

# An Anatomical Study of Incisive Canal and its Foramen

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## Research Article

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# Abstract

**Introduction:** Anatomically, the incisive canals start on the nasal fossa floor, close to the septum, and open at the incisive foramen of the maxillary palatine process. The nasopalatine nerve passes through the incisive foramen as well as the septal artery and the sphenopalatine vein. Also, there may be accessory canals. Typically, the incisive foramen has two incisive canals. This work aimed to analyze the morphology and morphometry of the foramen and incisive canals in the macerated cephalic skeletons.

**Material and methods:** For this purpose, we selected 150 samples of adult individuals, with no distinctions of sex and ethnicity. We analyzed the frequency of incisive canals in the foramen was analyzed as well the area, diameter, and communications of incisive canals with the fossa and nasal cavity.

**Results:** The cephalic analysis results showed that most incisive foramina have at least two canals that communicate the nasal cavity with the oral cavity. The right-side canal had an average of 1.975mm<sup>2</sup> in area and 1.281mm in diameter. Also, the left-side canal had an average of 1.468mm<sup>2</sup> in area and 1.182mm in diameter. The average area and total diameter of the incisive foramen were 8.148mm<sup>2</sup> and 3.101mm, respectively.

**Conclusion:** Hence, understanding anatomy and its variations is essential for clinical applications, as it may alter surgical technique and prognosis. Besides, it can be said all incisive canals have communication with the nasal cavity.

## Introduction

The incisive canals have been described beginning on the nasal fossa floor, close to the nasal septum, and open in the incisive foramen of the maxillary palatine process<sup>1,2</sup>. Moreover, there are two incisive canals in the incisive foramen and, additional canals may exist<sup>3</sup>.

Furthermore, anatomical study of the foramen and incisive canals is critical in the dental practice, as the nasopalatine nerve, the septal artery, and the sphenopalatine vein pass through incisive canals<sup>3,4</sup> are responsible for innervation, blood supply, and drainage of the soft tissue of the hard palate<sup>5</sup>.

The anterior maxilla is considered esthetic, phonetic, and functionally important<sup>7</sup>; however, it is the most common region exposed to trauma and tooth loss<sup>6</sup>. Surgeries in this site have been regarded as safe, although iatrogenic injury has been increasingly reported due to the growing surgical interventions in this<sup>8,9</sup>. Besides, in a hospital environment is common to use the procedure The LeFort I, which is one of the most commonly used techniques to correct midface deformities. In this case, the most important anatomical structures in this region must be well-known in order to prevent complications during and after surgery<sup>7,8,9</sup>.

For example, the knowledge of critical anatomical structures as the incisive canals and the incisive foramen is vital during dental implant procedures<sup>10, 11, 12</sup>. In this way, the comprehension of these structures' anatomy, morphology, and morphometry is crucial to perform surgical procedures without harming the patients<sup>13, 14</sup>. For this reason, this study aimed to analyze the morphology and morphometry of the incisive foramen and the incisive canals in macerated cephalic skeletons.

## Materials And Methods

The present study was carried out at the Department of Biological Science of the Bauru School of Dentistry – University of São Paulo, Brazil.

## Ethical statements

This study was approved by the Institutional Ethics Committee of the São Paulo University (n°1.713.069) and this work has followed the set of ethical principles from the Declaration of Helsinki in all methods that have been done. The informed consent was obtained from all subjects and/or their legal guardian(s).

## Design of study

150 macerated cephalic skeletons of adult individuals, which belong to the Anatomy discipline of Bauru School of Dentistry - University of São Paulo, were selected without identifying sex and ethnicity. The following procedures were performed:

1. The frequency of incisive canals presented in the incisive foramen.
2. Area and diameter of the incisive foramina.
3. Area and diameter of the incisive canals.
4. The evaluation of communication of the incisive canals with the nasal cavity and oral cavity.

The frequency of incisive canals and the evaluation of each canal's area and diameter were performed with the Dino Lite® microscope. Besides, we verified the incisive canals' communication with the nasal cavity through a stainless-steel orthodontic wire with 0.2- and 0.4-mm. Measurements were conducted with DinoCapture 2.0 software.

In all the samples, frequency, area, and the incisive foramen's total diameter were analyzed and also, the area and diameter of each incisive canal (Figure 1).

In the incisive foramina analysis, we determined the number of canals presented at each incisive foramen, with a minimum numerical variation of one (Figure 2) to a maximum of six incisive canals (Figure 3). In this way, we classified the incisive foramina as (Figure 4):

Type 1 – Only one incisive canal

Type 2 – Two incisive canals

Type 3 – Three incisive canals

Type 4 – Four incisive canals

Type 5 – Five incisive canals

Type 6 – Six incisive canals

Additionally, to the number of canals, the canal's name was established according to its location, which can be: anterior, posterior, right lateral, left lateral, right medial, and left medial (Figure 5).

## Statistical methods

Both measurements were assessed using descriptive statistics, using absolute frequency (N), relative frequency (%), mean and standard deviation with a probability of 5 percent being regarded as significant.

