Original Article

Analysis of Morphology and Dimensions of Nasopalatine Canal: A Cone-beam Computed Tomography Study

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ABSTRACT

Background: The palate and nasal cavity are connected by the nasopalatine canal (NPC), a narrow, long channel in the front maxilla. For orthodontic planning, maxillofacial surgery, and dental implants, an accurate definition of NPC is essential since differences in it might affect treatment outcomes and raise the risk of complications. **Aim:** This study aims to analyze the morphology and dimensions of NPC with cone-beam computed tomography (CBCT). **Materials and Methods:** To analyze the morphology and dimension of NPC, 100 CBCT images were used in this study. NPC's width and length were among the 5 linear measurements taken from the sagittal cross-section. According to Bronstein *et al*. classification given in CBCT coronal cross-sections, the NPC morphologies were divided into three groups. Age and gender influences on the measured dimension were evaluated. For statistical analysis, one-way analysis of variance, student independent *t*-test, and Chi-square test were employed. **Results:** The study comprised 100 sample size having 47 males and 53 females with a mean age of 37.02 ± 13.41. The mean length for females and males was 11.34 and 10.91 mm in NPC, respectively. Type A was the most common type of canal configuration seen. **Conclusion:** There are numerous variances in the NPC, and its size varies on the basis of age, gender, and dental health. To avoid difficulties, the maxilla should be radiologically assessed before undergoing any surgical treatments.

Key words: Cone-beam computed tomography, Dimension, Implant, Morphology, Nasopalatine canal

INTRODUCTION

One of the area's most frequently subjected to trauma and tooth loss is the premaxilla. The nasopalatine canal (NPC) is a very significant anatomical landmark in this area.[1] This canal is situated behind the central incisor in the maxilla's midline.[2] The incisive foramen is the oral canal's aperture, which is situated beneath the incisive papilla. Stenson's foramina are the apertures of this nasal canal.[3]

In premaxillary surgery, NPC, also referred to as the incisive canal or anterior palatine canal, is an important anatomical structure.[4] The neurovascular bundle is a part of the canal. Understanding the anatomical features and variations of significant landmarks is crucial before undergoing surgical procedures such as implant placement.[5]

Numerous radiography techniques have been employed to pinpoint the location of NPC. Magnification and distortion of the images might happen even though two-dimensional (2D) radiographs are commonly utilized for implant design.[6] Clear information regarding the buccolingual breadth and threedimensional (3D) structure of the bone in the chosen implant site cannot be obtained using traditional radiography methods.[7] Finding the right placement, size, and angle for dental implants as well as assessing the quantity and quality of bone in the chosen area, can be done with the help of preoperative radiographic evaluation. The NPC and surrounding bone must be accurately assessed to prevent these issues.[8]

Anatomical structures, including the NPC, mandibular canal, and mental foramen, may now be examined more precisely and closely because of advancements in imaging technology and the growing use of cone-beam computed tomography (CBCT) in dentistry.[9] Many dento-maxillofacial researchers have recently recognized the use of CBCT for 3D imaging as an amazing imaging

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tool due to its cheaper costs and reduced radiation doses when compared to computed tomography (CT).[10] To achieve the best surgical treatment plan while preventing implant contact with the canal neural tissue–which could result in a lack of osseointegration or sensory dysfunction–it is helpful to pay attention to the characteristics of NPC imaging.[11]

Hence, the study was directed with the aim of assessing the morphometric variations of NPC in CBCT sectional images.[12] Buccal bone plate width and the effects of gender and age on afore mentioned items were also examined.

MATERIALS AND METHODS

In this present study, all CBCT images were collected from departmental archives and evaluated in the Department of Oral Medicine and Radiology, Institute of Dental Sciences, Bareilly, Uttar Pradesh. CBCT images of sufficient diagnostic quality that covered the necessary imaging area and patients of either gender with an age of over 18 years were included. A history of any pathology in the area of interest, orthodontic treatment, fracture, or orthognathic surgery was excluded from the study.

