Original article

Topography of the greater palatine foramen in macerated skulls

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Abstract

The larger palatine foramen (FPM), for being the emerging point of the vasculo neural bundle that it is distributed to the hard palate, for being close the area that donates gingival grafts, for being area for performing anesthetic techniques for desensitization of the hard palate, and still, for being the point of entrance of the palatine channel for reaching the pterigopalatine ganglion, becomes fundamental in oral surgery interventions. 141 softened human craniums were studied, from which 82 were masculine craniums and 59 were feminine craniums. The measures were collected with a "Mitutoyo" precision pachymetry, and a compass, among the reference points previously standardized. The collected data were submitted to the statistical analysis. The results of this research demonstrated that there was a significant difference between the measures of right and left FPMs in relation to the interpalatine suture. In most of the craniums, the FPM was located closer to the third molar. The masculine craniums presented dimensions significantly larger than the feminine craniums and, except for the distance between left FPM and the incisive foramen, all the other distances from the FPM to the points taken as reference can be considered to be considered in order to estimate the sex. It can be concluded that the results found diverged in relation to some of the literature reviewed. Some new studied are suggested, mainly studies that consider the incisive foramen and the maxillary tuber as reference points to define the topography of the larger palatine foramen.

Keywords: anatomy, palatine foramen, topography.

1 Introduction

The human anatomy, in general, provides knowledge about the localization of structures in the human body, allowing a higher security for the professionals in the health area. In dentistry, as a heath field, is very important to know the constituting structures of the oral cavity and face, aiming to relate these structures to anesthetic and surgical procedures.

The greater palatine foramens (GPF) are close to the palate lateral border, behind the palate-maxillary suture, which previously are deep vascular grooves. Behind the upper border of these foramens, palatine crests are extended, which are slightly bilaterally arched and curved (FATTINI and DÂNGELO, 2007; WILLIAMS, WARWICK, DYSON, 1995). These foramens pierce the lateral border of the osseous palate and the palatine vases and nerves emerge out of these foramens, in order they can earlier run over the palate (MOORE, 2001).

Considering the execution of the operatory procedures in the posterior region of the hard palate, which demands anesthetic intervention, the puncture point is the greater palatine foramen where the nerve with the same name penetrates, responsible for the innervation of the reported area.

In this way, a higher topographic knowledge of this foremen, having as reference the fixed anatomic structures, generate a higher security in the anesthetic technique, with less punches, less quantity of anesthetic liquid, resulting in a higher comfort to the patient.

In the case of odontological interventions which demand anesthesia of the posterior part of the hard palate, precisely the greater palatine nerve which innervates this region, is necessary the knowledge considering the greater palatine foramen (GPF), which is an important anatomical structure placed in the horizontal plates of the palatine bone from where the greater palatine nerve emerge, going through the palatine canal to the pterygopalatine ganglion, where the vascular sheaf also goes through and spreads itself to the hard palate.

Therefore, it can be stated that the present study has as aim to determine the topography of the greater palatine foramen and its relation with the incisive foramen, inter-palatine foramen and the ipsilateral maxillary tuber, contributing to widen the understanding that can generate a higher security in the odontological practices.

2 Material and methods

The present study is classified as descriptive, one it has as aim to describe the topography of the greater palatine foramen in macerated skulls of males and females individuals. The sample was constituted of 141 macerated human skulls, being 82 male skulls and 59 female skulls, given by the federal universities of Uberlândia and São Paulo.

In order to form this sampling group, some requisites were previously defined: firstly the skull should be entire, do no present any fracture. Besides, the presence of the dental arcade was indispensable and, at last, the definition of gender was necessary. For skulls whose gender was not identified in the occasion of maceration, a set of characteristics to determine the gender, proposed by (PEREIRA and ALVIN, 1972; MADEIRA, 2001) was used.

The project was analyzed by the Ethics Committee of the University of Rio Verde – FESURV, Rio Verde Goias (process 026/2007). The study was performed after the authorization to the data collection.

The first phase was the quest of universities that had macerated skulls which fit in the requisites for the sampling. These skulls were from beggar corpse donated for studies, according to the law 8501/92. Through the Brazilian Society of Anatomy, the Federal University of Uberlândia and the Federal University of São Paulo were contacted, asking for the auhtorization for the data collection in the skulls of the referred universities had in their museums

After obtaining the authorization, the skulls were separated by gender according to the files and for those whose files did not mention the gender, the criteria defined by (PEREIRA and ALVIN, 1972; MADEIRA, 2001) were used.