## Results

### 1. Frequency of incisive canals presented at each incisive foramen

After the anatomical evaluation of 150 macerated cephalic skeletons, the number of incisive canals found was 1 single canal in 10 (6.7%), 2 canals in 52 (34.7%), 3 canals in 53 (34,0%), 4 canals in 27 (18%), 5 canals in 8 (5,3%) and 6 canals in 2 (1.3%) (Figure 6). Besides, from the total of incisive foramen analyzed, 54 had an anterior canal; 93 had a posterior canal; 123 had a right lateral canal; 127 had a left side canal; 10 had a right medial canal, and 10 had a left medial canal (Figure 7).

### 2. Area and diameter of the incisive foramina

Regarding the average area and diameter of incisive foramina, it is possible to state that the average total area of 150 incisive foramina analyzed was equal to 8.148mm<sup>2</sup>. The average of the entire diameter of the foramina was equal to 3.101mm (Table 1).

Table 1

The description of the incisive foramina averages of the area and total diameter.

Parameters	Average	Standart deviation
The total area of the foramen	8,148	4,616
The total diameter of the foramen	3,101	0,884

### **3. Area and diameter of the incisive canals**

The average areas of each incisive canal were as follows: Anterior canals – 0,341mm<sup>2</sup>; posterior canals – 1,068mm<sup>2</sup>; right lateral canals – 1,975mm<sup>2</sup>; left lateral canals – 1,468mm<sup>2</sup>; right medial canals – 0.330mm<sup>2</sup> and left medial canals – 0.383mm<sup>2</sup> (Figure 8).

The average diameters of each incisive canal were as it follows: Anterior canals – 0.572mm; posterior canals – 1,016mm; right lateral canals – 1,281mm; left lateral canals – 1,182mm; right medial canals – 0.644mm and left medial canals – 0.685mm (Figure 9).

### **4. Communication of the incisive canals with the fossa and nasal cavity**

In brief, in all of the incisive analyzed canals, communication between the nasal cavity and the oral cavity has occurred.

Therefore, from the results obtained, it is possible to state that the most incisive foramina have at least two canals, which communicate the nasal fossa, being the right lateral canal with an average of 1.975mm<sup>2</sup> in area and 1.281mm in diameter. Also, in the left lateral canal, with an average of 1.468mm<sup>2</sup> in area and 1.182mm in diameter, the average area and total diameter of incisive foramina were 8.148mm<sup>2</sup> and 3.101mm, respectively.

## **Discussion**

This study aimed to analyze the morphology and morphometry of incisive foramen also incisive canal in macerated cephalic skeletons. Our results showed that most incisive foramina have at least two canals, which communicate with the nasal cavity and the oral cavity .

Because of its location, the incisive foramen could target the installation of osseointegrated implants to compose a sound protein structure and protect through a balance between distribution and distance<sup>10, 11, 12</sup> . Thus, prior knowledge of its anatomy and physiology is critical since the proximity of the incisive

foramen with the anterior central elements affects the ability to place immediate implants on the ideal position<sup>11</sup>. On the other hand, the patient's age also hinders the ability to place immediate implants since the typical clinical profile of individuals seeking this type of treatment, in most cases, are over 60 years. In which it is demonstrated that the thickness of the anterior maxillary bone is affected by aging<sup>11</sup>.

In implantology, the necessity for implant installations over the incisive canals and their foramen is common. Thus, it is necessary to have anatomical expertise, in agreement with other authors, not to cause damage and harm to the patient. For example, the structures that pass through the incisive foramen, such as the sphenopalatine vein, are responsible for the hard palate's irrigation and drainage<sup>1,2,11,12,13</sup>.

In the literature, other authors have described the importance of anatomical variations for corrective surgeries in the craniomaxillofacial region<sup>10,11</sup>. Some surgical techniques used in clinical practice, such as the Le Fort I, require anatomical knowledge of the incisive canal and its foramen<sup>6,7</sup>.

To date, there are some morphological and morphometric studies of the incisive canals with also their foramen; however, using diagnostic imaging<sup>3,10,11</sup>. Considering the scarcity of studies on incisive canals and their foramen, performed on macerated skulls, the data of this study were compared with those from research using diagnostic imaging methods<sup>12</sup>.

In our study, we checked the frequency of the incisive canals and measured each canal's diameter with the Dino Lite® microscope, and performed the analysis of the images captured using the software DinoCapture 2.0. To check the incisive canal communication with the nasal cavity, we used stainless steel orthodontic wires in the macerated skulls to obtain a privileged view. It showed that the most macerated cephalic skeletons had two incisive canals, the right-lateral canal, and the left-lateral canal.

Thus, some works have described the incisive canal as a duct of the oral cavity, which divides into two canaliculi, and ends at the nasal cavity floor next to the nasal septum<sup>5</sup>. Other authors have classified the incisive canal based on symmetry, the number of canaliculi, and shape<sup>10,12,13</sup>.

A study carried out by Mraiwa et al. (2004) using the 2D, and 3D images showed that at the level of the nasal floor, commonly two, sometimes three or four orifices, referring to the incisive canals could be seen. In contrast, in some particular individuals, the incisive canal emerged as a single-cylinder with only one nasal opening<sup>16</sup>. This result agrees with our work since we observed accessory canals during the analysis of the macerated skulls. However, the numbers obtained were higher, reaching up to six openings.

