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Morphological variation of nasopalatine canal: A cone-beam computed tomography study

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Abstract
Aim: 1) to assess the morphological variation of the nasopalatine canal (NPC) concerning age and gender. 2). to assess the correlation between the gender and morphology of the canal. 3). to assess the correlation between age and length of the canal.
Materials and Methods: This is a retrospective, randomized observational study. The study comprised of 60 CBCT scans of maxilla showing NPC completely. The patients were in the age range of 15-75 years. Scan of 25 females and 35 males were included in the study. Patient below 15 years of age and NPC pathology or impacted teeth in same region were excluded in the study. The scans were obtained using ICAT17-19 machine and analyzed Vision software. Cone-Beam 3D Imaging Machine operating at 120 kvp, 37.07 mAs with 0.25 mm voxel size, and a field of view of 16 × 6 cm maxilla.
Results: Nasopalatine canal has 4 different morphological shapes. The most common shape was the cylindrical shape amongst both males and females. The least common shape was found to be hourglass shape with increasing age the length of NPC was found to decrease. The length of the canal was found to be longer in males when compared to females
Conclusion: This study highlights the importance of NPC morphology before or during surgical procedures involving the maxilla.

Keywords: Cylindrical shape, hourglass shape, nasopalatine canal, morphological shapes

Introduction

Anterior palatine canal is another name for nasopalatine canal. The canal is present in the middle of the anterior maxillary region. It is a long slender passage and it connects the palate to the floor of the nasal cavity [1]. Canal continues in the oral cavity as a single incisive foramen posterior to the central incisor teeth and in the nasal cavity as the foramina of Stenson, which are two in number. It contains the nasopalatine (incisive) nerve and nasopalatine artery, as well as fibrous connective tissue. Implant removal and tissue augmentation may be the consequences due to implant failure [2].

Neurovascular tissue contact with implant may result in the loss of Osseo integration, development of sensory disorders. So, before the placement of dental implant nasopalatine canal morphology and dimensions should be evaluated carefully [3].

To prevent complications due to placement of implants in the incisor area, three-dimensional configuration of nasopalatine canal, its position in relation to the surrounding structures, alveolar bone morphology, and incisors' morphological changes in the alveolar bone should be estimated carefully [4]. Also important anatomical structures like nasopalatine canal, incisive and mental foramina, inferior alveolar canal, nasal fossa and maxillary sinus should be properly evaluated while selecting the implant site. To gain the information regarding buccolingual width of the alveolar bone, anatomical structures' condition, or the 3D structure of the selected implant site, conventional radiographic techniques like panoramic and intraoral X- rays are not suitable [5]. Advanced imaging modalities are more accuarte in both diagnosing and treatment. Radiographic evaluation is a useful guide for selecting the proper site, number, size, and angle of implants as it measures the bone quality and quantity in the selected area [6]. For 3D visualization of various structures, which are difficult to detect on panoramic and intra-oral views, Cone beam computed tomography (CBCT) is recommended. [4]. In addition, there are no obvious differences between linear measurements on CBCT and direct measurements of maxillofacial structures, which is the gold standard [7].

The purpose of this study was to determine the morphological variations of nasopalatine

canal concerning age and gender by using CBCT

Material and Methods

This is a retrospective, randomized observational study. The study comprised of 60 CBCT scans of maxilla showing NPC completely. The patients were in the age range of 15–75 years. Scan of 25 females and 35 males were included in the study. Patient below the 15 years of age and NPC pathology or impacted teeth in same region were excluded in the study. The scans were obtained using ICAT17-19 machine and analyzed Vision software. Cone-Beam 3D Imaging machine operating at 120 kvp, 37.07 mAs with 0.25 mm voxel size, and a field of view of 16 × 6 cm maxilla.

Evaluation of images

The shape of the canal was observed in the sagittal section and is classified as:

1. Cylindrical shape: A cylindrical shape formed by parallel labial and palatal walls of the NPC [Figure 1a].
2. Funnel shape: A funnel shape formed by an increasing anteroposterior dimension of the NPC from the nasal fossa to the hard palate [Figure 1b].
3. Hourglass shape: An hourglass shape in which the narrowest anteroposterior dimension of the NPC was at the level compared to the dimensions at the nasal fossa and hard palate levels [Figure 1c].
4. Spindle shape: A spindle shape in which the widest anteroposterior dimension of the NPC was at the mid-level compared to the dimensions at the nasal fossa and hard palate levels [Figure 1d] [8].

