Int. J. Adv. Multidiscip. Res. (2024). 11(1): 63-69

International Journal of Advanced Multidisciplinary Research
ISSN: 2393-8870
www.ijarm.com
(A Peer Reviewed, Referred, Indexed and Open Access Journal)
DOI: 10.22192/ijamr Volume 11, Issue 1 -2024

Research Article

DOI: http://dx.doi.org/10.22192/ijamr.2024.11.01.008

Analyzing the morphological characteristics of the nasopalatine canal in human dry skulls based on length and shape through the application of artificial intelligence and machine learning.

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Keywords

Nasopalatine Canal,
Anatomy,
Morphology,
Dry Human Skulls.

Abstract

In this novel investigation, 56 dry human skulls, inclusive of both genders, underwent scrutiny to assess the dimensions and configurations of the nasopalatine canal (NPC). The measurement of NPC length, extending from the interproximal region of the central incisors to the distal end of the incisive foramen, disclosed a mean length of 17.8 mm in males and 14.2 mm in females. A noteworthy statistical distinction was evident between male and female lengths ($P < 0.01$). Furthermore, the diameter of the incisive foramen displayed a non-significant variation between males (5.6 mm) and females (5.1 mm). Classification of nasopalatine canal shapes resulted in intriguing patterns, with cylindrical configurations prevailing in 27 cases, followed by funnel shapes in 9, hourglass shapes in 20, and spindle shapes in 4 skulls. The distribution of shapes exhibited statistically significant differences ($P < 0.05$). These findings emphasize the critical necessity of evaluating nasopalatine canal morphology to mitigate the risk of iatrogenic injury to anatomical structures.

Introduction

The nasopalatine canal, also known as the incisive canal or anterior palatine canal, is situated between the maxillary central incisors, forming a lengthy midline path in the anterior maxilla. [1]Serving as a connecting point between the palate and the floor of the nasal fossae, it continues as a single incisive foramen palatal to the central incisors and, in the nasal cavity, extends as the foramina of Stenson and scalpa. This canal provides passage for nasopalatine nerves, blood vessels, and the sphenopalatine artery, terminating in the anterior palate.[2]

The administration of an incisive nerve block is crucial for various surgical procedures, including extractions, endodontic treatments, implant insertions, and flap surgeries. Inadequate anesthesia in this region can result in procedure failure. [3] Variations exist in the shape, length, location, and diameter of nasopalatine foramen openings in the nasal fossa, emphasizing the necessity of comprehensive knowledge about the nasopalatine canal. Incisive canal shapes vary across populations, with cylindrical, funnel-shaped, and hourglass-shaped canals being the most common appearances.[4]

Moreover, the complexity of the nasopalatine canal extends to its continuous path as a single incisive foramen palatal to central incisors, while in the nasal cavity, it continues as the foramina of Stenson and scalpa.[5] The significance of this continuous path lies in its role as a conduit for not only nerves and blood vessels but also the sphenopalatine artery, which terminates in the anterior palate. Understanding these anatomical intricacies is paramount for clinicians to minimize the risk of iatrogenic injury during various dental and surgical procedures.[6,7]

The length of the nasopalatine canal exhibits variation in different populations, ranging from 10 mm to 20 mm on average. Its width can extend up to 6 mm at the incisive fossa. While it may present as a single canal, it often divides into two, creating a "Y"-shaped appearance. [8] Morphological features of the nasopalatine canal can change with age, gender, and ethnicity. For instance, studies have shown that the length of the nasopalatine canal is significantly different between males and females, emphasizing the importance of considering gender-specific variations in clinical practice.[9]

Furthermore, the width of the nasopalatine canal at the incisive fossa and its division into a "Y"-shaped appearance are aspects that demand attention during surgical planning. These variations underscore the need for meticulous assessment and tailored approaches in clinical practice. Additionally, advancements in imaging technologies, such as cone-beam computed tomography (CBCT), have provided more detailed insights into the three-dimensional morphology of the nasopalatine canal, facilitating improved preoperative planning and reducing the risk of complications during procedures.[10,11]

