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## Morphological peculiarities of the hard palate

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### ABSTRACT

Our results were obtained on a total of 48 adult human skulls, assessing the morphological characteristics of the hard palate, measuring the palatine processes and analyzing the sutures (intermaxillary, interpalatine and maxillo-palatine); were determined the size, shape and features of the palatine foramens and incisive fossa. For the incisive fossa we describe three shapes: oval, round and rhombic. In 2 cases the incisive fossa was absent, being replaced by three round holes arranged in a triangle. The palatine process has a very irregular inferior face, being smoother only in its posterior quarter. Each palatine process of maxilla has a trapezoidal shape with the lesser base oriented anteriorly. The median palatine suture starts at the middle of the posterior circumference of the incisive fossa and ends, more often, on the line between second and third molars. The suture may be regular, located on the midline, so the two palatine processes of the maxilla are symmetrical and of equal size. The horizontal palatine lamina is thin, smooth and glossy, with very few vascular openings on its surface, mostly on its sides. The transverse palatine suture is most commonly curved posteriorly, with irregular contour and with an oblique posterior-lateral trajectory; it ends at the large palatine foramen. The large palatine foramens are voluminous, sometimes larger than the incisor one. The most common shape is oval and less frequently are rounded. The lesser palatine foramens are variable in number from 1 to 5; commonly are two on each side.

Keywords: hard palate - morphological peculiarities

### Introduction

The hard palate is formed anteriorly by the inferior face of the palatine process and posteriorly by the horizontal laminae of the palatine bones, all sutured together at the cruciform suture [1]. The palatine process of the maxilla is a thin bony lamina of triangular shape [2,3,4,5], almost triangular [6], quadrangular, rectangular [7] or trapezoidal, with the smaller base anteriorly [8,9]. Its superior face, slightly concave anterior-posterior, is smooth and forms the anterior 2/3 of the floor of the nasal cavity. In its anterior portion, near the midline, is the orifice of the incisive canal. The inferior face forms the corresponding part of the hard palate, is concave and rough, punctuated by numerous vascular foramina and palatine glands depression [3,5]. It forms together with the opposite palatine process the anterior 3/4 of the hard palate and at its level are: the pre-palatine grooves (Sulci palatine), medial and lateral, with antero-posterior direction earlier and which hosts the large palatine neurovascular bundle; the incisive fossa, located on the anterior-medial aspect of the face, which extends to the intermaxillary suture which forms the lateral aspect of the incisive foramen (Foramen incisivum); the palatine torus (Torus palatinus), an antero-posterior crest with variable length, located paramedian to intermaxillary suture.

The anterolateral border is concave posteromedially and is continued inferiorly with the alveolar process and superiorly with the nasal face of the maxilla. The medial border is thick and articulates with the opposite palatine process forming the intermaxillary suture (The median palatine suture).

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The nasal side of this margin is prominent and forms together with the opposite the nasal crest (*Crista nasalis*). In the anterior-inferior portion, posterior to the medial incisor, is an oblique anterior-inferior semicanal that articulates with the opposite, forming the incisive canal (*Canalis incisivus*), Y-shaped with two supero-lateral arms, right and left, starting in the nasal cavities, one the sides of the root of the nasal septum. They are oriented infero-medially, uniting in an inferior common arm that passes the intermaxillary suture to open in the antero-medial hard palate to the incisive foramen. Through these channels pass the large palatine neurovascular bundles. In the interval between the lateral incisor and the canine we find the incisive suture (*Suture incisive*), oriented medial and posterior, delimiting with the opposite the incisive bone (*Os incisivum*) or premaxilla (*Premaxilla*).