Nasopalatine canal length was measured between the floor of the nasal fossa and the level of the hard palate along the long axis of the canal in the sagittal section of the CBCT scan. And the length was measured by using a digital length measuring tool [9].

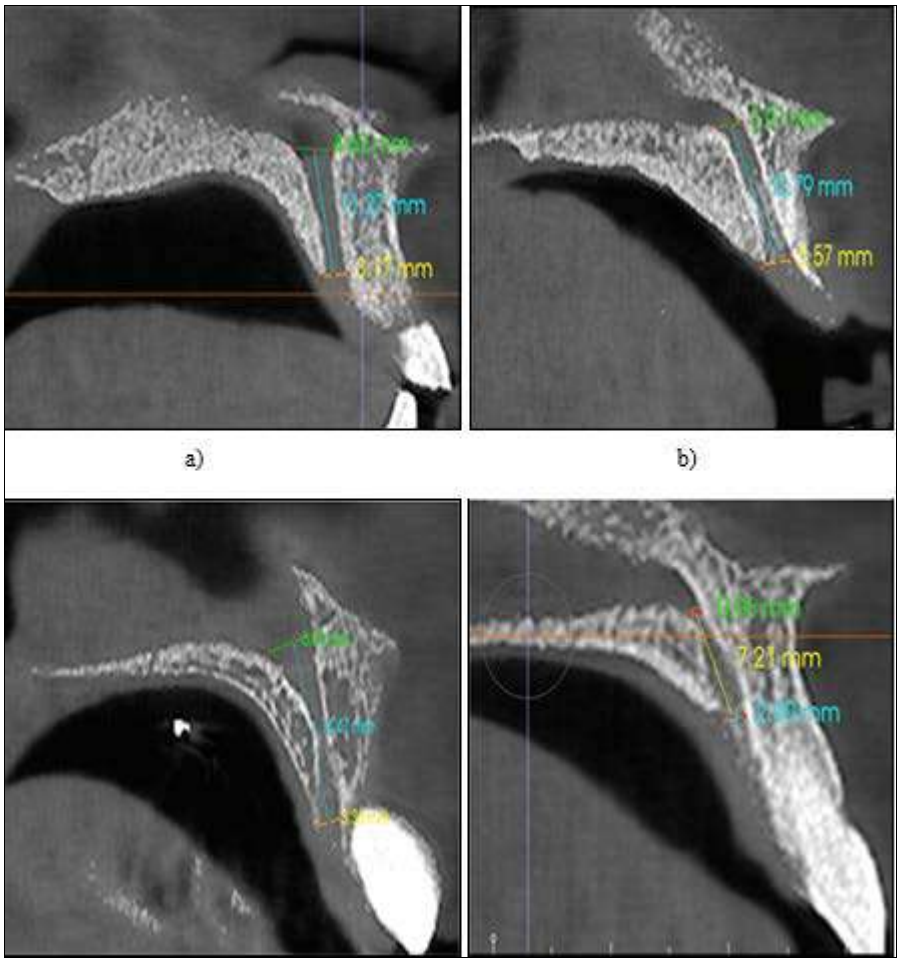

Fig 1: Cone-beam computed tomography images show the four shapes of the nasopalatine canal on sagittal planes. (a) Cylindrical shape, (b) funnel shape (c) hourglass shape (d) spindle shape

Statistical analysis

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean ± SD and categorical variables were summarized as frequencies and percentages. Graphically the data was presented by bar and pie diagrams. Chi-square test was employed for comparison of shape of NPC according to age and gender. A P-value of less than 0.05 was considered statistically significant.

Result

Table 1: Age distribution of study subjects

Age (Years)	Number	Percentage
≤ 25 Yrs.	32	53.3
26-35 Yrs.	21	35.0
36-45 Yrs.	7	11.7
Total	60	100
Mean ± SD = 26.3±6.74		

