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Study of the Anatomical Characteristics of the Nasopalatine Canal in a Senegalese Population with Cone Beam CT

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Abstract

Introduction: We set ourselves the objective of analyzing the anatomical and morphological characteristics of the nasopalatine canal in a Senegalese population using tapered beam computed tomography (CBCT). **Materials and Methods:** The study included 198 subjects, distributed equally among the sexes. CBCT was performed using a standard patient exposure and positioning protocol. The data from the CBCT images were split into three dimensions. The image planes on all three planes were sequentially analyzed for the location, morphology, and dimensions of the nasolabial canal. **Results:** The morphometric study of the nasolabial canal on CBCT images showed that the diameter at the entrance of the foramen nasolaplatine was 2.86 mm 1.22 mm. In the middle of the canal, the diameter was on average 2.2 mm 0.88 mm, and at the floor, The mean value was 3.05 mm 0.95 mm. The mean length of the nasopalatine canal was 13.1 mm 3.40 mm. **Conclusion:** The present study has shown a significant variability observed in the anatomy and morphology of the nasolabial canal.

Keywords

Cone-Beam Computed Tomography, Anatomy, Nasopalatine Canal

1. Introduction

The nasopalatine canal, also known as the incisor canal, is an important anatomical structure located in the middle of the premaxillary region. The nasopalatine

canal opens in the oral cavity by the incisive foramen. This particular anatomical region is also considered important in aesthetic rehabilitation of the anterior maxilla because this area is often involved in cases of dental trauma and tooth loss. In particular, the rehabilitation of this region often requires the placement of implants [1]-[3]. Therefore, the evaluation of a nasopalatine canal and its variations plays an important role in preventing complications during implant surgery, such as bleeding, pain, sensory dysfunction and potential failures of the osseointegration process [4]. Various means of exploration can be used to study the maxillomandibular anatomy. Radiological techniques are the most used because they are non-invasive. Two-dimensional techniques, such as panoramic radiography and intraoral radiographic techniques [5], are the most accessible. However, they have limitations such as overlay, magnification and distortion, which can affect the accurate assessment of anatomy [5] [6]. The advent of cone beam computed tomography (CBCT) has solved these limitations encountered in conventional radiography. The nasopalatine canal has been the subject of several studies at CBCT on various populations. The literature shows a diversity of morphologies and morphometric variations according to the individuals and populations studied. To the current knowledge of the literature, there is no anatomical study at CBCT of the nasopalatine canal in an African melanoderm population. This work aimed to analyze the anatomical and morphological characteristics of the nasopalatine canal in a Senegalese population at CBCT.

2. Materiel and Methods

This was a cross-sectional study of descriptive-type on CBCT examinations in a Senegalese population. The CBCT examinations were taken from the database of the dental-maxillofacial radiology service of the Institute of Dentistry and Stomatology in Dakar for the period from January 2021 to June 2023. Inclusion criteria were age 18 years or older and, the presence of two central maxillary incisors. Subjects with a traumatic or pathological lesion of the anterior maxilla, such as a nasal-palatal cyst, periapical lesion, tumors, cleft lip, patients who have already undergone surgery in this area, partial or complete anterior edentulism, dental implants, bone grafts, and subjects with braces and metal restorations were not included. The study concerned all CBCT examinations collected in the database of the dental-maxillofacial radiology department of the Dakar Institute of Dentistry and Stomatology. The sample size was comprehensive, with all files meeting the selection criteria selected. CBCT was performed on a Carestream CS 9600 (Atlanta, GA). The field of view (FOV) for imaging dental and maxillomandibular systems was cylindrical, with sizes from 8 cm 8 cm to 16 cm 12 cm. The machine comes with pre-installed imaging protocols for use with different sociodemographic data of the patient, including children, small adults, medium-sized adults, and large adults. Voxel size was between 180 and 250 μm. The images were read on the manufacturer's software Carestream CS 3D Imaging, with multiplanar reconstructions on different anatomical planes (axial, sagittal, and coronal) and in