The horizontal blade (*Lamina horizontalis*) of the palatine has a quadrangular shape with two faces and four borders. The superior face, nasal (*Facies nasalis*) is smooth, concave transversally and forms the posterior part of the inferior wall of the nasal cavity. The inferior face, palatine (*Facies palatina*) is rough, contributing to the formation of posterior third of the hard palate. At its level are: a the palatine crest (*Crista palatina*) lying transversely and anterior to the posterior border, which is inserted the aponeurosis of tensor veli palatini muscle, b. the large palatine foramen, located in the posterolateral angle of the horizontal lamina, which passes the omonime neurovascular bundle; c. the groove for the greater palatine nerve, which extends and branches on the palatine process of the maxilla and hosts the neurovascular bundle of the greater palatine nerve. The anterior border is thin, serrated and articulates with the palatine process of the maxilla, forming the transverse palatine suture (*Sutura palatina transversa*). The posterior border is free, thin, sharp, concave posteriorly, situated between the posterior nasal spine and the pyramidal process, and forming the inferior border of the choanal frame that is inserted the palatine aponeurosis. The medial border is represented by a vertical surface, rough, thick, which articulates with the contralateral on the median line, forming the interpalatine or median palatine suture (*Sutura palatina mediana*). The upper edge of the medial border is higher and protrudes supero-

laterally to the nasal cavity. By articulating of the two edges is formed the nasal crest (*Crista nasalis*), which continues posteriorly the nasal crest of the maxilla, showing: a. two lateral, alar expansions; b. a median groove into which enters the lower edge of the vomer, forming a schindilesys. At the union of the medial and posterior borders appears a semi-spine that articulates with the opposite one, forming the posterior nasal spine (*Spina nazalis posterior*), which are inserted the muscular structures of the soft palate. The lateral border has three zones: a posterior one, which continues with the perpendicular blade and the pyramidal process; b. an intermediate one, which is forming the medial semi contour of the notch of the large palatine canal; c. an anterior one, which articulates with the medial face of the maxilla.

## Materials and methods

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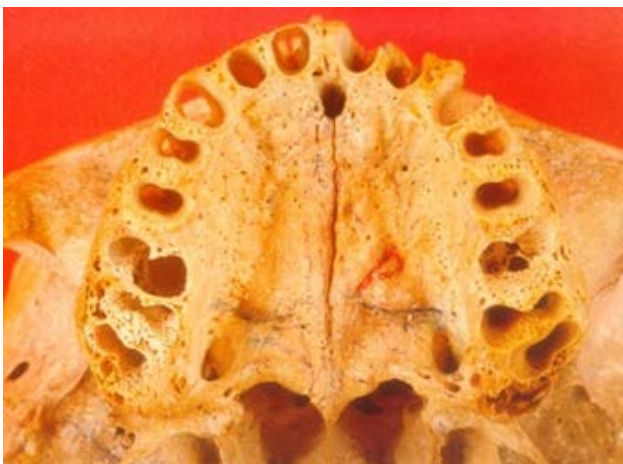
Our study was performed on a total of 48 adult human skulls assessing the morphological characteristics of the hard palate, measuring the palatine processes of the maxillae and the palatine horizontal blades, both anterior-posterior and transverse. We measured and analyzed the sutures (intermaxillary, interpalatine and maxillo-palatine), we determined the size, shape and features of the incisive foramen and greater and lesser palatine foramens and the characteristics of the bony surfaces. All these were comparatively studied by the two sides of the palate. The measurements were performed with tools from the Esculap anthropological kit of the anatomy laboratory.

## Results

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We studied the incisive fossa of 39 skulls,

describing it three shapes: most commonly, in 21 cases (53.84% of cases) it was oval, with large anterior-posterior axis or slightly oblique to the right or left; in 12 cases (30.77% of cases) we found a rounded incisive fossa, and in 4 cases (10.26% of cases) it was rhombic, with a large anterior-posterior axis. In 2 cases (5.13% of cases) the incisive fossa was absent, founding three round holes arranged in a triangle. The dimensions were variable, with 4-8 mm antero-posteriorly and 2-4 mm transverse. The incisive fossa corresponds to the median inter-incisive space, located at a distance of 2-4 mm from the alveolar process. In one case, this distance was larger (7.4 mm), between the incisive fossa of the oval shape and the alveolar margin appearing three round holes. There are cases where the incisive fossa corresponds more to the left medial incisor and less to the interincisive median space, almost 2/3 of its surface corresponding to this incisor, an aspect found in 11 cases (28.20% of cases). More rarely, in 4 cases (10.26% of cases), it exceeded more to the right of the midline.



