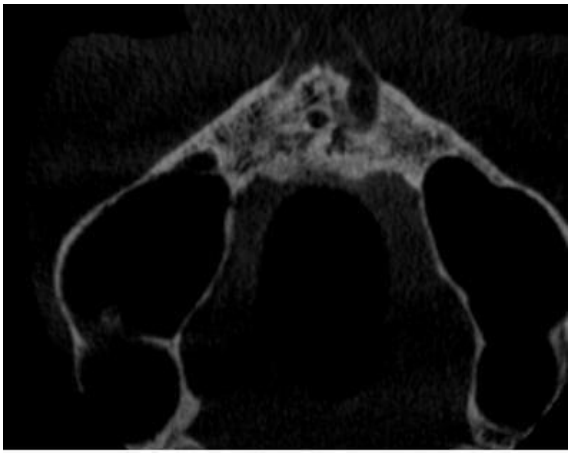


Fig. 6. Oval shape

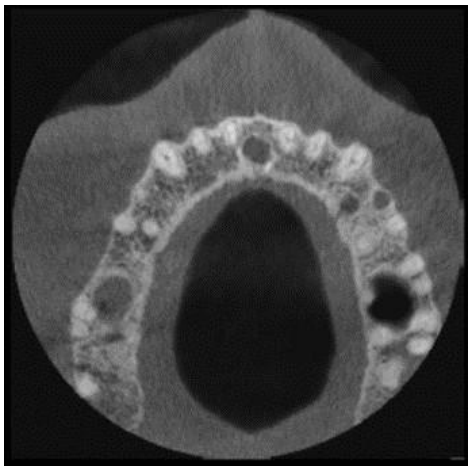


Fig. 7. Round shape

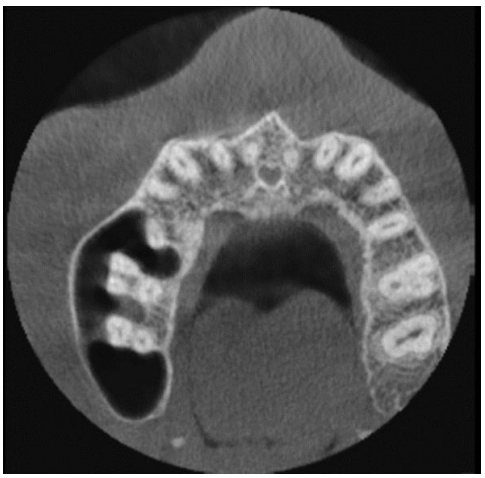


Fig. 8. Heart shape

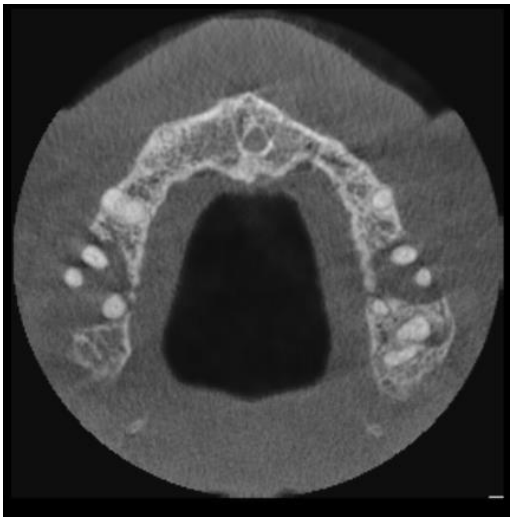


Fig. 9. Triangular shape

2.1 Statistical Analysis

Chi-square test was done to draw inter-group comparisons between males and females among different age groups in evaluating the shape of nasopalatine canal in sagittal and coronal planes and shape of nasopalatine canal at mid-level in axial plane. One way analysis of variance (ANOVA) was done to draw significance of length of NPC in males and females among different age groups. The data was analysed utilizing SPSS software version 22. Statistical significance was accepted for p value < 0.05.