As a result, most adult individuals have two incisive canals with insignificant length differences between them, varying only in diameter and width according to gender<sup>10,12,13</sup>. In our study, the canals' average area and diameter were 1.975mm<sup>2</sup> and 1.281mm for the right-lateral canal. Furthermore, for the left-

lateral canal, the average area and diameter were 1.468mm<sup>2</sup> and 1.182mm. To date, no other study has individually evaluated the diameter of accessory canals.

As a result, our work shows that the average area and total diameter of the incisive foramina is 8.148mm<sup>2</sup> and 3.101mm, respectively, similar to others described by other authors<sup>3, 4, 14</sup>. However, recent research carried out by Reinhard et al. (2015) showed that the average diameter of incisive foramen varies according to its trajectory. Thus, at the oral cavity opening, the diameter was 4.49mm and 3.43mm at the nasal floor level.

## Conclusion

In conclusion, our study shows that it is possible to affirm that the anatomy of the incisive canals and their foramen are variable. Therefore, the knowledge and analysis of these structures are crucial for surgical procedures in the maxilla's anterior region.

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## Figures

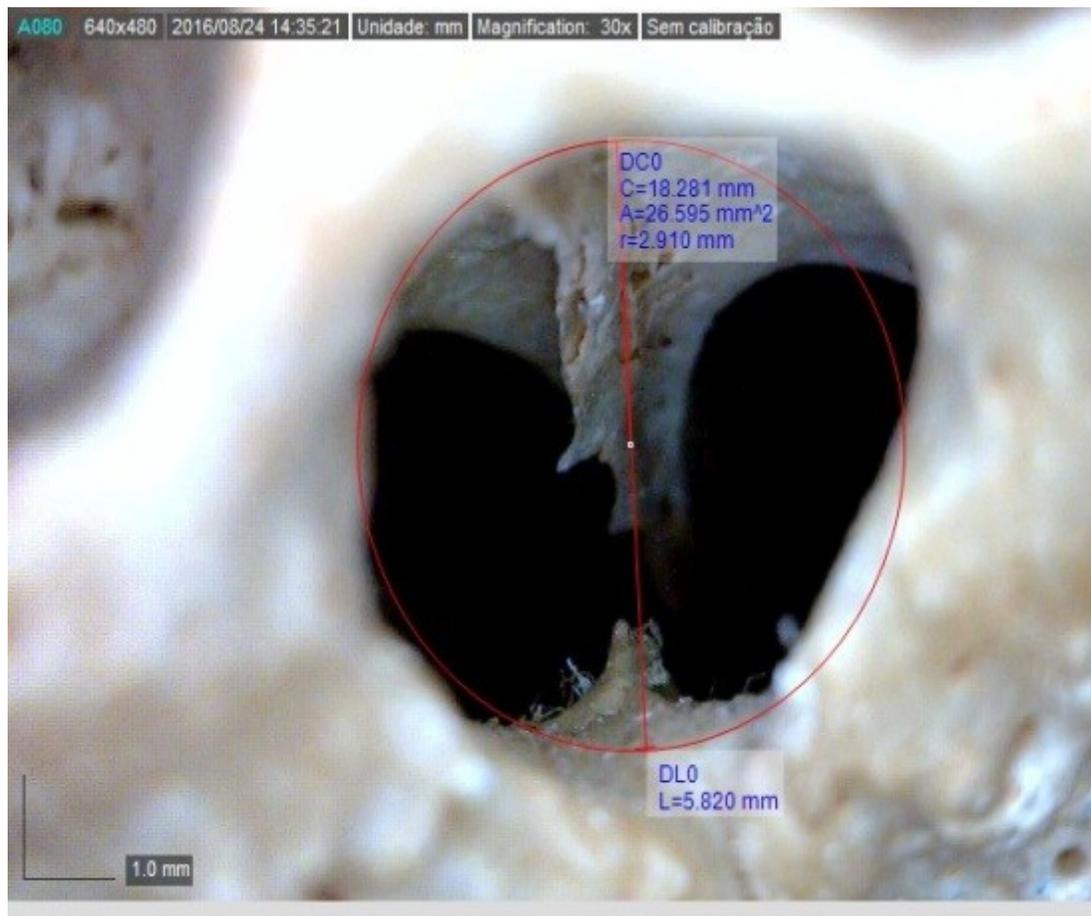
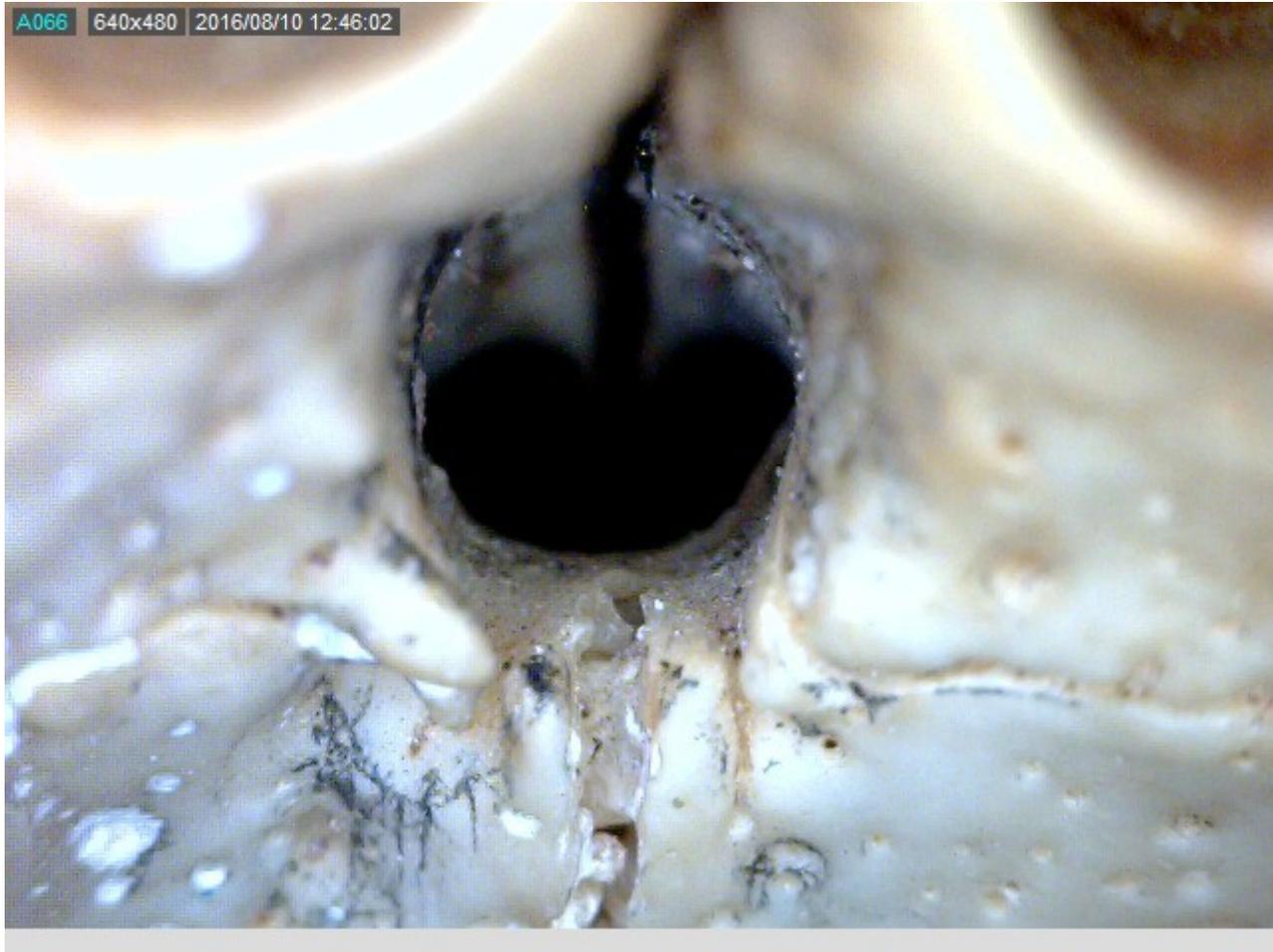