All the CBCT images were attained using a Vatech A9 machine (Gyeonggi-do, Seoul, South Korea) in an 8 × 8 cm field of view. The Kodak Dental CS 3D Imaging Software V3.5.7.0 (Carestream Health Inc., St. Rochester, NY, USA) was used. The total of 100 CBCT images was taken in the study, calculated using the formula given below

Exact - Correlation: Bivariate normal model

Options:	Exact distribution		
Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	One
Correlation ρ H1		=	0.3
α err prob		=	0.05
Power (1-β err prob)		=	0.95
Correlation ρ H0		=	0
Output: Lower critical r		=	0.1541491
Upper critical r		=	0.1541491
Total sample size		=	100
Actual power		=	0.9501151

The images obtained from CBCT were created in digital imaging and communication in medicine format. The retrieved demographic data of all included cases were recorded on a data sheet.

Ethics

The study was permitted by the Institutional Ethics Committee of IDS, Bareilly (IEC/385/2025/07).

Measurement of NPC

Both the anatomy and the size of NPC were examined, according to Khojastepour *et al.*[10] Using the sagittal CBCT sections, the NPC canal's dimensions were measured in millimeters (mm) as follows: K1 (diameter of the canal's nasal opening), K2 (diameter of the canal's oral orifice), K3 (canal length; maximum vertical length between the nasal and oral orifice), K4 (width of the buccal cortical bone plate over the oral opening), and K5 (width of the buccal bone plate over the nasal orifice)[13] [Figure 1].

In the coronal section of CBCT, the NPC anatomy was classified into three groups based on Bornsteins *et al.*'s classification[14] [Figure 2]. This classification comprised Type A with single canal; Type B having two parallel canals and type C, which showed variations of the Y-type of canal with 1 oral opening (incisive foramina) and 2 or more nasal openings (foramen of Stensen).[15]

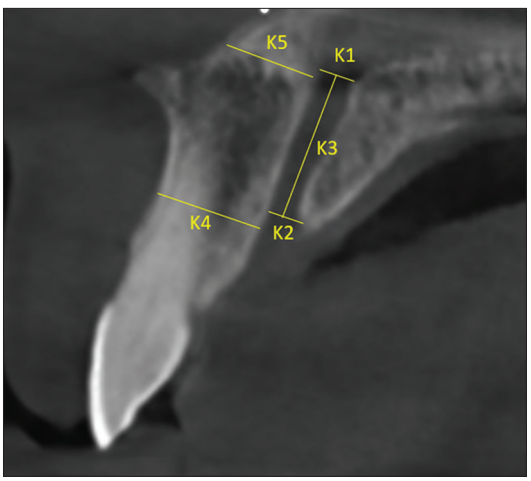


Figure 1: Dimensions of nasopalatine canal

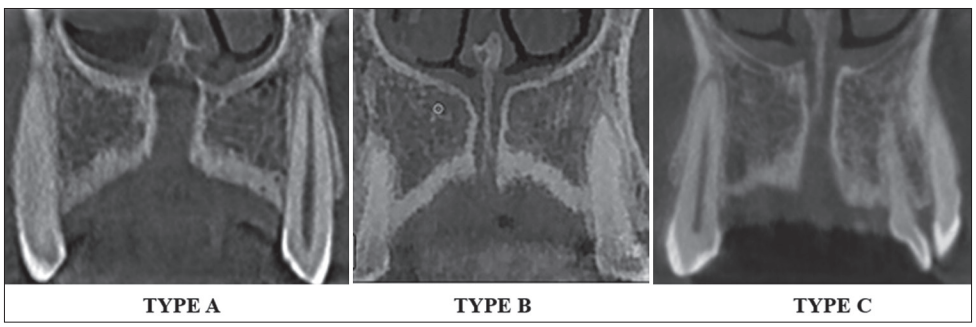


Figure 2: Bornstein *et al.*'s classification of nasopalatine canal

Statistical analysis

The collective data were entered into a Microsoft Excel spreadsheet and imported into Statistical Package for Social Sciences version 28 for statistical analysis. Qualitative data were presented in frequency and percentage, but quantitative data were presented in mean and standard deviation format. Chi-square test, Student-independent *t*-test, one-way analysis of variance test, and Pearson correlation were performed to find a significant difference in different variables. A $P < 0.05$ was considered statistically significant and $P < 0.001$ was considered a highly significant value.