curvilinear reconstruction. The slices were spaced between 75 and 200 μm thick. All images were viewed and analyzed by a dental surgeon who specializes in dental radiology, maxillo-facial, with more than 10 years of experience. To reduce intra-examiner variability, a calibration was first performed on 30 randomly selected CBCT. The intra-examiner reproducibility was calculated by reassessing 15 CBCT randomly selected one week later. Intra-class correlation coefficient (ICC) 91% and 95% CI to quantify intra-observer reliability of the linear measurements. A match was observed. All 198 CBCTs were analysed consecutively, with no more than 15 files per day per examiner.

The variables studied were age, sex, and anatomical data of the nasopalatine canal. The nasopalatine canal was studied in terms of its location, morphology and anatomical dimensions.

Morphological variables: The morphology of the nasopalatine canal was classified and presented in different forms: vertical, funnel or Y, hourglass, and curved or banana (**Figure 1**).

Morphometric variables:

- The length of the NPC was measured in the sagittal plane, defined as the distance between the floor of the nasal cavity and the level of the hard palate.
- The diameter of the foramen was measured at three levels: at the opening at the crestal level, in the middle of its course, and at the nasal level (**Figure 2**).

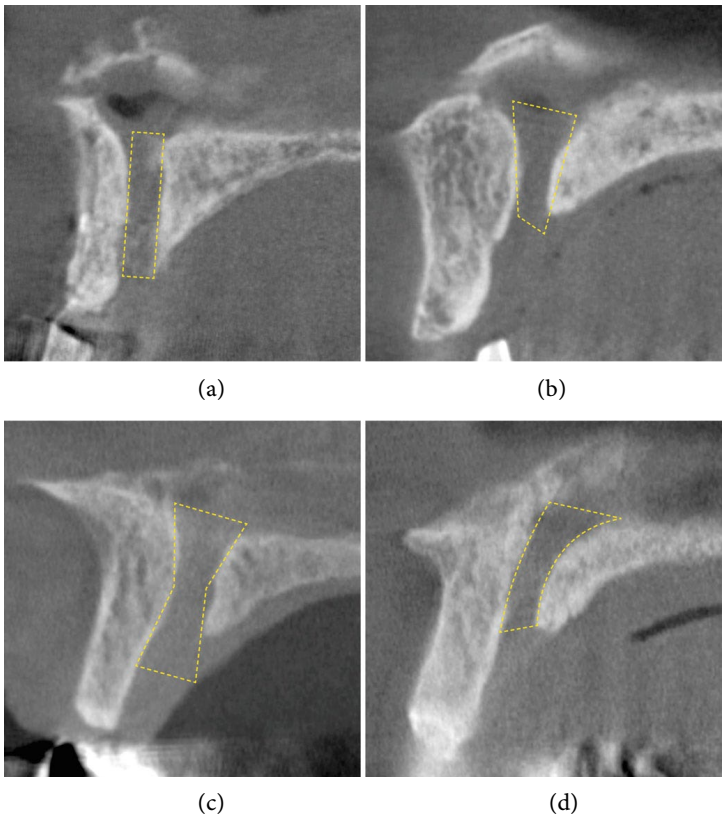

Figure 1. Shape of the nasopalatine canal in sagittal section, vertical (a), funnel-shaped (b), hourglass-shaped (c), and (d) curved.

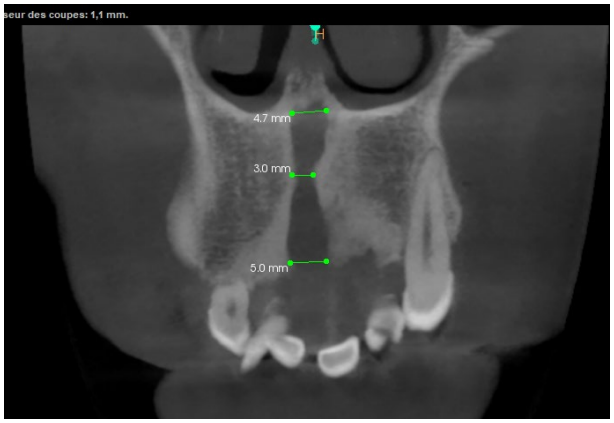

Figure 2. Evaluation of canal diameters at different levels in coronal sections: at the foramen, in the middle, and in the nasal region.

