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Anatomical alterations of the nasopalatine canal in dentate and edentulous patients at the front superior sector based on cone beam computed tomography

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Abstract: Background: The nasopalatine canal (NPC) is a long and thin intraosseous passage, located in the anterior midline of the maxilla, connecting the palate with the floor of the nasal cavity. The objective of the study was to compare the measures of nasopalatine canal and its shape by cone beam tomography in dentate patients with respect to edentulous patients in the frontal anterior sector. Materials and methods: A descriptive and comparative study, 150 CT scans of anterosuperior dentate patients and 52 CT scans of anterosuperior edentulous patients were taken from the archive of the Imaging Department. Using the Excel program and its tool "random", 30 CT scans of dentate patients were selected as well as the 30 CT scans of edentulous. The anteroposterior distance of the upper third, middle third and lower third of the horizontal nasopalatine canal was measured on the oblique sagittal plane. To determine its height, the axial plane was taken from the level of the upper bifurcation to the palatal opening. The acquisition of images was done through the i-Dixel software of the 3D Accuitomo 170 MORITA, DICOM system. Results: The dentate patients present higher heights in relation to the edentulous patients. In transverse diameter, the size of NPC channel in edentulous patients is larger. The measurements at the lower, middle and upper levels in the cortices of the diameter of the NPC in dentate patients are lower in relation to the edentulous patients. Conclusion: Patients of 40 to 70 years old, male and female, with frontal anterior edentulism presented structural topographic variations that consist of greater width, smaller longitudinal dimension and larger transversal dimension being enlarged canals.

Key words: atrophy; edentulous; cone-beam computed tomography; maxilla; maxilla edentulous; partially

1 Introduction

The nasopalatine canal (NPC) is also known as the incisor canal or the anterior palatine canal. In its description, we observed that the hemi-maxillary is connected to each other in the sagittal plane. In each hemi-maxillary, it is located in the front and rear of the alveolar process, as well as in the front of the palatal process of the maxilla. It completes the medial junction of both jaws, forming the anterior palatine foramen and mouth of the nasopalatine duct that bifurcates upward in a

"Y" shape, ending at the floor of the nasal fossa on either side of the septum.

The catheter is a long and thin passage, located in the anterior midline of the maxilla, connecting the bottom of the palate and nasal cavity. It continues to exist in the oral cavity as an incisor hole behind the central incisor, and in the nasal cavity as a Stenson's foramina, which usually takes the shape of two [1]. The terminal branches of the nasopalatine artery, the medial sphenopalatine artery and the nasopalatine nerve respectively pass through them to communicate with the greater palatine artery, the terminal of the descending palatine artery and the greater palatine nerve in the palate [1].

The angle between the NPC and the horizontal plane is about 70º [1]. Rouviere establishes as measures 1 cm in length, 5 mm in diameter and an oval shape [1]. Understanding the form and path of NPC is crucial for evaluating jaw pathology and trauma cases, as well as oral surgery, apicectomy of central incisors, removal of nasopalatine duct cysts, assisted palatal expansion, and Le Fort I osteotomy [2]. It is also important to know the position of the central alveolar artery in the elevation of the maxillary sinus, and in the transplantation cases where implants or orthodontic mobilization are carried out in the inflated space of the maxillary sinus. The position and size of NPC are data that must always exist in the anterior surgical approach of maxilla [2, 3].

The diameter of the NPC can be affected by local pathologies such as embryonic cysts derived from epithelial remnants that can be triggered to proliferate by a traumatic stimulus or an infectious process. Liceaga et al. pointed out that if the NPC diameter is 7 mm to 20 mm, it may be due to the presence of embryonic cysts [4, 5]. Surgical techniques involving the removal of NPC or the displacement of its neurovascular components may lead to nasopalatine nerve bleeding and/or injury, resulting in hypersensitivity or paresthesia [6, 7].

In complete edentulous patients, resorption can be attributed to the application of excessive forces on the remaining ridge, resulting in loss of height of the palatal vault, which is vestibular and inferior, so that the ridge migrates backwards and shortening. After bone removal, the scarring process and the loss of teeth will lead to a gradual reduction, which will lead to a reduction in the length of the nasopalatine canal at the upper front level. Whates mentioned in his article that within three to five years after tooth extraction, 25% of the width was lost, and 40% to 50% of the width was lost, most of which was at the expense of lip contour [8].