*Figure 1 – The incisive foramen corresponds more to the left medial incisor and less to the interincisive space; the median suture deviated anterior and to the left; the two palatine processes of the maxilla are uneven; the incisive fossa is oval; the palatine foramens are large, the right being doubled anteriorly by another big foramen, oval with large transverse axis, located at the bottom of the maxilopalatine suture; the palatine openings are small and three on both sides.*

From the lateral sides of the median incisor or between the lateral incisor and the canine or even at first premolar (more commonly on the left), we can find the incisive suture. This suture, when visible, may be frequently curved, with the concavity posterior.



*Figure 2 – Rhombic, median, voluminous incisive fossa. Median suture tilted anteriorly; two unequal palatine processes; two large right palatine foramens, both oval, with large oblique postero-lateral axis, the posterior being very large and the anterior one more narrow; left large palatine foramen is bounded incomplete medially (palatal notch); on the left is one small palatine foramen, oval and on the right also one, but larger, approximately round and incompletely defined, similar to the large one (notch).*

The palatine process has is very irregular inferior face in most cases, being less irregular only in its posterior quarters. Sometimes the irregularities covering the inferior face of the palatine process are evenly distributed on both processes; in others cases they may be particularly prominent as mamelonate processes on the anterior 1/2. Most often they coexist with small bony crests of different lengths, which may also occur on the horizontal suture. Parallel to the alveolar border are two anteroposterior crests that limit the palatine canal. Each palatine process of the maxilla has a trapezoidal shape with the small margin oriented anteriorly. Its anteroposterior length was found between 25-34 mm, the width of the middle portion of each being from 11.5 to 14.4 mm. Between the small (anterior) and the large (posterior) palatine borders we found a difference of 2-4 mm.



*Figure 3 - Symmetrical hard palate, regular, rectilinear median suture; absence of the incisive fossa with presence of three spherical palatine foramens arranged in a triangle; left incisive suture up to first premolar and the right one up to the canine; right palatine process shorter anterior-posterior than the left one; right greater palatine foramen next to the posterior face of third molar and the left one next to the center of the third molar; posterior border of the transverse suture, serrate, ends, both right and left, next to the interdental space between molars two and three.*

The median palatine suture between maxillary palatine processes begin in the middle of the posterior circumference of the incisive fossa, often ending between molars two and three. The suture can be regular, located on the midline, so that the two palatine processes of the maxilla are symmetrical, being of equal size. Frequently, in 16 cases (41.03% of the cases) may be placed anterior (more commonly, in 13 cases, 33.67% of the cases) or posterior, to the left, so that the two processes are shorter in their bases with approximately 1.5-3 mm. In three cases (7.69% of cases), the median suture as a whole was curve concave to the left, so the left palatine process was wider in the middle portion and narrower on the two bases.

The palatine toruses are evident either up to near the front of the alveolar process, on both processes or only in the anterior half of both or only

one palatine process, most commonly the left one. Their height wasn't larger than 2 mm.



*Figure 4 - Oval large palatine foramens, more voluminous than the incisive fossa; the two palatine foramens are located in different planes, the left being located further posterior; voluminous right palatine foramens, two in number; three left small palatine foramens; visible palatine toruses; palatine groove more pronounced on the right, parallel to the alveolar margin; three round palatine orifices anterior to the incisive fossa.*

The horizontal palatine lamina is thin, smooth, glossy, with very few vascular openings on its surface, in particular on its sides. In anterior-posterior direction was 7-12 mm, sometimes with a difference of only 1-1.5 mm between the two blades. On the midline, up to the nasal spine is 11-14 mm. Transversally was 13.5 to 15.2 mm, from the transverse suture to the alveolar process.

The transverse palatine suture is most commonly curve with posterior concavity, with lacy contour, ending laterally either next to the second molar (its middle or posterior half) or in the space between molars two and three and rarely in the third molar. It ends at the great palatine foramen.