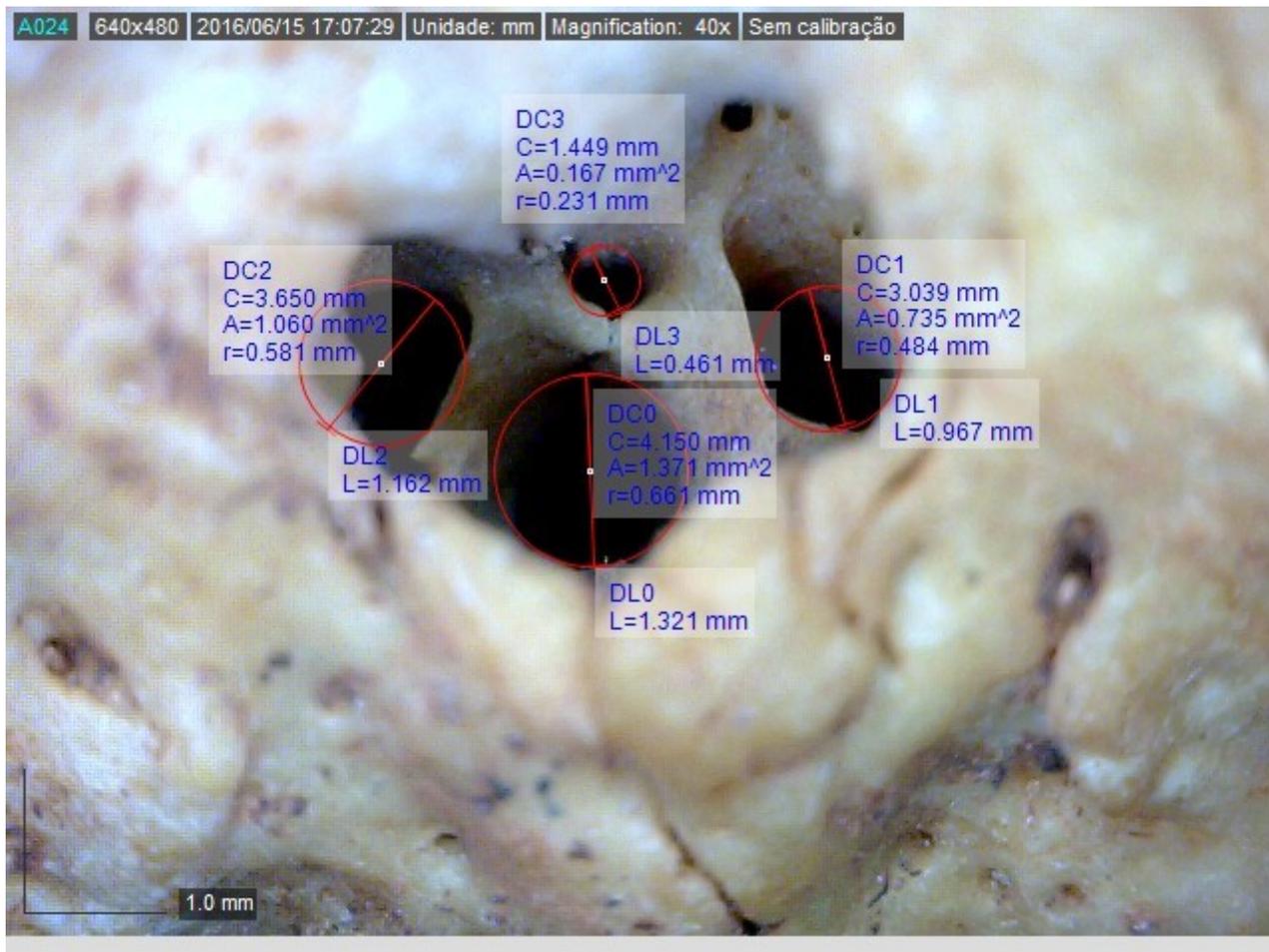
Figure 1

Measurement of the incisive foramen area and total diameter performed through the software DinoCapture 2.0. Area (A) and diameter (rx2).



