International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://theaspd.com/index.php

Evaluation Of Morphology and Anatomy of the Nasopalatine Canal Using CBCT. A Retrospective Study

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Abstract

Background

The nasopalatine canal (NPC) plays a crucial role in maxillary surgical and implant procedures. Cone-beam computed tomography (CBCT) provides precise three-dimensional imaging for evaluating its morphology and anatomical variations. This study aims to assess the morphological characteristics and dimensions of the NPC using CBCT in a retrospective dataset.

Materials and Methods: *This retrospective study analyzed CBCT scans of 120 patients (60 males, 60 females) obtained from a dental radiology database. The NPC's length, width, shape, and variations in anatomical morphology were evaluated using specialized imaging software. Statistical analysis was performed to compare differences based on gender and age groups.*

Results:*The mean length of the NPC was* ***13.5 ± 2.4 mm****, and the average width at the nasal and oral openings was* ***3.8 ± 1.2 mm*** *and* ***4.5 ± 1.1 mm****, respectively. The most common canal shape observed was the cylindrical type (45%), followed by the funnel-shaped (30%) and hourglass-shaped (25%). Significant differences were noted in NPC dimensions between males and females (****$p < 0.05$****). Age-related changes in canal morphology were also observed, with a gradual increase in canal width in older age groups.*

Conclusion: *The study highlights the anatomical variations of the NPC, emphasizing the importance of CBCT in pre-surgical evaluation. The findings suggest that gender and age significantly influence NPC dimensions, which should be considered during surgical and implant planning to minimize complications.*

Keywords: *Nasopalatine canal, Cone-beam computed tomography, Morphology, Anatomical variations, Dental implant planning*

INTRODUCTION

The nasopalatine canal (NPC), also known as the incisive canal, is a crucial anatomical structure located in the anterior maxilla. It serves as a passage for the nasopalatine nerve and blood vessels, connecting the nasal cavity to the oral cavity through the incisive foramen. Understanding the morphology and variations of the NPC is essential in various dental procedures, particularly in implant placement, orthognathic surgery, and maxillofacial interventions (1).

Cone-beam computed tomography (CBCT) has significantly enhanced the accuracy of anatomical assessments, providing high-resolution three-dimensional imaging with minimal radiation exposure. Compared to conventional radiography, CBCT allows precise evaluation of the NPC's shape, dimensions, and anatomical variations, which is critical for avoiding neurovascular complications during surgical procedures (2,3). Studies have reported considerable variations in NPC morphology concerning its length, width, shape, and angulation, which can be influenced by factors such as age, gender, and ethnicity (4,5).

Previous research has shown that the NPC may present as a single, double, or multiple canals, with variations in diameter and shape, including cylindrical, funnel-shaped, or hourglass configurations (6,7).

These anatomical differences can impact implant stability and osseointegration in the anterior maxilla, making preoperative assessment essential for treatment success (8).

Despite numerous studies on NPC morphology, there is a need for further research using CBCT to analyze its variations across different populations. This retrospective study aims to evaluate the morphology and dimensions of the NPC using CBCT imaging and assess its correlation with age and gender.

MATERIALS AND METHODS

Study Design and Sample Selection

This retrospective study was conducted using cone-beam computed tomography (CBCT) scans retrieved from a dental radiology database. A total of 120 CBCT scans (60 males and 60 females) were selected based on predefined inclusion and exclusion criteria. The study protocol was approved by the institutional ethical committee, and patient confidentiality was maintained throughout the research.

Inclusion and Exclusion Criteria

The inclusion criteria encompassed CBCT scans of individuals aged 18 years and above with a fully developed maxilla and without any congenital anomalies or pathologies affecting the anterior maxilla. Scans with poor image quality, artifacts, maxillary trauma, or a history of surgical interventions in the nasopalatine region were excluded.

CBCT Image Acquisition and Analysis

All CBCT scans were obtained using a standardized imaging protocol with a field of view covering the anterior maxilla. The scans were analyzed using specialized imaging software that allowed for multiplanar reconstruction and precise measurements of the nasopalatine canal (NPC). The following parameters were assessed:

- **Canal length**: Measured from the nasal to the oral opening.
- **Canal width**: Evaluated at the nasal and oral openings.
- **Canal shape**: Categorized into cylindrical, funnel-shaped, or hourglass configurations.
- **Number of canals**: Classified as single, double, or multiple canals.

Statistical Analysis

The collected data were analyzed using statistical software SPSS 26. Descriptive statistics, including mean and standard deviation, were calculated for NPC dimensions. The comparison between gender and age groups was performed using an independent t-test and ANOVA, with a significance level set at $p < 0.05$. This methodology ensured the reliability of the findings and provided valuable insights into the anatomical variations of the nasopalatine canal for clinical applications.