To express the three-dimensional anatomical structure of NPC through the three-dimensional imaging mode of Cone Beam Computed Tomography (CBCT), as well as its potential in surgical planning and measurement based on three-dimensional reconstruction, it has great advantages in evaluating the nasopalatine canal. The conventional 2D radiographic image only shows the anterior palatal foramen, that is, the mouth of the NPC, projected between the upper roots, at the level of the middle and apical thirds of the central incisors. Its shape, size, borders and radius lucidity vary considerably. This variability is mainly due to the different angles at which the X-ray beam points to the upper central incisor [9].

CBCT was developed in the late 1990s to obtain a three-dimensional scanner for maxillofacial bones at a radiation dose lower than that of CT. CBCT uses an innovative technology in cone X-ray beam image acquisition. It allows images to be acquired in a volume rather than a plane, just like medical CT scans [10, 11]. It is important to thoroughly understand the anatomy and variation of NPC, placement of local anesthesia in the anterior maxillary region and placement of implants before surgery. Complications of implant rehabilitation include a lack of osseointegration of the implant due to contact with nerve tissue or sensory dysfunction [12].

This study can determine the anatomical variation of NPC in edentulous patients compared with those with teeth in the anterior upper sector, so as to determine the changes in repair surgery to restore the function and aesthetics of the anterior sector.

2 Materials and methods

These images were taken on the Accuitomo 170 3D digital tomography scanner of MORITA brand, with a working window of 50 mm × 150 mm and a vortex size of 80 µm. The values for this device are 90 kV and 6 mA, and the exposure time is about 12 to 15 seconds, depending on the physical condition, the presence of teeth, and the type of upper jaw. On the workstation, through the i-Dixel software DICOM system of the 3D team Accuitomo 170 MORITA, and through the 30" LCD panel monitor of the high brightness IPS technology, the sectional images are edited to obtain the best contrast details with the "Spot View" technology. The diagnosis is conducted through indirect light and quiet environment. Under these conditions, the different tomographic sections were obtained, selecting the sagittal section (for axial) and generating the oblique section from it. Three measurements perpendicular to the anatomical structures were generated on this oblique tomographic slice.

The first vertical measurement was taken on the oblique sagittal section at the lower level of the NPC, from the endothelium to the exodermis of its anterior wall. The second measurement is carried out at the middle level of the catheter, which is equidistant between the upper and lower parts and located in the inner and outer cortex. The third measurement was performed at the top of the anterior wall of NPC, the bottom of the nostril, and the level from the endothelium to the exodermis. The vertical measurement is made from the top to the bottom of the horizontal measurement in the center of the guide lamp (see Figures 1 and 3). The transverse measurement is obtained by horizontal axial cutting at the upper and lower equidistant points (see Figures 2 and 4).

The inclusion criteria were male and female patients aged 40 to 70 with maxillary anterior teeth. The exclusion criteria were considered to be pathologies at the level of the nostrils, bone pathologies at the maxillary level, presence of bone bonding prosthesis and a history of extraction of a dental organ of the anterior maxillary region more than 5 years. The initial subjects were 150 patients with anterior upper teeth, and 52 patients with anterior upper edentulous met the inclusion criteria. Using the Excel program and the "random" formula, 30 scans were selected from the group of 150 dentures, and another 30 scans from the initial group of 52 edentulous patients.

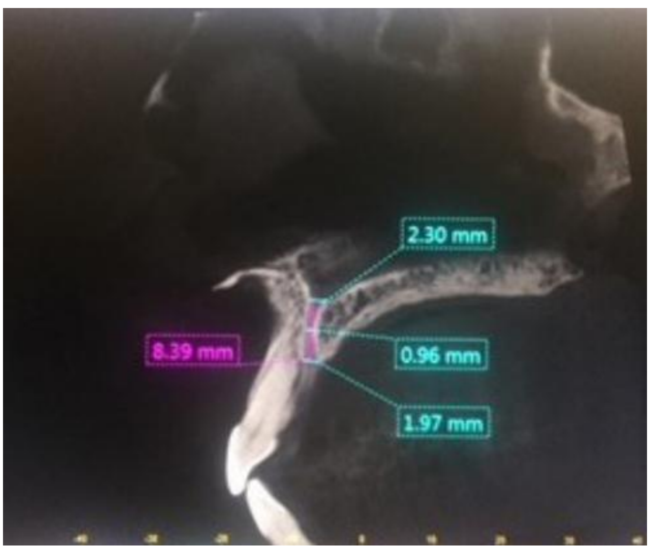

Figure 1. Oblique sagittal notch of NPC in dental patients
The vertical measurements and the upper, middle and lower diameter of the NPC are observed。