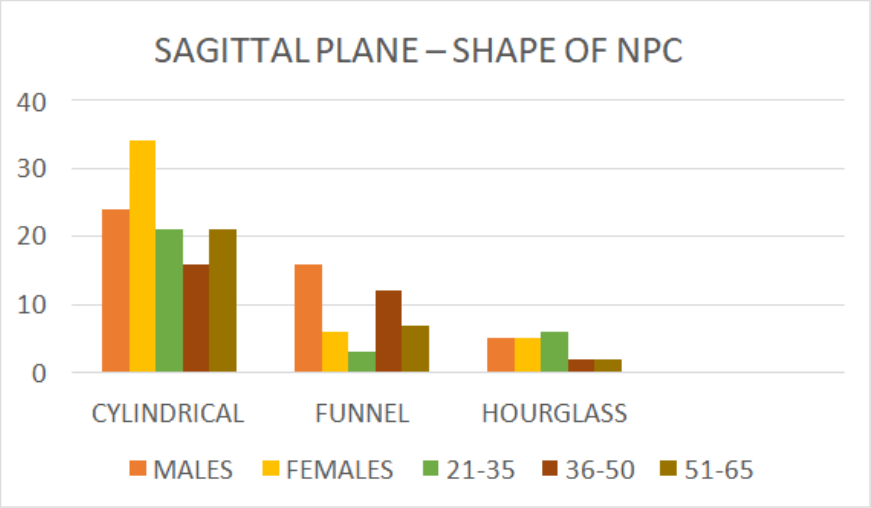
3. RESULTS

Nasopalatine canal was assessed in detail in 90 subjects (females – 45, males - 45) among three different age groups – group I – 21-35 years (n-30), group II – 36-50 years (n-30), group III – 51-65 years (n- 30). The shape of NPC was compared in males and females and among different age groups in all the three orthogonal planes.

3.1 The Shape of the NPC in Sagittal Plane

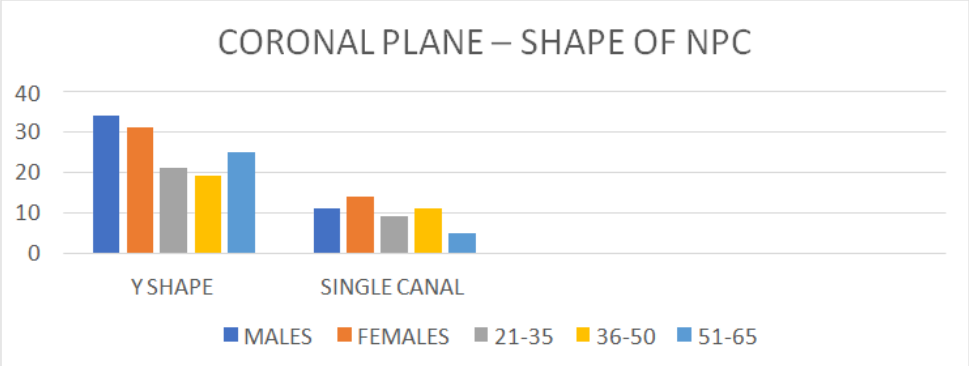
The shape of the nasopalatine canal in sagittal plane is classified into cylindrical, funnel, hourglass and spindle shapes. In sagittal plane the cylindrical shape was most commonly observed in males and females and among all the age groups. Graph 1 shows distribution of shape of nasopalatine canal in sagittal plane in males and females. Cylindrical shaped nasopalatine canal was most frequently observed in 53.33% of male subjects followed by funnel shaped canal in 35.56% of male subjects while hourglass shaped was least prevalent in 11.11% of male subjects. Whereas in females cylindrical shaped (75.56%) canal was observed with highest frequency while 13.13% of funnel shaped canal was observed and hourglass was least prevalent observed with a percentage of 11.11. In both the genders cylindrical shape was observed with highest frequency of 64.44%. There is a statistical significance noted in shape of nasopalatine canal in sagittal plane in males and females with p value P = .044* (P < 0.05).

Graph 1 shows the frequency of distribution of shape of nasopalatine canal in sagittal plane in different age groups. Among all the three age groups the most prevalent shape of NPC observed is cylindrical shape (64.44%), least frequently observed shape is hourglass (10%). In group I, 70% of the subjects has cylindrical shaped NPC, whereas least frequent NPC shape observed was funnel shape (10%). In group II, highest frequency noted was cylindrical shape (53.33%) and least frequently observed shape was hourglass (6.67%). In group III, highest distribution observed was cylindrical shape NPC (70%) whereas least common observed was hourglass (6.67%). A significant difference was found in shape of nasopalatine canal of different age groups in sagittal plane with P = .048* (P<0.05).