Statistical analysis

The statistical analysis of the data was descriptive. The quantitative data were expressed in mean and standard deviation, and the qualitative data in frequency and size. A comparison of means was performed by the T-test. The khi-2 test was used to compare qualitative variables. The significance threshold was set at $p < 0.05$. Statistical analysis was performed on Jamovi.

3. Results

The study sample consisted of 198 CBCT images of Senegalese subjects, divided between 99 men and 99 women. The average age was 39 ± 14 years. Evaluation of CBCT images of the nasolabial canal has shown that it can be vertical, hourglass, funnel or Y-shaped and curved. The hourglass form is the most common, with 128 cases, or 65%, followed by the vertical form with 15% (n = 30). The curved shape was found in 14% of cases (n = 28). The Y form is the least common, with a rate of 5% (n = 10) (Table 1).

Table 1. Distribution of the nasopalatine canal according to shape.

	n	%
Vertical	30	15
Funnel	10	5
Hourglass	128	65
Curved	28	14

According to this study carried out on the Senegalese population, sex has no statistically significant impact, with a p of 0.98. Although the hourglass shape (the most common) is slightly more common in men than women, there is no significant variation for other shapes, including vertical, curved and Y-shaped (Table 2). The morphometric study of the nasolabial canal on CBCT images showed that the diameter at the entrance to the foramen nasopalatine was 2.86 mm 1.22 mm.

In the middle of the canal, the diameter was on average 2.2 mm 0.88 mm, and at the nasal floor, a mean length of the nasolabial canal was 3.05 mm 0.95 mm. The median length of the nasopalatine canal was 13.1 mm 3.40 mm, with an angle of 120˚ 15.2˚ to the bispinal plane (Table 3). Comparison of the morphometric values of the nasopalatine canal by sex did not show statistically significant differences.

Table 2. Distribution of the nasopalatine canal according to shape by sex.

Sex	Vertical	Funnel	Hourglass	Cur ed	p
♂	14	5	67	13	
♀	16	5	63	15	0.983
Total	30	10	130	28	

Table 3. Morphometric measurements of the nasopalatine canal, diameters and angulation.

	sex	Means ±		p
Length of the NPC	♂	13.43	3.66	**0.15**
	♀	12.75	3.10	
Diameter of the foramen	♂	3.02	1.28	**0.07**
	♀	2.71	1.12	
Diameter of the middle	♂	2.40	0.88	**0.04**
	♀	2.15	0.86	
Diameter of the nasal	♂	3.24	0.97	**0.005**
	♀	2.86	0.91	
Angulation	♂	118.51˚	15.8˚	**0.18**
	♀	121.33˚	14.4˚	

♂: man, ♀: woman.

4. Discussion

The nasolabial canal is a canal that connects the nasal passages to the oral cavity. It is also known as the incisive channel. It is an important anatomical structure located in the middle of the premaxillary region. The nasopalatine canal opens in the oral cavity by the incisive foramen. The nasopalatine canal contains fibrous connective tissue, adipose tissue, minor salivary glands and terminal branches of the artery and nasopalatine nerve [7]. The nasopalatine canal has significant clinical implications in various areas of dentistry and maxillofacial surgery. A good understanding of its anatomy and functions is essential to ensure quality care and minimize risk to patients. The topographic study of the nasopalatine canal is particularly important for planning surgical interventions in the premaxillary region. However, morphological and morphometric variations of the nasopalatine canal have been noted in the literature. Various radiographic methods were used to determine the location of the nasopalatine canal [8]. Although two-dimensional X-

rays are frequently used, image magnification and distortion may occur. CBCT is the non-invasive technique of choice for studying dental and bone structures. It has been reported that there is no significant difference between linear CBCT measurements and direct measurements of maxillomandibular structures [9].