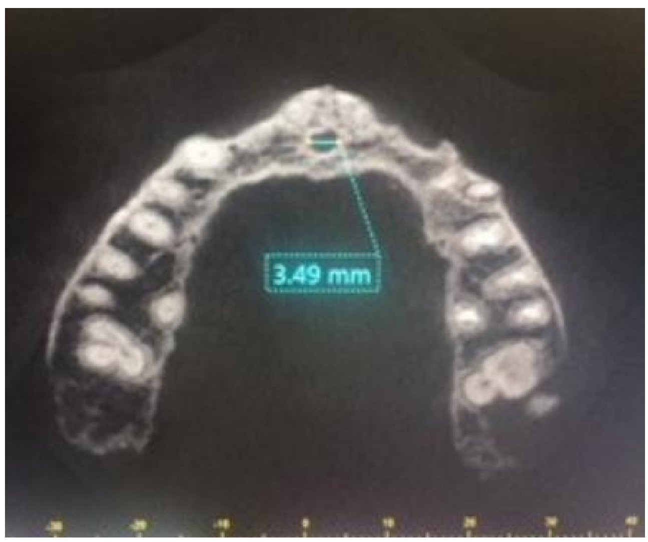

Figure 2. Axial cutting of NPC in dental patients
Observed measurement of NPC transverse diameter

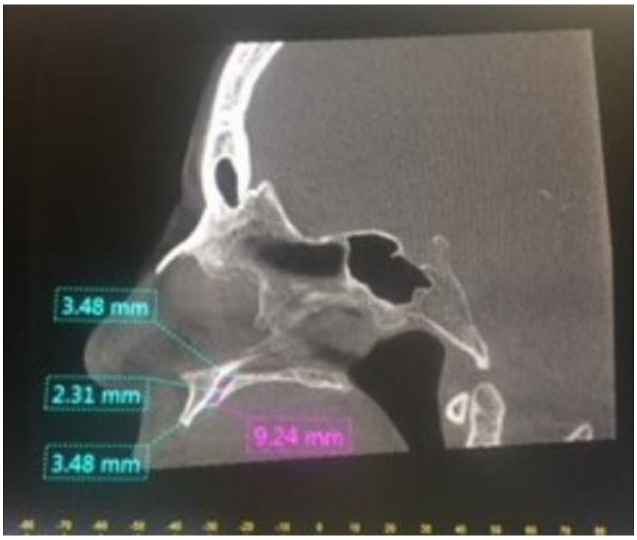

Figure 3. Oblique sagittal notch of NPC in edentulous patients

The vertical measurements and the upper, middle and lower diameter of the NPC are observed.

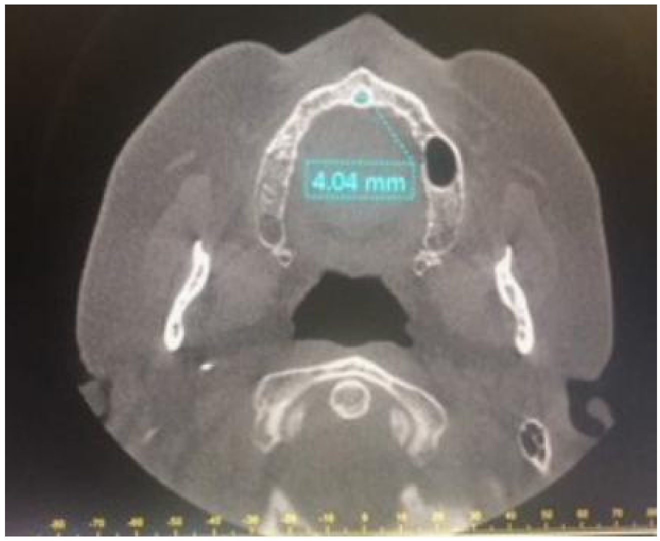

Figure 4. Axial cutting of NPC in edentulous patients. Observed measurement of NPC transverse diameter.