The measurements between the reference points, previously patterned, were done using the following instruments: precision caliper from "Mitutoyo", and a compass. They were written down in a research protocol to register the measurements.

The first measurements performed from the right and left greater palatine foramens to the interpalatine suture. As the caliper did not reach the fringe of the foramens, a compass was used and the opening measurement was done using the caliper. Following that, the distance between the incisive foramen and the right and left GPF, using the same technique previously described. At last, the compass was used to measure the distance between the right GPF and the right maxillary tuber and also the left GPF and the left maxillary tuber.

After the data collection, data were submitted to statistical analysis though the SPSS for Windows. The analyzed variables were: distance between each antimeres of the greater palatine foramen and the reference points (interpalatine suture, incisive foramen, right and left maxillary tuber), mean and standard deviation and comparison of these distances between the genders. The *t*-test of Student was used to verify the presence or not of significant differences among the means obtained from the distances of each antimere of the GPF and the reference points. Finally, the Pearson´s correlation was applied aimed to verify if there was correlation among some measurements.

3 Results

The sample was composed by a total of 141 skulls, with higher frequency of male skulls, according to Table 1. In relation to the age that corpses were in the moment of the skull maceration, the sample presented a high variation and average age of 31.64. And in 36 corpses the age was not possible to precise.

It was performed measurements of the distances of each greater palatine foramen (right and after the left one) the selected points as references (interpalatine suture, incisive foramen, right and left maxillary tuber). From these data the means and standard deviation were done, which are presented in Table 2. and also the minimum and maximum mean in each point. It is highlighted that the higher standard deviation for the distance between the left greater palatine foramen and the incisive foramen (STD ± 0.38 cm) and the lowest standard deviation between the right greater palatine foramen and the interpalatine suture (DSTD ± 0.16 cm).

The mean of the performed measurements were compared between the antimeres of the GPF and each point of the reference, aiming to verify if the difference between was statistically significant. These data are presented in Table 3. A significant difference was obtained only between the measurements of the right and left GPFs in relation to the interpalatine suture. Between them, the left side presented the highest mean

Table 1. Demographic data related to gender and age distribution.

		Frequency	Percentage
	N	141	-
Gender	Female	59	41.8
	Male	82	58.2
Age	Mean	31.64	-
	Standard deviation	±13.14	-
	Mode	22*	-
	Minimum	15	-
	Maximum	99	-
	Unknown age	36	25.5

* there are several modes, this is the lower value.

Table 2. Descriptive data of the performed measurements in relation to the Great Palatine Foramens.

	Minimum	Maximum	Mean	Standard Deviation
Right GPF to the Interpalatine suture	1.20	2.00	1.57	0.16
Left GPF to the Interpalatine suture	1.20	2.05	1.62	0.16
Right GPF to the right tuber	0.70	2.10	1.18	0.24
Left GPF to the left tuber	0.55	2.05	1.15	0.26
Right GPF to the incisive foramen	3.25	4.90	3.93	0.34
Left GPF to the incisive foramen	3.08	4.95	3.91	0.38

Aiming to verify it there was relation between the variables, the Pearson´s correlation was applied. Firstly, the relation between ages and the other variables were analyzed. A direct correlation was found between agen and the right maxillary tuber (r = 0.20; p = 0.039; N = 105), the older the individual the higher is the measurement. And also a direct correlation between age and the left maxillary tuber (r = 0.19; p = 0.048; N = 105). In the other measurements this correlation with age was not found.

Table 4 present the remaining data found from the correlation between the sample measurement (N = 141). In relation to each reference point (interpalatine suture, incisive foramen, right and left maxillary tuber) a direct correlation was obtained between the antimeres of the greater palatine foremen the higher the measurement in the left side, the highest is the measurement in the right side. In addition, a positive correlation was found between the distance from the right GPF to the interpalatine suture and the distance from the left GPF to the incisive foramen.