RESULTS

The study contained a total of 100 CBCT scans, which were randomly selected; out of which 47% were males with mean age of 35.88 ± 10.88 and 53% were female with a mean age 38.29 ± 15.81. The overall mean age was 37.02 ± 13.41.

The average dimension of the nasal opening in the canal came out to be 3.03 ± 1.22, the diameter of nasal opening of canal was 3.45 ± 0.91 with average canal length as 11.34 ± 2.5 [Table 1]. Type A canal is the most common in both genders, 54.45% in females and 62.26% in males. Type C canal was the least common, 21.2% seen in females and 18.87 % seen in males [Table 2].

In our study, the effect of measured dimensions was also seen in which K1 is significantly larger in females, 3.33 ± 1.32 ($P = 0.019$). Other parameters show no significant gender-based differences [Table 3 and Graph 1]. On comparison of NPC and buccal bony plate dimension between different types of canal, only K2 showed a statistically significant variation among canal types ($P = 0.035$) [Table 4].

K1 positively correlates with age, suggesting that incisive foramen width increases with aging. K3 and K4 negatively correlate with age, indicating a reduction in canal length and buccal plate height as age advances. These age-related changes may influence treatment planning in older patients [Table 5].

Table 1: The description of measured dimensions in nasopalatine canal

Variable	Minimum	Maximum	Mean±Standard deviation
K1 (mm)	1.1	7.1	3.03±1.22
K2 (mm)	1.9	5.9	3.45±0.91
K3 (mm)	6.8	17.7	11.34±2.5
K4 (mm)	1.8	7.6	5.68±1.24
K5 (mm)	2.4	11.2	6.62±1.67

Table 2: Gender-specific frequencies and percentages of different nasopalatine canal types

Sex	Canal type		
	A (%)	B (%)	C (%)
Female	27 (54.45)	10 (21.28)	10 (21.28)
Male	33 (62.26)	10 (18.87)	10 (18.87)

#*P*>0.05 statistically not significant

DISCUSSION

A thorough radiographic evaluation in the maxilla anterior region is required before dental implant surgery and other surgical operations to verify the exact position and size of the anatomical features.[16] There are numerous studies in the literature on the application of different imaging techniques for the morphological assessment of NPC. To name a few, Safi *et al.*[12] assessed the anatomical and morphological differences of the NPC in their investigation. The NPC's cylindrical shape predominated (65.33%). There were significant differences between the two genders, with the mean NPC length of 12.85 ± 2.63mm being higher in men ($P < 0.001$). In the coronal plane, Y-type canal morphological variation was most prevalent (50%), while Type A canal was the most common in both genders in our study.

In a related study, Demiralp *et al.*[5] observed that the mean NPC volume was statistically significantly bigger in males than in females (P < 0.02). The mean age of the anterior edentulous (AE) and anterior dentate (AD) groups was 58.3 ± 8.3 and 51.7 ± 9.2 years, respectively. The AE and AD groups' mean linear measurements of the NPC and buccal residual bone differed statistically (P#0.05).

There were 199 (66.3%) patients with type A canals (cylindrical without a branch), 69 (23%) with type B canals (a canal with a branch in the upper section), and 32 (10.7%) with type C canals (a

Table 3: Effect of different gender in measured dimensions on sagittal sections of cone-beam computed tomography

Gender	Dimensional measurement mean±standard deviation mm				
	K1	K2	K3	K4	K5
Male	2.76±1.07	3.44±0.96	11.72±2.6	5.65±1.4	6.33±1.65
Female	3.33±1.32	3.46±0.86	10.91±2.34	5.71±1.04	6.94±1.66
P-value	0.019*	0.939#	0.106#	0.805#	0.067#