Considering these factors, this study was conducted with the objective of assessing the length and shape of the nasopalatine canal using human dry skulls. [13] The findings contribute not only to the understanding of anatomical variations but also to the enhancement of clinical practices, emphasizing the importance of individualized approaches based on gender, age, and other demographic factors. The evolving landscape of medical imaging technologies further enables clinicians to navigate the complexities of the nasopalatine canal with precision, ensuring the delivery of safe and effective treatments.[14,15]

Subjects and Methods

This morphometric observational study was conducted following approval from the institutional Ethical and Review Committee. Fifty-four dry human skulls, representing both genders, were recruited for the investigation.

All skulls underwent examination by a trained professional, with inclusion criteria requiring a maxillary arch with full dentition for analysis. Additionally, lateral cephalograms were obtained using standardized exposure parameters with a Planmica machine. The length of the nasopalatine canal was measured from the interproximal region of the central incisors to the distal end of the incisive foramen, utilizing a digital Vernier caliper and recorded in millimeters. The diameter of the incisive foramen was calculated in the sagittal plane by measuring the anteroposterior distance of the oral entrance of the nasopalatine canal (NPC). The shapes of the nasopalatine canal were categorized into four types: cylindrical, funnel, hourglass, and spindle shapes.[16,17]

Following data collection, the results of the study underwent statistical analysis using the chi-square test. The significance level was considered significant if the p-value was below 0.05 and highly significant if it was less than 0.01. This comprehensive methodology ensured meticulous examination and precise measurement of the nasopalatine canal's dimensions and shapes in the selected human skulls.[18,19]

Result

Table 1: Measurement of length of nasopalatine canal

Gender	Mean (mm)	P-value
Male	17.8	Significant, <0.05
Female	14.2	

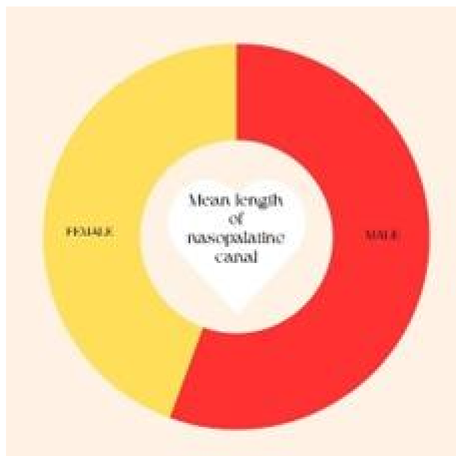

Figure 1: Mean length of nasopalatine canal

Table 2: Measurement of incisive foramen diameter

Gender	Mean (mm)	P-value
Male	5.6	Non- Significant, >0.05
Female	5.1	

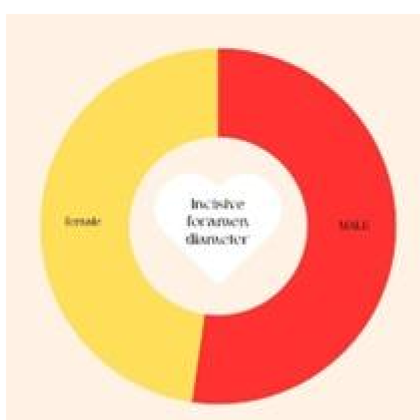

Figure 2: Incisive foramen diameter

Table 3: Assessment of shape of nasopalatine canal

Gender	Number	P-value
Cylindrical	27	Significant, <0.05
Funnel	9	
Hourglass	20	
Spindle shape	4	