3 Results

In dental patients, the average diameter of the lower level was 2.5 mm, the average diameter of the middle level was 1.75 mm, and the average diameter of the higher level was 2.33 mm. The average height is 10.68 mm, and the transverse diameter is 3.45 mm (Table 1 and Figure 1). In edentulous patients, the average diameter of the lower level was 3.55 mm, the average diameter of the middle level was 2.55 mm, and the average diameter of the higher level was 3.01 mm. The average height is 7.9 mm, and the transverse diameter is 4.55 mm (Table 2 and Figure 2).

In the variable height, it is determined that the height of patients with teeth is higher than that of patients without teeth, and the standard deviation is 1.4 mm. Compared with the measurements obtained in edentulous patients, fewer measurements were determined at the lower, middle and higher levels of NPC diameter cortex in dental patients.

Table 1. Millimeter measurement of NPC in dental patients

	Height	Transverse diameter	Lower level in the cortices	Middle level in the cortices	Higher level in the cortices
Average value	10.68	3.45	2.50	1.75	2.33
Maximum	14.70	7.26	3.47	2.88	3.49
Minimum	7.25	1.76	1.25	0.95	1.23
Standard deviation	2.00	0.96	0.48	0.53	0.66

Note: The average value was observed in millimeters: height, transverse diameter and the lower, middle and higher levels in the cortices. Measurement of oblique incision in specific cone beam tomography software.

Table 2. Millimeter measurement of NPC in edentulous patients

	Height	Transverse diameter	Lower level in the cortices	Middle level in the cortices	Higher level in the cortices
Average value	7.9	4.55	3.55	2.55	3.01
Maximum	10.5	8.25	6.42	5.09	6.10
Minimum	5.0	1.81	1.85	1.03	1.30
Standard deviation	1.4	1.46	0.96	1.07	1.17

Note: The average value was observed in millimeters: height, transverse diameter and the lower, middle and higher levels in the cortices. Measurement of oblique incision in specific cone beam tomography software.

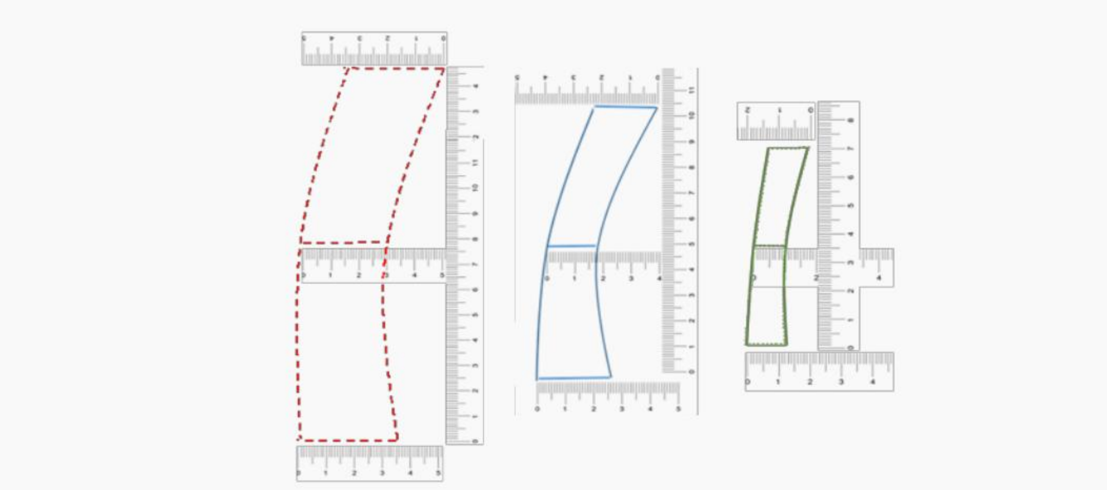

Figure 1. Measurements in millimeters of the average, maximum and minimum values of NPC in dentate patients.