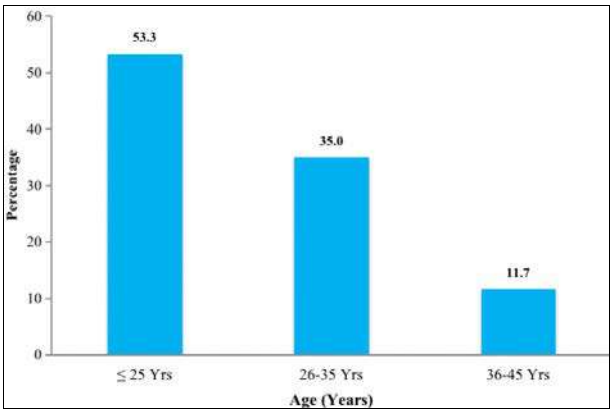

Fig 2: Age distribution of study subjects

Table 2: Gender distribution of study subjects

Gender	Number	Percentage
Male	35	58.3
Female	25	41.7
Total	60	100

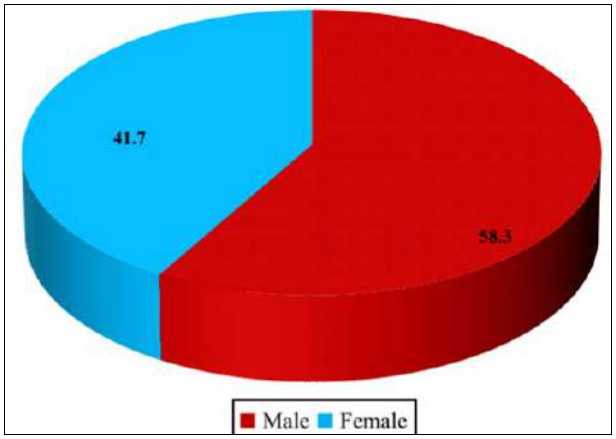

Fig 3: Gender distribution of study subjects

Table 3: Shape of Nasopalatine Canal (NPC)

Shape	Number	Percentage
Cylindrical	33	55.0
Funnel	18	30.0
Hourglass	4	6.7
Spindle	5	8.3
Total	60	100

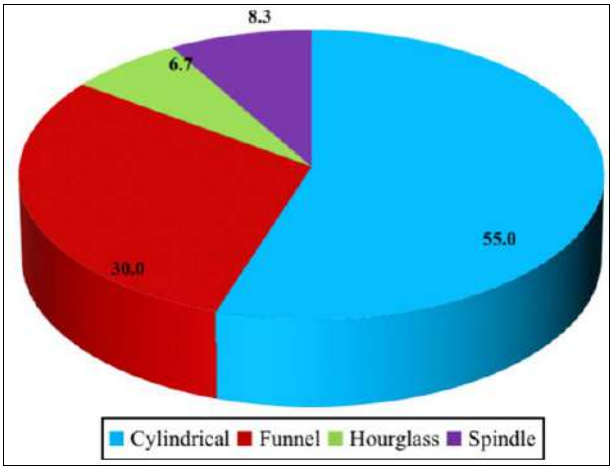

Fig 4: Shape of nasopalatine canal (NPC)

Table 4: Distribution of NPC shape according to gender

Shape	Male		Female	
	No.	%age	No.	%age
Cylindrical	19	31.7	14	23.3
Funnel	9	15.0	9	15.0
Hourglass	3	5.0	1	1.7
Spindle	4	6.7	1	1.7
Total	35	58.3	25	41.7
Chi-square = 1.945; P-value = 0.584				

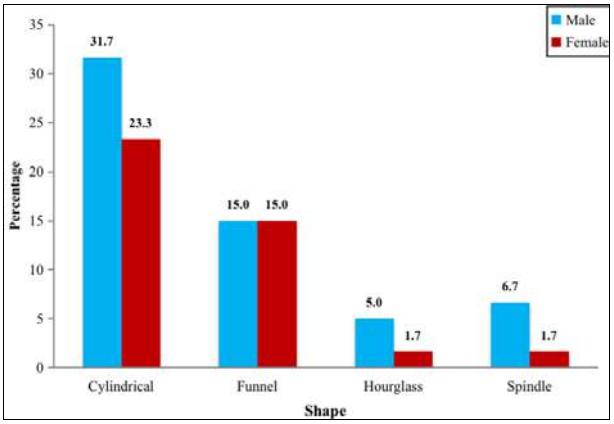

Fig 5: Shape of nasopalatine canal (NPC)

In both genders out of 60 subjects, cylindrical shape was the most common shape of nasopalatine canal seen in 33 scans whereas hourglass shape was its least common shape seen in only 4 scans (Table 3). However, among females both the hourglass and spindle shaped canals were seen in only one scan (Table 4).