In order to compare the measurements in the male and female skulls of the left and right GPFs in relation to the interpalatine suture, the *t*-test of Student was performed to independent samples. A significant difference was found between male and female genders in relation to the antimeres of the GPF and the interpalatine suture. As is observed in Table 5, male skulls had a higher mean when compared to the female ones. All means of distances between the right and left GPFs and each point selected as reference in both genders. Notice that the measurements are higher value in the male individuals.

The *t*-test of Student was also performed to independent samples, aiming to compare, in female as male skulls, the measurements of the right and left greater palatine foramens in relation to the maxillary tubers of the respective antimeres. A significant difference was found in both genders in relation to the antimeres and tubers. It can be observed in Table 6 that male skulls had a higher mean in relation to the female ones, in statistical terms.

In order to compare the measurements obtained from the left and right greater palatine foramen in relation to the incisive foramen in both genders the *t*-test of Student was used to independent samples (Table 7). Male skulls presented higher means than the female ones in relation to both measurements. But only in the right incisive, this difference was statistically significant.

4 Discussion

In relation to the topography of the greater palatine foramen (GPF) it could be observed that its right antimere in laterally located to the interpalatine suture with a mean of 1.57 cm (STD ± 0.16 cm), posterolaterally to the incisive foramen and in an average distance of 3.93 cm (STD ± 0.34 cm) and anteromedially to the right maxillary tuber in a mean distance of 1.18 cm (STD ± 0.24 cm). However, the left antimere is laterally located in the interpalatine suture with the mean of

Table 3. *t*-test comparing the mean of antimeres of each reference point.

	Mean	Satandard Deviation	t	P
Right GPF to the Interpalatine suture	1.57	0.16	–3.224	0.002*
Left GPF to the Interpalatine suture	1.62	0.16	-	-
Right GPF to the right tuber	1.18	0.24	1.929	0.056
Left GPF to the left tuber	1.15	0.26	-	-
Right GPF to the incisive foramen	3.93	0.34	0.700	0.485
Left GPF to the incisive foramen	3.91	0.38	-	-

*Significant at the level of 0.05.

Table 4. Pearson´s correlation between measurements taken as reference relation to the Greater Palatine Foremen.

	Right GPF to the Inter palatine suture	Left GPF to the Inter palatine suture	Right GPF to the right tuber	Left GPF to the left tuber	Right GPF to the incisive foramen	Left GPF to the incisive foramen
Right GPF to the Interpalatine suture	1	-	-	-	-	-
Left GPF to the Interpalatine suture	0.667(**)	1	-	-	-	-
Right GPF to the right tuber	0.060	0.123	1	-	-	-
Left GPF to the left tuber	0.001	0.102	0.563(**)	1	-	-
Right GPF to the incisive foramen	0.269(**)	0.160	0.143	0.102	1	-
Left GPF to the incisive foramen	0.207(*)	0.078	0.152	0.161	0.788(**)	1

* Significant correlation at the level of 0.05; ** Significant correlation at the level of 0.01

Table 5. Mean, standard deviation and *t*-test of Student comparing male and female skulls in relation to the distances of the right and left GPF and the palatine suture.

	Female (N = 59) Mean Standard Deviation	Male (N = 59) Mean Standard Deviation	T	P
Right GPF to the interpalatine suture	1.53 ±0.14	1.60 ±0.16	–2.65	0.009*
Left GPF to the interpalatine suture	1.56 ±0.13	1.65 ±0.17	–3.316	0.001*

* *t*-test of Student significant at level of 0.05.

Table 6. Mean, standard deviation and *t*-test of Student comparing the measurements of the right and left tubers in relation to the greater palatine foramen in female and male skulls.

	Female (N = 59) Mean Standard Deviation	Male (N = 82) Mean Standard Deviation	T	P
GPF to the right Tuber	1.10 ±0.21	1.24 ±0.24	–3.418	0.001*
GPF to the left tuber	1.08 ±0.23	1.20 ±0.28	–2.711	0.008*

* *t*-test significant at the level of 0.05.

Table 7. Mean, standard deviation and *t*-test of Student comparing the measurements of the right and left greater palatine foramens in relation to the incisive foramen in both genders.

	Female (N = 59) Mean Standard Deviation	Male (N = 82) Mean Standard Deviation	T	P
Right GPF to the Incisive Foramen	3.86 ±0.33	3.97 ± 0.34	–1.982	0.049*
Left GPF to the Incisive Foramen	3.86 ±0.39	3.95 ± 0.36	–1.407	0.162

* *t*-test significant at the level of 0.05.