This study carried out on 198 Senegalese subjects showed that the nasopalatine canal was present in the whole sample. A study by Thakur *et al*. [10] of 100 Indians at the CBCT confirmed the presence of a nasopalatine canal in the population studied. In this study, the hourglass shape was the most common form with 65% of cases, followed by the vertical shape and the curved shape with 15%. Funnel or "Y" shape was found in 5% of cases. Compared to data from previous studies, the variation was found between populations studied. Sanchis *et al*. [11] out of 150 Spaniards found hourglass, banana, vertical, and "Y" shapes. Mardinger *et al*. [12] of 207 Israeli subjects found that the hourglass form was most commonly encountered, followed by the vertical form. The funnel shape was the third most common form, contrary to our study results, with 14.5%. Out of 150 Turks, Bahsi *et al*. [13] found 28.7% with an hourglass shape, followed by a vertical shape with 26.7%. The curved, funnel, and banana shapes were slightly similar in frequency with 13.3%, 14.7% and 16%. According to Al-Ghurabi *et al*. [14] out of 200 Iraqis, the Y configuration was more represented (43.5%), followed by a single type I channel (35.5%) and a Type II channel with 2 parallel channels (21%). For Görürgöz *et al*. [15] of 320 subjects, the most common channel was funnel (29%). This study also obtained morphometric data of the nasopalatine canal, such as length, diameters and angulation relative to the bispinal plane. Regarding the diameter of the nasopalatine canal, the values found in our study were 2.86 mm at the foramen, 2.2 mm in the middle of the nasopalatine canal and 3.05 mm at the palatal level. The average channel length was 13.1 3.4 mm. This value was higher than that found by Jayasinghe *et al*. [16] on 50 Sri Lankans (l = 12.14 mm) and Milanovic *et al*. [17] on 113 Serbs (l = 10.26 mm). Similarly, an average length of 10.08 mm was found in an Indian population. In 2022, the average length of a nasal-palatine canal was 9.49 mm for 100 Turkish subjects [3]. Görürgöz *et al*. found an average LWOP length of 11.45 2.50 mm, with statistically significant differences between men and women. Khojastepour *et al*. [18] found, in an Iranian population, that the mean length of a nasopalatine canal in men and women was 11.46 mm and 9.37 mm respectively, with a statistically significant difference. The other dimensions of a nasopalatine canal and the thickness of the alveolar bone were also larger in men. Of 90 CBCT in Pakistani subjects, the mean length and width of the nasopalatine canal were 11.28 ± 1.90 mm and 2.62 ± 0.91 mm respectively. The nasopalatine canal was significantly longer and wider in men than in women [19]. These variations of the nasolabial canal according to morphology can be explained by the interindividual anatomical variations, but also by the ethnicity studied. These mean values also vary according to the subjects studied. From this analysis, it is important to note that the mean length of the nasopalatine canal varies according to the population studied. Melanoderm subjects have a longer mean

length of the nasolabial canal than their Caucasian or Indian counterparts. Anatomical variations of a nasopalatine canal must be recognized to prevent complications during implant surgery, such as pain, bleeding, sensory dysfunction, and failure of the osseointegration process. During extractions or treatments of the anterior teeth, it is crucial to take into account the presence of the nasopalatine canal to avoid nervous or vascular complications. It is important to take into account the position of the nasolabial canal to ensure proper fit and avoid any discomfort for the patient.

5. Conclusion

This study shows that, in the Senegalese population, the naso-palatine canal presents morphological and morphometric variations. The Cone Beam CT provides valuable information on studying anatomical variations, which can be useful for dental and maxillofacial surgeons.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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