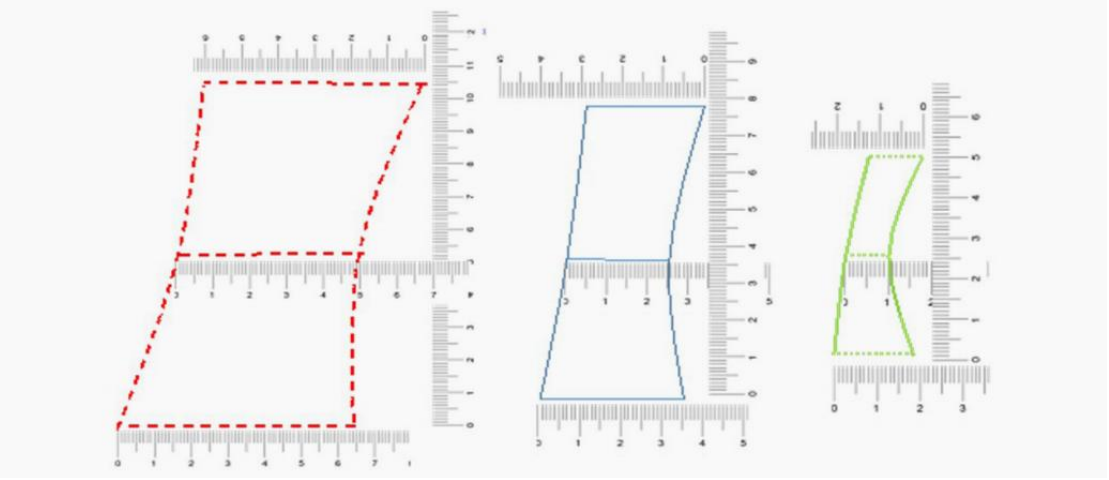

Figure 2. Measurements in millimeters of the average, maximum and minimum NPC values in edentulous patients.

4 Discussion

The results of this study demonstrate variability in NPC width and length in dentate and edentulous patients in the anterosuperior sector. In the sagittal incision, the hourglass shape, the top, wide base and narrowing in the midline of path were mainly observed. In the research conducted by Gönül, the axial cutting variables of cardioid, triangle, separated ellipse and non separated ellipse were found [2]. The shape of Bornstein's coronal incision was a single channel, two parallel channels and a Y-shaped channel [13]. On the sagittal section, Martinger divided it into cylinder (50.7%), funnel (30.9%), hourglass (14.5%) and banana shape (3.9%), similar to the figure presented in our study [5].

The maxilla has a larger proportion of spongy bone, so its cortex is narrow and its resistance is low. The outer skin layer of the nasopalatine canal is thicker than the endothelial layer, while the outer skin layer of the mandible is thicker on the incisor layer. The volume of alveolar process decreased after extraction [5, 12]. Because of the remodeling and healing process, this loss is more serious in the early stage. As this process advances, it gradually slows down. With the approach of vestibule and palatal cortex, the height, width and surface disappeared. The loss during the first year in the upper jaw is two to three times that of the lower jaw and, with the passage of time, resorption is usually slower than in the mandible [2, 14, 15].

At the vestibular level, resorption is more obvious than at the palatal level, because structurally speaking, the palatal cortex has cortical bone with strong resistance. The most important factors of bone resorption are tooth loss and prosthesis load [16]. The alveolar bone of natural dentition receives traction through the periodontal ligament, which plays the role of transferring it to bone tissue. The second factor is the use of mucosal supported prostheses, because the loss of teeth will lead to a decrease in tactile sensitivity perception, while overpressure will lead to greater bone loss [17]. We agree with Mardinger in the fact that with tooth loss and with age, the diameter of the NPC increases [5].

Conventional radiographic techniques did not allow an accurate diagnosis of the size and height of the nasopalatine duct due to the two-dimensionality of the radiographed structures and the non-elimination of additions. With the incorporation of volumetric tomography (CBCT), three-dimensional images were obtained and it was possible to obtain 1 to 1 measurements in a sophisticated software projecting additions and obtaining a great accuracy to visualize anatomical repairs[8, 16]. The presence of modifications in the shape and diameter of the NPC make it necessary to take into account changes for the use of implants; for example, a greater separation between them in the anterior sector, or to consider placing them with angulation.

5 Conclusion

The present study highlighted the anatomical variability of the NPC in relation to the parameters established in the study. It was determined that among the 40 to 70 year old male and female frontal anterior edentulism patients in the Andean region of southern Ecuador, their topographical structure had changed, including wider, shorter and larger cross-sectional dimensions, and the catheter had expanded.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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