The large palatine foramens are large, sometimes bigger than the incisive foramen. The most common are oval and less frequently rounded, being oriented obliquely poster lateral. The long axis was between 3-5 mm and the transverse axis between



1.6-2.5 mm. From their anterior part starts anteriorly, towards the alveolar process, the palatine canal. At the alveolar border they correspond to the third molar, or may be located behind it. Commonly, they are located on the same transverse plane, but it is not rare that one of them can be located in a plane anterior to the other (the left may be located posterior), or they may have different shapes and sizes frequently. We encountered two cases with two large right palatine foramina, in one case both were oval, with large posterior lateral axis, the posterior being very large, and the anterior one narrower. Also in this case, the great palatine foramen was incomplete medially (palatal notch), lacking its posteromedial edge. In the second case with large, double palatine foramen, the anterior was oval, like the other, with large transverse axis, located at the transverse suture.



*Figure 5 – Round and large incisive fossa; uneven and slightly asymmetric palatine processes; irregular median suture deviated to the left; irregular, curved transverse suture with the concavity oriented posterior and its lateral extremities ending next to the large palatine foramen, in the right interdental space between molars two and three; both large palatine foramina are voluminous, the right one oval, with large anterior-posterior axis, the left almost round, corresponding to the third molar; on the right, two small palatine foramina relative equal in volume.*

The small palatine foramina are in a variable number, 1 to 5, the most common two holes on both sides, one of them being well represented. When there are two or three on one side, they are separated from each other by a strip of bone that can be 1-3 mm in width, and the separation between them and the great palatine foramen is also through a bony lamina of 2-4 mm. When this bone is thinner, it is sharp anteriorly. These small foramina may be oval or round, with dimensions ranging from 0.15 to 2.5 mm; when small in size, they are reduced to a simple slot. When large palatine foramen was missing, both right and left are only small ones, the left also being incomplete (a small notch in the free margin of the horizontal blade). The depth of the hard palate was 6 to 11 mm.

## Discussions

Not every hard palate looks alike, each showing their own characteristics in the anatomical landmarks. Differences are also found within same palate, the palatine processes of maxilla being not perfectly symmetrical. According to [2], the incisive fossa has a length of 10 mm and a width of 5 mm, and we found the maximum length of 8 mm, and the width of 4 mm, hence less than 1 mm. [9 and 11] show that the interincisive suture extends from the incisive fossa frequently to canine, also confirmed by us, but are not rare the cases when it is until first premolar, especially on the left side. According to [5] the incisive fossa is placed behind the incisor; we found it around the median incisor interdental space, often being deviated, especially to the left. [12] found that the average length of hard palate is 48 mm, [13] 44.04 mm, Moreira [cited by 14] 41.90 mm, 45.59 mm by Biserka [cited by 14] and [14] founds 47.13 mm, so the differences between these authors are between 0.87 to 6.10 mm, which shows that, taking into account the dimensions we found on the skull, the soft parts may be from 7.90 to 14 mm. The height (depth) of the hard palate is described in the literature

as being between 10 to 12 mm; we found it 6 to 11 mm.

Author	Height of the hard palate
Boboc	11.11 mm
Johnson	12 mm
Firu	10 mm
Taylor	12 mm
Duric-Srejec	11.45 mm
Stefănescu	11.57 mm
Personal cases	6-11 mm

It appears that, given the maximum depth of the palate found by us, the differences are larger by 1 mm from [15] and lower by 0.11 mm to [13], with 0.45 mm from Duric [quoted by 14], with 0.57 mm than [14] and with 1 mm of [12]. We consider as slightly exaggerated the values given by Breathnach.S [quoted by 14] with a 15-17 mm.

Regarding the large palatine foramen, [16] locates it at the third molar and we found it

## Conclusions

The palate increases the bearing surface of the dental prosthesis and receives some of the occlusal pressure. It allows a better adhesion of the maxillary prosthesis compared to the mandible, where the bearing surface is much lower [11]. The presence of a palatine torus determines partial or total damage such as sores and tilting of the prosthesis. Sometimes (in the case of low toruses), the modulation of the prosthesis can solve the problem but sometimes is required surgical correction. The diminish of the prosthetic base can lead to accumulation of saliva, the air is dissolved and the retention of the prosthesis decreases. The more distal is the torus and especially when crossing the line of reflection of the soft palate, the difficulties of achieving the closing edge of the prosthesis are high [11]. The average shape of the hard palate (intermediate, in 'U') is considered beneficial

for prosthetics as optimal vertical and horizontal resistance. The vault of the palate helps maintain the total prosthesis through the phenomenon of adhesion [11].

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