1.62 cm (STD ± 0.16 cm), posterolaterally to the incisive foramen and to a mean distance of 3.91 cm (STD ± 0.38 cm) and anteromedially to the left maxillary tuber to an average mean of 1.15 cm (STD ± 0.26 cm).

In the scientific literature, the measurements between the antimere of the GPF and the incisive foramen were little explored. In relation to the distance between the GPF and the interpalatine foramen, the measurements vary (WESTMORELAND and BLANTON, 1982; WANG, KUO, SHIH et al., 1988; AJMANI, 1994; GRAY and GOSS, 1988; MALAMED and QUINN, 2001), but they remained between 1.5 and 1.84 cm; whereby in the studies, the majority present measurements close to the data of this verified research. Considering the localization of the GPF in relation to the molars, scientific studies are unanimous. All of them found a low number of GPF near the second molar. The position of the closest GPF to the third molar is show in the majority of studies (WESTMORELAND and BLANTON, 1982; GRAY and GOSS, 1988; WANG, KUO, SHIH et al., 1988; AJMANI, 1994; MALAMED and QUINN, 2001; METHATHRATHIP, APINHASMIT, CHOMPOOPONG et al., 2005; SUJATHA, MANJUNATH, BALASUBRAMANYAM, 2005; PRADO, AMORIN, CARIA, 2006) and they are in accordance to the data presented in this study.

Another relevant data was the comparison between the mean of the measurements of the reference points in relation to the GPF antimeres, aiming to verify a possible bilateral asymmetry between them. The obtained results only demonstrated a significant difference to the distance from the GPF antimeres to the interpalatine suture, what is also in accordance to other scientific studies that proposed to verify this information (WESTMORELAND and BLANTON, 1982; WANG, KUO, SHIH et al., 1988; SUJATHA, MANJUNATH, BALASUBRAMANYAM, 2005; PRADO, AMORIN, CARIA, 2006).

Another important data is the correlation between the antimeres of each measurement, even in those where a bilateral asymmetry was verified, meaning that, in occurring significant differences between both sides, a relation between them still remains, otherwise anatomical variations very inharmonious anatomic changes would be frequent.

Reports in Legal Dentistry several times contribute to reach na identity of an individual, from information given by its skull. In relation to the possibility of gender identification through skull measurements, several studies have been developed (PAIVA and SEGRE, 2003).

Male skulls, in general are more angled, larger, heavier and they have a higher thickness in skull bones (PEREIRA and ALVIN, 1972). Paiva and Segre (2003), claimed that male skulls sent measurement significantly higher than female skulls, in relation to the reference points, in this case is the mastoid. In this study, the difference in dimensions between

male and female skulls is in accordance to the literature. The mean of the measurements of the reference points in relation to the GPF in both genders were performed, and it was possible to verify that all means were higher in male samples, being this difference only not significant in relation to one measurement.

On the other hand, Garbin and Daruge (2003), claim that the distance between the right and left greater palatine foramens is not significant to estimate the gender. In this present study, for not being objective, the simple distance between the antimeres was not performed. However, as mentioned previously, the data found suggest that the distances from the greater palatine foramen to other reference points (interpalatine suture, right maxillary tuber, left maxillary tuber) can be taken to estimate the gender. Only the distance from the left GPF to the incisive foramen was not significant different between the genders.

Prado, Amorin, Caria (2006) state that mean distance between the center of the GPF and the interpalatine suture of the hard palate is statistically different between the genders and that male skulls presents dimensions significantly higher, what is in accordance to the present study.

5 Conclusion

Through the methodology applied and the obtained results, we could observe that the GPF in the majority of the skulls studied was located closer to the third molar, comparing the distances of the GPF antimeres in relation to the reference points, only was found a significant difference between the right and left GPF in relation to the interpalatine suture. Male skulls presented higher dimensions significantly different from the female skulls and expect the distance between the Left GPF to the incisive foramen, the other distances from the GPF to the points taken as reference (interpalatine suture, right maxillary tuber, left maxillary tuber, right GPF to the incisive foramen) can be considered to estimate gender.

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