Graph 1. Distribution of different shapes of NPC in males and females among different age groups in sagittal plane

3.2 The Shape of Nasopalatine Canal – Coronal Plane



Graph 2. Distribution of different shapes of NPC in males and females among different age groups in coronal plane

In coronal plane, the shape of NPC is classified into 3 groups – Y shaped, single canal and double canal. The shape of NPC is compared in males and females and among different age groups. Graph 2 shows distribution of shape of nasopalatine canal in coronal plane in males and females. The most commonly observed shape in coronal plane was Y shaped canal in both males (75.56%) and females (68.89%) and least observed was single canal in both males (24.44%) and females (31.11%). There was no statistically significant difference found between males and females as P value = .480 (P>.05).
Graph 2 shows frequency distribution of shape of NPC in different groups. Among all the age groups Y shaped canal (72.22%) was commonly observed while single canal (27.7%) was least observed. There was no statistically significant difference in shape of NPC in coronal plane in different age groups as P = .212 (P>0.05). Double canal was not observed in this study population.

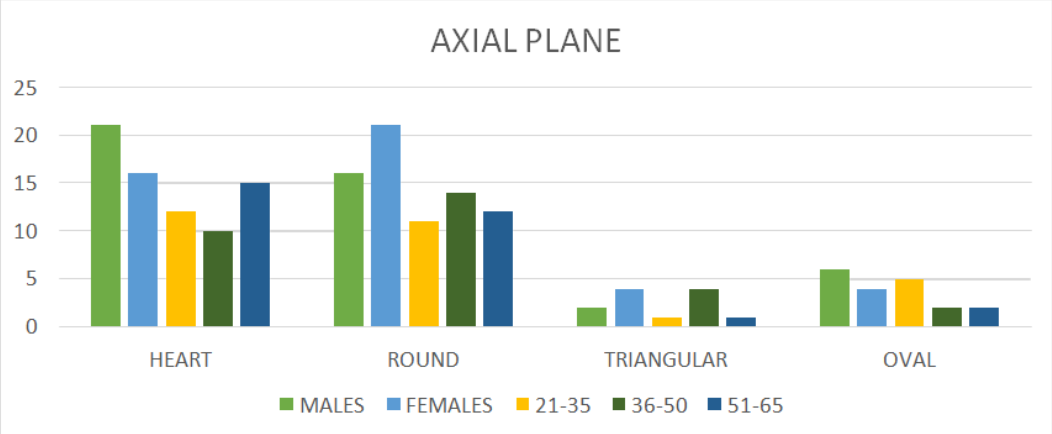
3.3 The Shape of Nasopalatine Canal at Mid-Level – Axial Plane

In axial plane, the shape of NPF is classified into 4 groups – round, oval, triangular and heart shape. The shape of NPF is compared in males and females and among different age groups. Graph 3 shows distribution of shape of nasopalatine foramen in axial plane in males and females. Heart shaped foramen (46.67%) had highest frequency in males followed by round shaped foramen (35.56%). Whereas the least observed shape was triangular (4.4%) in males. In females, most prevalent shape observed was round (46.67%) followed by heart shape (35.56%). Whereas the least observed shape was oval (8.89%) and triangular (8.89%) in females. There was no statistically significant difference in shape of nasopalatine foramen in axial in males and females with P = .527(P>0.05).

Graph 3 shows distribution of shape of nasopalatine foramen in axial plane among different age groups. Heart shape (40%) was more frequently observed in group I followed by round shape (36.67%) whereas least prevalent was triangular shape (3.33%). Round shape (46.67%) was commonly observed in group II followed by heart shape (33.33%) whereas least prevalent was oval shape (6.67%). Heart shape (50%) was more frequently observed in group III followed by round shape (40%) whereas least prevalent was triangular shape (3.33%). There was no statistically significant difference in shape of nasopalatine foramen in axial among different age groups as P = .285 (P>0.05).

3.4 The Length of Nasopalatine Canal – Sagittal Plane

The length of the nasopalatine canal in sagittal plane was measured between the level of the nasal fossa and the level of the hard palate along the long axis of the canal in males and females and among different age groups. The mean length of nasopalatine canal in males was 12.26 mm ± 3.5mm. The mean length of nasopalatine canal in females was 10.66 mm ± 3.4 mm. The length of the nasopalatine canal in sagittal plane is higher in males compared to females. Statistically significant difference was observed in NPC length between males and females with P = 0.035^{*} (P<0.05).