Table 5: Distribution of NPC shape according to age

Shape	≤ 25 Yrs.		26-35 Yrs.		36-45 Yrs.	
	No.	%age	No.	%age	No.	%age
Cylindrical	19	31.7	10	16.7	4	6.7
Funnel	10	16.7	7	11.7	1	1.7
Hourglass	1	1.7	2	3.3	1	1.7
Spindle	2	3.3	2	3.3	1	1.7
Total	32	53.3	21	35.0	7	11.7
Chi-square = 2.965; P-value = 0.813						

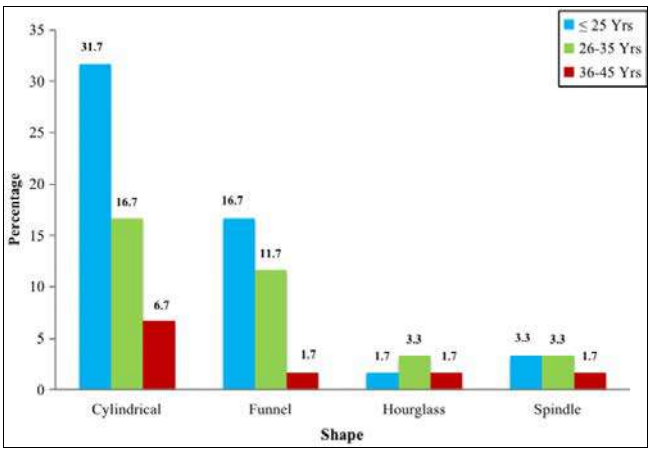

Fig 6: Distribution of NPC shape according to age

Below the age of 25 years, out of 60 subjects, the most common shape of NPC found was cylindrical and hourglass shape was the least common shape found.
Between the age group of 26-35 years the most common

shape of NPC found was cylindrical whereas both hourglass shape and spindle shape were seen in only 2 scans Between the age group of 36-45 years the most common shape of NPC found was cylindrical (Table 5).

Table 6: Length of nasopalatine fossa according to age

Age (Years)	N	Mean	SD	Range
≤ 25 Yrs.	32	11.46	2.13	9.15-18.62
26-35 Yrs.	21	10.87	1.94	8.78-14.45
36-45 Yrs.	7	9.73	0.87	8.71-11.12
Total	60	11.05	1.79	8.71-18.62

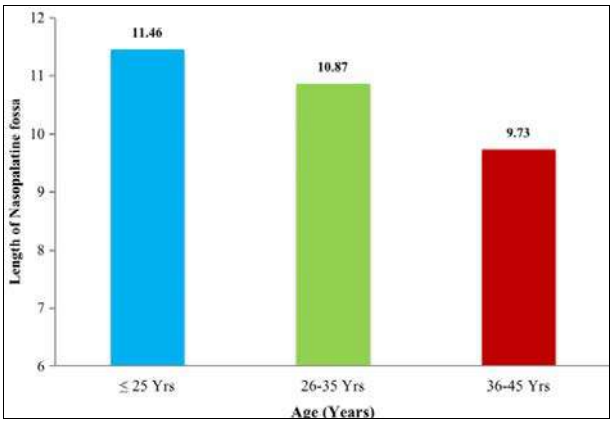

Fig 7: Length of nasopalatine fossa according to age

According to the age, length of NPC was observed. With the advancement of age, length of the canal was decreasing in both the genders (Table 6).

Table 7: Length of Nasopalatine fossa according to gender

Gender	N	Mean	SD	Range
Male	35	11.46	2.07	9.24-18.62
Female	25	10.48	1.28	8.71-14.45
Total	60	11.05	1.79	8.71-18.62

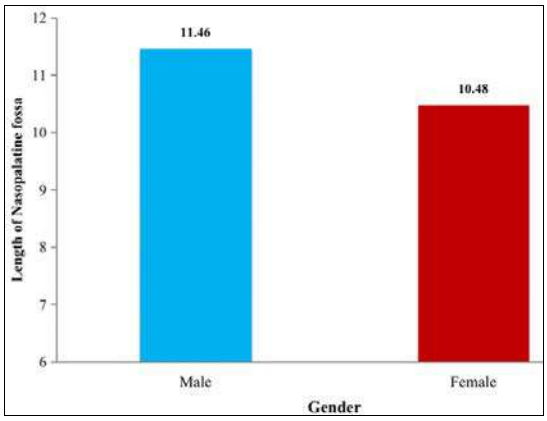

Fig 7: Length of nasopalatine fossa according to gender

The length of the NPC was measured between the level of the nasal fossa and the level of the hard palate along the long axis of the canal. It ranges from 9.24-18.62 mm in male with a mean of 11.46 mm and from 8.71-14.45 mm in females with a mean of 10.48 mm. This shows that the length of the NPC is relatively greater in male than in female.