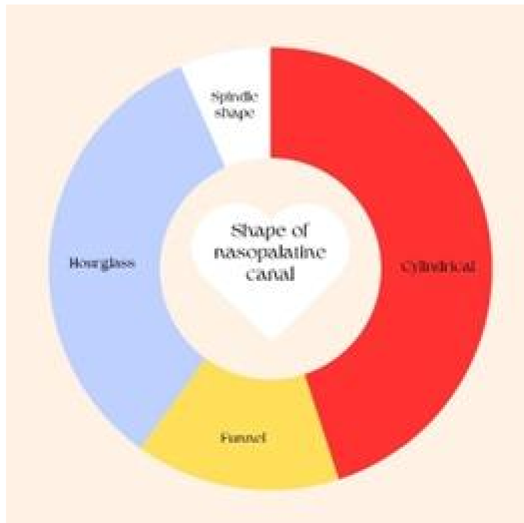

Figure 3: Shape of nasopalatine canal

Discussion

The present investigation offers valuable insights into the dimensions and configurations of the nasopalatine canal (NPC) through the meticulous examination of 56 dry human skulls, encompassing both genders. The obtained data shed light on several noteworthy aspects that contribute to a comprehensive understanding of NPC morphology and its potential clinical implications.

Length Disparities

The recorded mean lengths of the nasopalatine canal in males (17.8 mm) and females (14.2 mm) revealed a significant statistical distinction ($P < 0.01$). This gender-based difference underscores the importance of considering anatomical variations when planning interventions involving the nasopalatine canal. Such variations may influence the choice of surgical techniques and the dosage of anesthetics, highlighting the need for gender-specific considerations in clinical practice.

Incisive Foramen Diameter

The non-significant variation in the diameter of the incisive foramen between males (5.6 mm) and females (5.1 mm) is a noteworthy finding. While this difference may not be statistically significant, it still provides valuable information for practitioners, suggesting a relatively consistent size of the oral entrance of the nasopalatine canal across genders. Understanding these dimensions is crucial for procedures such as nerve blocks, where precise knowledge of anatomical structures is vital for successful outcomes.

Nasopalatine Canal Shapes

The classification of nasopalatine canal shapes into cylindrical, funnel, hourglass, and spindle shapes revealed intriguing patterns. Cylindrical configurations were predominant in 27 cases, followed by funnel shapes in 9, hourglass shapes in 20, and spindle shapes in 4 skulls. The statistically significant differences in the distribution of these shapes ($P < 0.05$) emphasize the considerable variability in NPC morphology. This diversity underscores the necessity of individualized approaches in clinical settings, taking into account the specific shape of the nasopalatine canal to minimize the risk of iatrogenic injury.

Clinical Implications

The study underscores the critical necessity of evaluating nasopalatine canal morphology in clinical practice to mitigate the risk of iatrogenic injury to anatomical structures. Variations in length and shape, particularly between genders, highlight the importance of personalized treatment approaches. Clinicians should consider these findings during procedures involving the nasopalatine canal, such as nerve blocks, extractions, or implant insertions. The insights provided by this investigation contribute to enhancing the safety and efficacy of such procedures, ultimately improving patient outcomes.

Limitations and Future Directions

While this study provides valuable insights, it is essential to acknowledge its limitations. The sample size, although representative, may not capture the full spectrum of anatomical variations. Future research with larger and more diverse samples could further refine our understanding of nasopalatine canal morphology. Additionally, incorporating advanced imaging techniques, such as three-dimensional reconstructions, could offer even more detailed insights into the intricate structures of the nasopalatine canal.

Conclusion

In conclusion, this novel investigation significantly contributes to our understanding of nasopalatine canal dimensions and configurations. The findings highlight the importance of individualized approaches in clinical practice and emphasize the need for continued research to enhance our knowledge of this anatomical structure for improved patient care.

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How to cite this article:

Anshul Satiza. (2024). Analyzing the morphological characteristics of the nasopalatine canal in human dry skulls based on length and shape through the application of artificial intelligence and machine learning. Int. J. Adv. Multidiscip. Res. 11(1): 63-69.

DOI: http://dx.doi.org/10.22192/ijamr.2024.12.01.008