Graph 3. Distribution of different shapes of NPC in males and females among different age groups incoronal plane

The mean length of nasopalatine canal in group I was 10.79mm with a standard deviation of 3.15 mm. The mean length of nasopalatine canal in group II was 12.12 mm with a standard deviation of 4.22 mm. The mean length of nasopalatine canal in group III was 11.49 mm with a standard deviation of 3.38 mm.

There was no statistically significant difference found between different age groups as P=.368 (P<0.05).

4. DISCUSSION

The nasopalatine canal is an important and vital structure in anterior maxilla region. The vital structures running through and close to the NPC might get injured during surgical intervention and implant placement in the anterior maxilla results in surgical complications with excessive bleeding, sensory impairment, or inadequate osseointegration of implants [2]. To employ any surgical interventions like implant placement, cysts in the anterior maxilla region, knowledge of morphological variations of nasopalatine canal is of crucial importance. Radiological evaluation is required prior to dental procedures like extraction of impacted tooth, enucleation of cysts in anterior maxilla, apicectomy, implant placement to surge the positive outcome and prevent redundant complications [9,10]. The present study was done to evaluate the morphological variations of nasopalatine canal in 90 subjects in coastal Andhra Pradesh population. According to the results of the current study, the NPC and NPF displayed significant variability in both its morphological appearance and its dimensions.

In this study, the shape of nasopalatine canal in sagittal plane was assessed in both the genders and among different age groups. The most prevalent NPC shape observed was cylindrical shape in males and females with a frequency of 64.44%. The results of the current study were in accordance with studies conducted by Thakur et al. [11], I. Bahsi et al. [6], Liang et al. [12], Mardinger et al. [13], Gonul et al. [14] and Sudheer A et al. [7] where cylindrical shape NPC was most commonly observed with a frequency of 38%, 28.7%, 53.3%, 50.7%, 48% and 54% respectively. The least common NPC shape observed was hourglass in males and females with a frequency of 11.11%. Spindle shape NPC was not observed in any of the subjects in this study. The results obtained were similar to the results of the study by Sudheer A et al. [7] with hourglass as least commonly observed NPC with a frequency of 6%. In contrast to the results of the present study, Etoz and sisman et al. [15], Hakbilen and magat et al. [16] found hourglass (38.8%), conical (26.17%) as most common shape of nasopalatine canal respectively, whereas least commonly observed was tree branch (1.4%) and banana shape in 11.14% of the subjects respectively.

The most commonly observed shape of NPC in all three age groups was cylindrical which was similar to results of Thakur et al. [11], Sudheer A et al. [7] and the least observed shape was funnel in group I and hourglass in group II and III which was similar to Sudheer A et al. [7] where hourglass was least commonly observed in all the age groups. In contrast to the results of present study, most common shape of NPC observed by Ana Carolina et al. [3], Fukuda et al. [17] and

Etoz and Sisman et al. [15] was funnel, funnel and hourglass respectively. Least common NPC shape observed contrarily was banana (13.3%) by Ana Carolina et al. [3]. These significant changes in the morphology of NPC in sagittal planein different studies could be due to racial differences and discrepancy in sample size compared to other research studies.

The length of the nasopalatine canal was measured in males and females in sagittal plane. Results showed the mean length of NPC is significantly greater in males compared to females. Similar results were obtained by Kajan ZD et al. [18], Safi Y et al. [19], Thakur et al. [11], Leila Khojstepour et al. [20] and Jaligama B Rao [21]. In contrary i. Bahsi et al. [6] observed mean length of NPC is greater in females. These variations could be due to different populations with different race and ethnicity and also various orthogonal planes used for measuring length of the NPC. Mean length of males is greater than females could be due to greater cranio- caudal measurement in males. The present study reveals age has no influence on length of NPC which is similar to results of Thakur et al. [11]. In contrary, Sudheer A et al. [7] stated age influences length of NPC. Mean length of the canal decreases as age progresses. This could be due to physiological resorption that occurs over time and also systemic conditions that alter the bone morphology like diabetes mellitus, osteoporosis in post menopause women.

The most common shape of NPC in coronal plane observed was Y shaped canal in both males and females similar to results of Jaligama B Rao et al. [21], I. Bahsi et al. [6] and Leila Khojestapor et al. [20], however Leila Khojestapor et al. [20] stated Y shaped canals were prominent in males as of this study, contrarily single canals were prominent in females. Mehrdad Panjnoush et al. [22] also stated single canals were most commonly observed. The most common shape of NPC in coronal plane observed was Y shaped canal in all the age groups similar to Zainab et al. [23], contrarily single canal was most commonly seen in all the age groups according to Al Linjawi et al. [24]. These variations could be due to geographic distribution and convenience sampling taken in other studies, increased sample distribution compared to current study, age group analysis done in the current study, ethnic and racial differences, variation in observer's analysis.