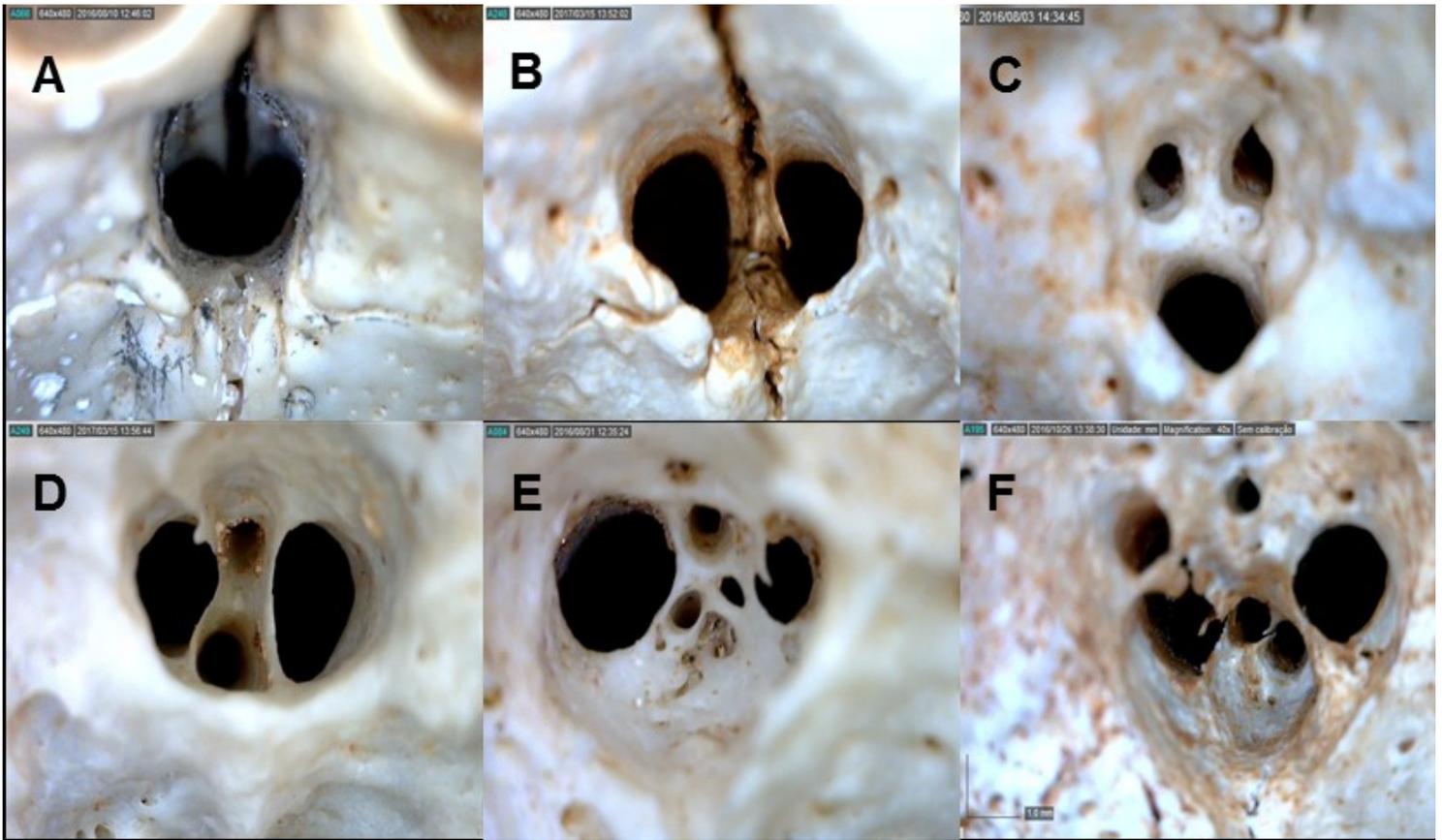
**Figure 2**

The presence of a single canal.



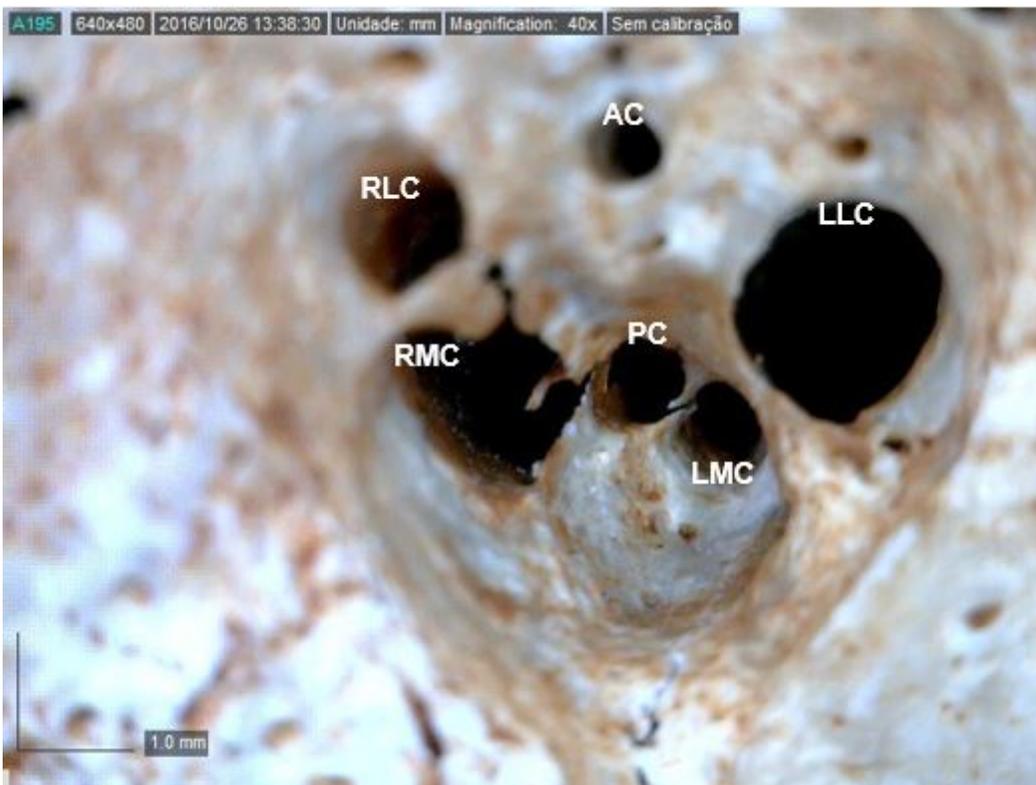
**Figure 3**

The presence of the six canals: AC (anterior canal), PC (posterior canal), RLC (right-lateral canal), LLC (left-lateral canal), RMC (right-medial canal), and LMC (left-medial canal).