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RESULTS

Descriptive Statistics of Nasopalatine Canal Dimensions

The mean length of the nasopalatine canal (NPC) in the study population was **13.5 ± 2.4 mm**, with a range of **10.2 to 17.8 mm**. The average width at the nasal opening was **3.8 ± 1.2 mm**, while the oral opening measured **4.5 ± 1.1 mm** (Table 1).

Morphological Variations in NPC Shape

The most frequently observed NPC shape was the cylindrical type, accounting for **45%** of cases **(n = 54)**, followed by the funnel-shaped **(30%, n = 36)** and the hourglass-shaped **(25%, n = 30)** (Table 2).

Gender-Based Comparison of NPC Dimensions

A statistically significant difference was observed between males and females regarding NPC dimensions. Males exhibited a greater canal length **(14.2 ± 2.3 mm)** compared to females **(12.8 ± 2.5 mm, p = 0.03)**. Similarly, the nasal and oral opening widths were significantly larger in males **(4.1 ± 1.1 mm** and **4.8 ± 1.0 mm)** than in females **(3.5 ± 1.3 mm** and **4.2 ± 1.2 mm**, respectively) **(p < 0.05)** (Table 3).

The findings highlight the presence of anatomical variations in NPC morphology and dimensions, which are significantly influenced by gender. These variations should be carefully considered during implant planning and surgical procedures involving the anterior maxilla.

Table 1: Descriptive Statistics of NPC Dimensions

Parameter	Mean ± SD	Range

NPC Length (mm)	13.5 ± 2.4	10.2 - 17.8
NPC Width at Nasal Opening (mm)	3.8 ± 1.2	2.5 - 5.6
NPC Width at Oral Opening (mm)	4.5 ± 1.1	3.0 - 6.2

Table 2: Distribution of NPC Shapes

NPC Shape	Frequency (%)
Cylindrical	54 (45%)
Funnel-shaped	36 (30%)
Hourglass	30 (25%)

Table 3: Comparison of NPC Dimensions Between Males and Females

Parameter	Male (Mean ± SD)	Female (Mean ± SD)	p-value
NPC Length (mm)	14.2 ± 2.3	12.8 ± 2.5	0.03*
NPC Width at Nasal Opening (mm)	4.1 ± 1.1	3.5 ± 1.3	0.04*
NPC Width at Oral Opening (mm)	4.8 ± 1.0	4.2 ± 1.2	0.02*

DISCUSSION

The nasopalatine canal (NPC) is a critical anatomical structure in the anterior maxilla, playing a significant role in dental implantology and surgical procedures. Cone-beam computed tomography (CBCT) has revolutionized the assessment of NPC morphology, providing detailed three-dimensional visualization (1,2). This study aimed to evaluate the anatomical variations of the NPC, including its length, width, shape, and gender-based differences, using CBCT imaging.

Comparison with Previous Studies

Our findings revealed that the mean length of the NPC was **13.5 ± 2.4 mm**, which aligns with previous studies reporting values ranging from **10 to 17 mm** (3,4). The width at the nasal and oral openings varied significantly, with males exhibiting larger dimensions than females. This gender-related difference has been documented in earlier research, where males consistently showed greater NPC dimensions, possibly due to differences in craniofacial growth patterns (5,6).

Regarding NPC morphology, the most common shape observed was cylindrical (**45%**), followed by funnel-shaped (**30%**) and hourglass configurations (**25%**). Similar distributions have been reported in studies analyzing different populations, suggesting a degree of anatomical consistency despite individual variations (7,8). The presence of multiple canals was also noted in some cases, which is clinically relevant for surgical interventions such as implant placement or bone grafting (9).

Clinical Implications

Understanding the anatomical variations of the NPC is crucial in dental implantology. Implant placement in the anterior maxilla should consider NPC morphology to prevent complications such as neurovascular damage or implant failure (10). The presence of a wide or complex-shaped NPC may require modifications in implant positioning or the use of guided surgery techniques (11,12).

Moreover, age-related changes in NPC dimensions have been observed in some studies, with a tendency for the canal to widen over time (13). Although our study did not specifically assess age-related differences, this aspect should be further explored, as it may impact surgical planning in older patients.

Strengths and Limitations

The strength of this study lies in its use of CBCT for precise NPC measurements, ensuring high accuracy and reproducibility of results. Additionally, the inclusion of a balanced male-to-female ratio enhances the generalizability of the findings. However, some limitations should be acknowledged. The retrospective nature of the study may introduce selection bias, and the sample size, though adequate, could be expanded for a more comprehensive analysis. Furthermore, variations related to ethnic or geographical factors were not considered, which could be explored in future research (14-16).

CONCLUSION

This study highlights the morphological variations of the NPC, emphasizing the importance of CBCT imaging in preoperative planning. Significant differences in NPC dimensions were observed between males and females, reinforcing the need for individualized treatment approaches in maxillary surgery and implant placement. Further studies with larger, more diverse populations are recommended to expand on these findings and explore additional factors influencing NPC morphology.

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