The shape of the nasopalatine canal at the midlevel is assessed in axial plane. The prevalent shape observed was heart shape in males which is similar to results obtained by i. Bahsi et al. [6], Mahtab et al. [25] and round shape in females similar to observations of i. Bahsi et al. [6]. Most common shape observed was heart in group I and group III and round in group II which is similar to the results of Mahtab et al. [25]. These variations could be due to inter observer discrepancy in interpreting at different levels of the nasopalatine canal, errors made by observers, different CBCT software used, geographic distribution, sample size evaluated, racial and ethnicity variations may cause difference in the morphology of NPC in males and females and among different age groups.

To prevent complications in anterior maxillary region during surgical intervention, it is always better to place an implant 1-2 mm away from the nasopalatine canal in the apico-coronal direction to avoid neurosensory disturbances [26]. Also, the evaluation and assessment of morphological variations of nasopalatine canal in males and females and among different age groups is essential for pre-surgical assessment to prevent complications which can be achieved by 3D imaging modality.

5. CONCLUSION

The current study has given adequate insight and emphasized the importance of assessing and evaluating the morphometric variations of nasopalatine canal in various orthogonal planes. Sectional images in all the planes aids in exact approximation of this anatomical structure from dental implant can be determined, thus ensuring the success of treatment. Increased knowledge of this anatomic structure and its diversity leads to enhanced surgical procedures and reduced complications. Failure of acknowledging these morphometric variations may cause failure of osseointegration of implant, neuro sensory disturbances during surgical treatment. Thus, evaluation of NPC through sectional images of CBCT prevents post- operative complications and failure. Further studies with larger sample size are required to evaluate the morphometric variations of NPC with standardization maintained in all the orthogonal planes.

6. LIMITATIONS

Subjects were selected through non-probability sampling which limits the study as the general population was not studied, but only healthy individuals were assessed. Larger population

from different geographic locations would rationalize the morphological variations of NPC precisely.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

The study design was thoroughly scrutinized and approved by the Institutional Review Board [IRB] and Ethical Committee (IECVDC/ 2021/PG01/OMR/IVT/25) of Vishnu dental college, Bhimavaram.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Lake S, Iwanaga J, Kikuta S, Oskouian RJ, Loukas M, Tubbs RS. The incisive canal: a comprehensivereview. Cureus. 2018;10(7).
2. Jacob S, Zelano B, Gungor A, Abbott D, Naclerio R, McClintock MK. Location and gross morphology of the nasopalatine duct in human adults. Archives of Otolaryngology–Head & Neck Surgery. 2000;126(6):741-8.
3. de Lima AC, Peniche DA, Coutinho TM, Guedes FR, Visconti MA, Risso PA. The nasopalatine canal and its relationship with the maxillary central incisors: a cone-beam computed tomography study. Research, Society and Development. 2021;10(15): e351101522978.
4. Peñarrocha D, Candel E, Guirado JL, Canullo L, Peñarrocha M. Implants placed in the nasopalatine canal to rehabilitate severely atrophic maxillae: a retrospective study with long follow-up. Journal of Oral Implantology. 2014;40(6):699-706.
5. Venkatesh E, Elluru SV. Cone beam computed tomography: basics and applications in dentistry. Journal of istanbul University faculty of Dentistry. 2017;51(3 Suppl 1):S102.
6. Bahşi I, Orhan M, Kervancıoğlu P, Yalçın ED, Aktan AM. Anatomical evaluation of nasopalatine canal on cone beam computed tomography images. Folia Morphologica. 2019;78(1):153-62.
7. Sudheer A, Rani K, Kumari A, Singh AK, Anand K, Singh K. Morphological variation of the nasopalatine canal: A cone-beam computed tomography study. Journal of Indian Academy of Oral Medicine and Radiology. 2020;32(1):27-30.
8. Bornstein MM, Balsiger R, Sendi P, Von Arx T. 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. 2011;22(3): 295-301.
9. Milanovic P, Selakovic D, Vasiljevic M, Jovicic NU, Milovanović D, Vasovic M, Rosic G. Morphological characteristics of the nasopalatine canal and the relationship with the anterior maxillary bone—a cone beam computed tomography study. Diagnostics. 2021;11(5):915.
10. Iamandoiu AV, Mureşan AN, Rusu MC. Detailed Morphology of the Incisive or Nasopalatine Canal. Anatomia. 2022; 1(1):75-85.
11. Thakur AR, Burde K, Guttal K, Naikmasur VG. Anatomy and morphology of the nasopalatine canal using cone-beam computed tomography. Imaging science in dentistry. 2013;43(4):273-81.
12. Liang X, Jacobs R, Martens W, Hu Y, Adriaensens P, Quirynen M, Lambrichts I. Macro-and micro- anatomical, histological and computed tomography scan characterization of the nasopalatine canal. Journal of clinical periodontology. 2009; 36(7):598-603.
13. Mardinger O, Namani-Sadan N, Chaushu G, Schwartz-Arad D. Morphologic changes of the nasopalatine canal related to dental implantation: a radiologic study in different degrees of absorbed maxillae. Journal of periodontology. 2008;79(9):1659-62.
14. Gönül Y, Bucak A, Atalay Y, Beker-Acay M, Çalişkan A, Sakarya G, Soysal N, Cimbar M, Özbek M. MDCT evaluation of nasopalatine canal morphometry and variations: An analysis of 100 patients. Diagnostic and interventional imaging. 2016;97(11):1165-72.
15. Etoz M, Sisman Y. Evaluation of the nasopalatine canal and variations with cone-beam computed tomography. Surgical and Radiologic Anatomy. 2014; 36:805-12.
16. Hakbilen S, Magat G. Evaluation of anatomical and morphological characteristics of the nasopalatine canal in