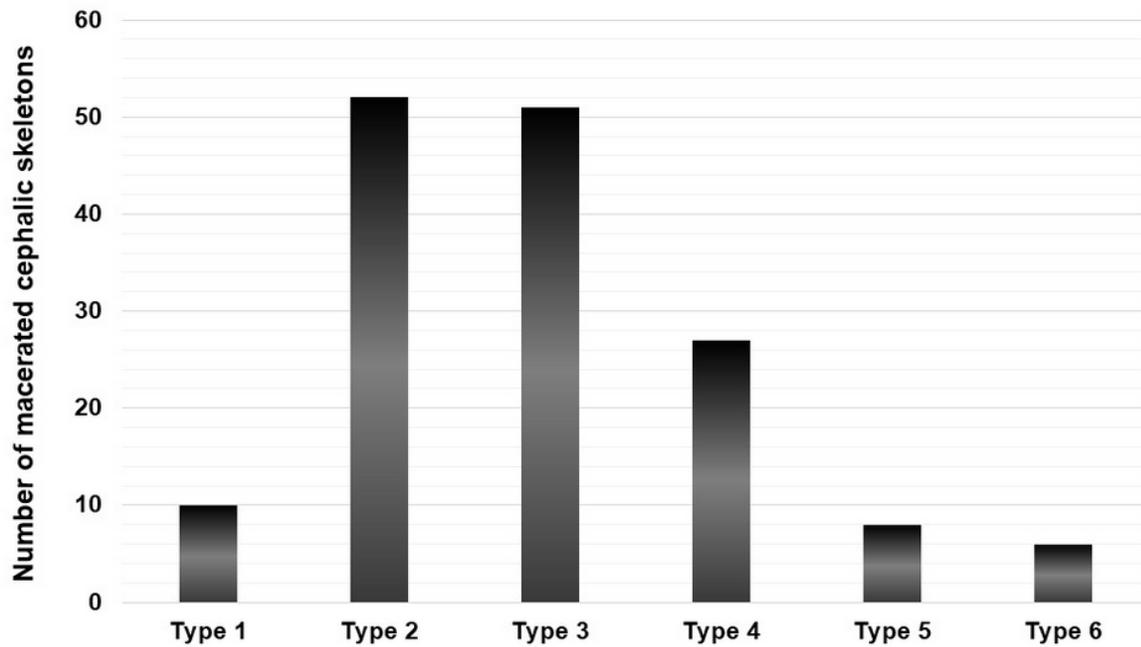
**Figure 4**

Classification of incisive foramina according to the number of incisive canals: A (type 1), B (type 2), C (type 3), D (type 4), E (type 5), and F (type 6).



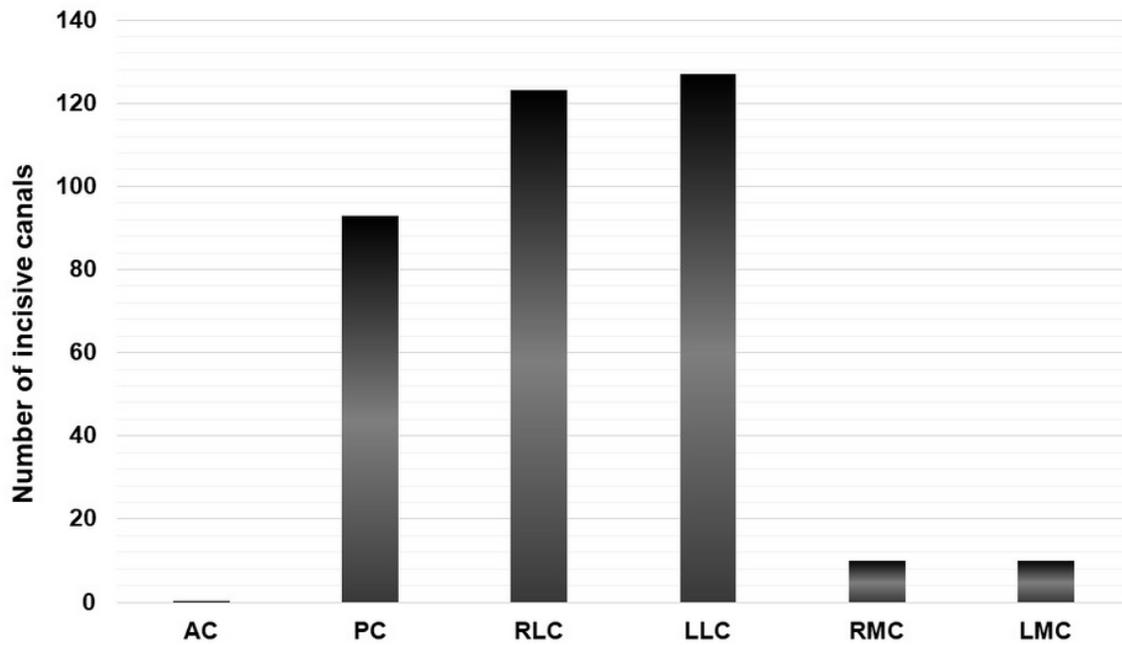
**Figure 5**

Anterior canal (AC), Posterior canal (PC), Right-lateral canal (RLC), Left-lateral canal (LLC), Right-medial canal (RMC), and Left-medial canal (LMC).