**P*<0.05 statistically significant. #*P*>0.05 statistically not significant

Table 4: Comparison of nasopalatine canal and buccal plate dimensions between different types of canal (analysis of variance)

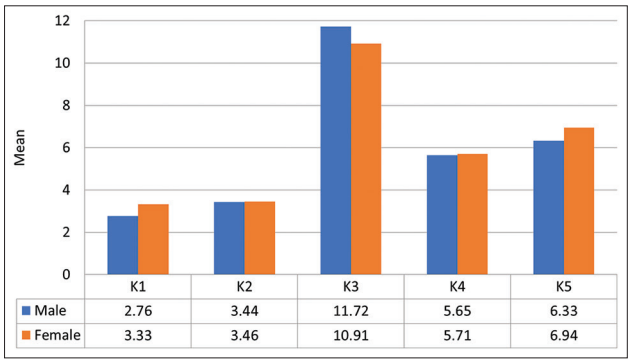
Canal types	Dimensional measurements mean±standard deviation mm				
	K1	K2	K3	K4	K5
A	2.86±1.1	3.64±0.9	11.2±2.36	5.63±1.17	6.72±1.42
B	3.56±1.43	3.24±0.88	11.56±3.08	5.59±1.6	6.54±2.17
C	3.02±1.27	3.1±0.86	11.57±2.37	5.91±1.04	6.39±1.87
P-value	0.086#	0.035*	0.774#	0.654#	0.734#

**P*<0.05 statistically significant. #*P*>0.05 statistically not significant

Table 5: Correlation between measured dimensions and age

Variable	Correlation coefficient (r)	*P*-value
K1	0.22	0.028*
K2	0.053	0.603
K3	−0.202	0.044*
K4	−0.313	0.002**
K5	−0.007	0.945

**P*<0.05 statistically significant. #*P*>0.05 statistically not significant. **< 0.01 statistically highly significant.



Graph 1: Effect of different gender in measured dimensions on sagittal sections of cone-beam computed tomography

canal with a branch in the middle part), according to another study by Beshtawi *et al.*[2] The sagittal section's incisive foramen diameter measured 4.7 ± 1.11 mm. The alveolar bone width in the anterior portion of the canal was greater than in our sample, measuring 12.3 ± 1.7 mm in the upper third and 9.8 ± 1.4 mm in the lower third.

Alasmari,[14] in contrast to my study, looked at the CBCT images of 182 males (45.4%) and 219 females (54.6%), with an average age of 40.17 ± 2.31 years. Both the superior and inferior canal widths were 4.07 ± 2.06 mm, 3.4 ± 1.42 mm, and 13.86 ± 2.68 mm, respectively, as was the NPC's overall length. The males had a statistically significantly greater superior canal width (3.62 ± 1.78 mm) and inferior canal width (4.33 ± 1.79 mm), according to an independent *t*-test.

Keşkek *et al.*[11] conducted a retrospective analysis of CBCT pictures from a total of 1000 patients. Sections were used to categorize the NPCs shape. Variations were assessed, and its dimensions were measured. The cylindrical type (47.1%) and C-shaped canal (51.1%) were found to be the most prevalent NPC shapes in sagittal and coronal sections, respectively. Two Stenson foramen (45.2%) were the most commonly observed in the axial section, while oval foramens (60.7%) were the most common type.

NPC tends to enlarge with age, particularly following tooth extraction, rather than remaining a constant structure. The current study demonstrated that NPC volumes varied greatly and were impacted by both sex and age.

CONCLUSION

NPC exhibits a wide variety of sizes and shapes. In the population under study, single canals make up the majority of cases, whereas Y-shaped canals were the least common variety. In males, the buccal bone width over the oral entry of the canal and all NPC canal parameters are substantially larger. In addition, age has a direct influence on the width of the buccal bone plate and the NPC diameter. To improve surgical outcomes and lower surgical complications, a deeper understanding of this anatomic structure and the use of cross-sectional imaging are required, as the current results highlighted the variability of the NPC in terms of multiple parameters.

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