a Turkish population by cone beam computed tomography. Folia Morphologica. 2018;77(3):527-35.
17. Fukuda M, Matsunaga S, Odaka K, Oomine Y, Kasahara M, Yamamoto M, Abe S. Three-dimensional analysis of incisive canals in human dentulous and edentulous maxillary bones. International journal ofimplant dentistry. 2015;1(1):1-8.
18. Kajan ZD, Salari A. Presence and course of the mandibular incisive canal and presence of the anterior loop in cone beam computed tomography images of an Iranian population. Oral Radiology. 2012; 28:55-61.
19. Safi Y, Moshfeghi M, Rahimian S, Kheirkhahi M, Manouchehri ME. Assessment of nasopalatine canal anatomic variations using cone beam computed tomography in a group of Iranian population. Iranian Journal of Radiology. 2017;14(1).
20. Khojastepour L, Haghnegahdar A, Keshtkar M. Morphology and dimensions of nasopalatine canal: a radiographic analysis using cone beam computed tomography. Journal of Dentistry. 2017; 18(4):244.
21. Rao JB, Tatuskar P, Pulla A, Kumar N, Patil SC, Tiwari I. Radiographic Assessment of Anatomy of Nasopalatine Canal for Dental Implant Placement: A Cone Beam Computed Tomographic Study. The Journal of Contemporary Dental Practice. 2018;19(3):301-5.
22. Panjnoush M, Norouzi H, Kheirandish Y, Shamshiri AR, Mofidi N. Evaluation of morphology and anatomical measurement of nasopalatine canal using cone beam computed tomography. Journal of Dentistry (Tehran, Iran). 2016;13(4):287.
23. Artzi Z, Nemcovsky CE, Bitlitum I, Segal P. Displacement of the incisive foramen in conjunction with implant placement in the anterior maxilla without jeopardizing vitality of nasopalatine nerve and vessels: a novel surgical approach. Clinical Oral Implants Research: Novel Development. 2000; 11(5):505- 10.
24. Linjawi AI, Othman MA, Dirham AA, Ghoneim SH, Aljohani SR, Dause RR, Marghalani HY. Morphological evaluation of the incisive canal with reference to gender and age: A cone-beam computed tomography study. Nigerian Journal of Clinical Practice. 2021;24(11):1596-601.
25. Talebian M, Etemad S, Seimareh KA. Morphological and anatomical assessment of the nasopalatine canal in edentulous patients using cone beam computed tomography. Revista Publicando. 2018; 5(16):494-502.
26. Ebenezer S, Kumar VV, Thor A. Basics of Dental Implantology for the Oral Surgeon. Oral and Maxillofacial Surgery for the Clinician. 2021:385-405.