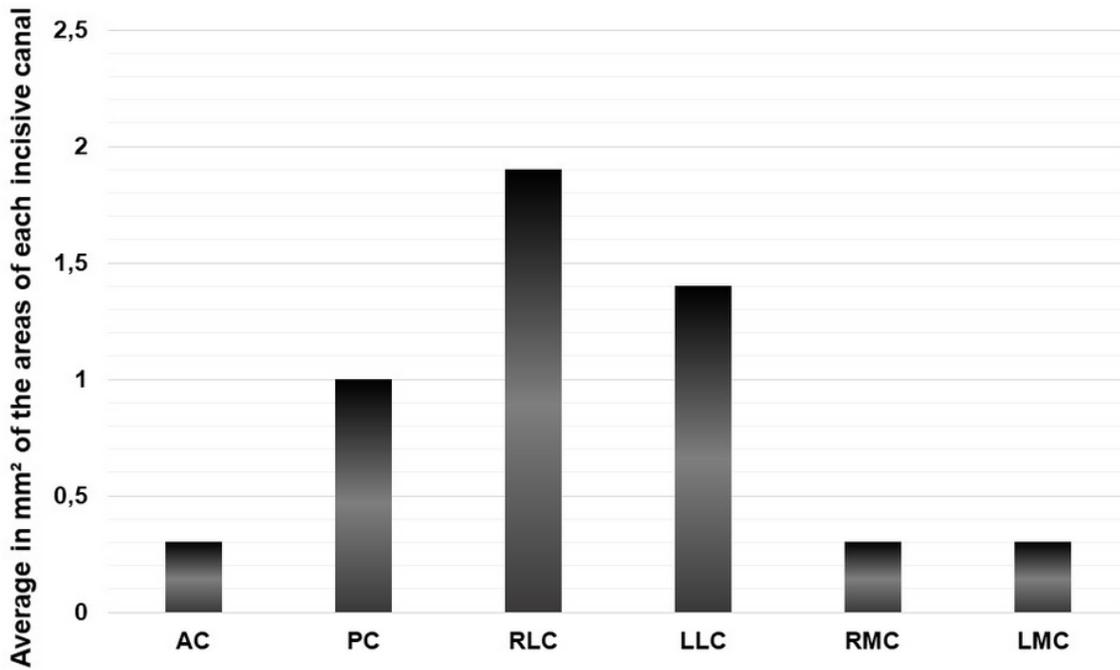
**Figure 6**

The frequency of incisive canals in the incisive foramen. Type 1 (single canal), Type 2 (two canals), Type 3 (three canals), Type 4 (four canals), Type 5 (five canals) and Type 6 (six canals).



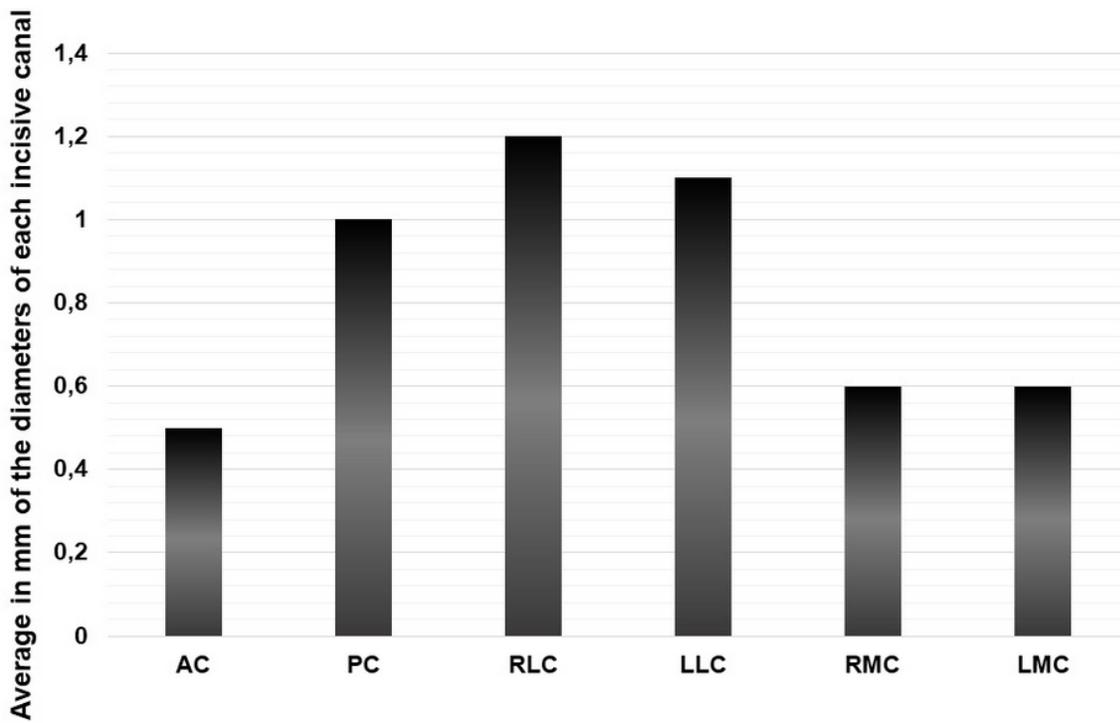
**Figure 7**

The frequency of incisive canals related to the anatomical position. AC (anterior canal), PC (posterior canal), RLC (right-lateral canal), LLC (left-lateral canal), RMC (right-medial canal), and LMC (left-medial canal).



**Figure 8**

The average in mm<sup>2</sup> of the areas of each incisive canal. AC (anterior canal), PC (posterior canal), RLC (right-lateral canal), LLC (left-lateral canal), RMC (right-medial canal), and LMC (left-medial canal).



## Figure 9

The average in mm of the diameters of each incisive canal. AC (anterior canal), PC (posterior canal), RLC (right-lateral canal), LLC (left-lateral canal), RMC (right-medial canal), and LMC (left-medial canal).