Discussion

Lot of changes has been brought in dentistry due to development of CBCT. However with CBCT, patients are exposed to a slightly higher radiation dose it provides detailed quantitative and qualitative information which the conventional methods do not give and this makes the increased radiation dose justifiable. To evaluate the effects of this technique on improved diagnostic accuracy and for the development of treatment plans, future studies are necessary and if this imaging modality does not improve diagnostic accuracy then patients should not be subjected to increased radiation. The dose of Cone Beam Computed Tomography is three to seven times higher than that of Conventional Radiography and it is more time consuming also. However CBCT is strongly recommended due to its many advantages in implant fields. For each imaging modality, the risks and benefits should be considered carefully, particularly in the youth as any extra radiation exposure may lead to unfavorable effects on growing tissues [10]. In a study by Farman [11], ALARA (as low as reasonably achievable) principle was the fundamental criterion in choosing CBCT and other diagnostic radiographic modalities. It is necessary to define principles for CBCT in this regard. It should be noted that CBCT radiation dose has decreased significantly without any considerable effects on the image quality.

Due to the close anatomical relation between the nasopalatine canal and the maxillary central incisor roots, precise radiographic evaluation of the canal before implant placement is of utmost importance. However, only few studies have been conducted on variations in canal anatomy, morphology and dimensions [3].

The present study indicates that the most common shape of NPC was cylindrical shape amongst both males and females. The least common shape was found to be hourglass shape [3]. The findings are similar to the results of the study done by Thakur *et al*. in 2013 [8].

Present study indicated that the NPC showed a great deal of variability with regard to its length as well as to its morphological appearance. In our study, four anatomical Shapes of NPC were seen in the sagittal CBCT slice [12, 13]. The findings are similar to the results of the study done by Mraiwa *et al*. in 2013 [3]. In our study, the cylindrical shape was found in 55% of the scans, the funnel-shaped canal was found in 30%, spindle shape 8.3%, and an hourglass in 6.7% [Table 3] [11].

our results are also consistent with the ones of Yasser *et al*., Liang *et al*., Asaumi *et al*. [15, 12, 4] Other shapes like (1) cone shape, (2) banana like, (3) tree branch like shapes of the canal have also been reported by Etoz and Sisman. [16]. The average length of the NPC in our study was found to be 11.05mm ranging from 8.71 to 18.62 mm; result close to the ones of Richa Mishra *et al*., Thakur *et al*., Tozum *et al*., and Fukuda *et al*., whose mean canal length measurement in a sagittal plane was 10.08, 10.86 and 11.75 mm ranging from 6.15 mm to 16.04 mm.[1, 8, 17] In our study length of NPC below the 25 year of age the most common NPC shape was found to be cylindrical shape and least common shape was hourglass shape. Between the ages range 26-35 years of age the most common NPC shape was cylindrical shape and least common shape was hourglass and spindle shape. And between 36-45 year of age range the most common NPC shape was cylindrical shape and least common shape was funnel shape, spindle and hourglass shape [Table 5].

In our study length of NPC was found to decrease with increasing age which was similar to the study done by

Fernandez-Alonso *et al*. and Liang *et al*. [4, 8] [Table 6].
In our scans the GPN canals in females were found to be significantly shorter in the male, a thing which was supported by the findings of Richa Mishra *et al*., Thakur *et al*., Liang *et al*. [1, 8, 12] [Table7].
The variations in NPC concerning sex, shape, age, and length is of paramount importance in pre-surgical planning. With the advent of CBCT, the technological knowledge can be a soon in treatment planning. Larger samples can aid in giving more conclusive statistical data [14].

Conclusion
The result from our present study highlights the anatomic variability of the NPC concerning age, gender, shape, length, etc. [1]. The result from this study suggests that gender is an important factor that can affect the characteristics of the NPC and the amount of bone in anterior region [15]. The length of canal varies with age. Sound knowledge of the anatomy of NPC concerning age and gender using CBCT is a new diagnostic tool and a boon for surgical planning in the maxillary anterior region [16].

Conflict of Interest
Not available

Financial Support
Not available

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