Journal of Morphological Sciences
J Morphol Sci
Brazilian Society of Anatomy

Original Article
J Morphol Sci 2023;40:258-262

Osteometric Analysis of the Greater Palatine Groove in Dry Skulls with Dentulous and Edentulous Superior Alveolar Arches in a Brazilian Sample

Fernanda Vieira Gomes Aranda[1], Clarissa de Oliveira Lisboa[1], Célio Gabriel Freire Galindo[1], Maria Letícia Monteiro da Silva[1], Estácio Luiz Valente Filho[2], Fernando José Camello de Lima[3], Renata Cristinny de Farias Campina[4], Olavo Barbosa de Oliveira Neto[1,3]

[1]CESMAC University Center, Maceió, AL, Brazil

[2]Professional Masters Research in Health, CESMAC University Center, Maceió, AL, Brazil

[3]Anatomy Division, Institute of Biological and Health Sciences, Federal University of Alagoas, Maceió, AL, Brazil

[4]Department of Anatomy, Federal University of Pernambuco, Recife, PE, Brazil

Disclose and conflicts of interest: none to be declared by all authors

ABSTRACT

Introduction: the aim of the present study was to analyze osteometric aspects regarding the location of the greater palatine groove in dry human skulls with dentulous and edentulous superior alveolar arches. Seventy-five dry human skulls were selected, photographed in a standardized mode and had measures analyzed on Image J software. Of the 75 dry skulls, 28 were dentulous and 47 were edentulous. M3 and M4 presented statistically significant values ($p<0.05$) for comparisons between the means of the right and left sides of skulls with the same dental situation. For skulls with different dental situations, two variables (M1 and M3) presented statistical differences on the right side and two variables (M3 and M4) on the left side ($p<0.05$). Since differences were of approximately 0.5mm, a symmetry of plausible clinical applications should be considered, which means that the presence or absence of teeth does not interfere with the anatomy of the greater palatine groove.

Keywords: Greater palatine groove; Hard palate, Asymmetry; Dentulous, Edentulous.

Introduction

The hard palate is located in the viscerocranium and is constituted by the palatine process of the maxillae and the horizontal plates of the palatine bone, bilaterally. The greater palatine groove (GPG) is located in the hard palate, laterally to the palatal spine and medially to the alveolar process of the maxillae, determining the course of the greater palatine neurovascular bundle through the hard palate[1-3].

The greater palatine neurovascular bundle is constituted by the greater palatine nerve and vessels (artery, vein, and lymphatics). The main artery of the hard palate is the greater palatine artery, which is a branch of the descending palatine artery, a branch of the third part of the maxillary artery, running downwards through the greater palatine canal and emerging on the greater palatine foramen. The greater palatine vein accompanies the artery and drains to the pterygoid venous plexus. Lymphatic vessels accompany the vein[2-4].

Osteometric parameters regarding the GPG may help dental surgeons to predict the route of the greater palatine neurovascular bundle, and thus avoiding injuries to it, which is helpful for dental practice, specially, in procedures involving soft tissues of the hard palate, such as dental extractions, dental implant placement, palatal soft tissue grafts, treatment of palatal fractures and others[7-8].

Since few papers are currently available addressing the GPG, it becomes necessary to expand the current knowledge, adding new information and confirming or not existing results. However, the main scientific gap on the theme is whether exist differences between dentulous and edentulous individuals, i.e., if the presence of teeth influences on GPG anatomy[9-11].

Thus, the aim of the present study was to analyze osteometric aspects regarding the location of the greater palatine groove in dry human skulls with dentulous and edentulous superior alveolar arches.

Methodology

Ethical Aspects and Sample Size Calculation

In conformity with the Brazilian Federal Law 8.501, November 30, 1992, we used 75 dry human skulls as sample with previous authorization of the Department of Anatomy (Federal University of Pernambuco, Recife, Pernambuco, Brazil), as a part of an umbrella research project approved by the institutional research ethics committee (ID number: 66287517.7.0000.5208).

Sample was obtained by means of sample size calculation, based on the hypothesis of 95% of symmetry between bilateral structures of the hard palate, confidence level of 95% and standard error of 5%.

DOI: 10.51929/jms.40.263.2023
ISSN 2177-0298

Eligibility Criteria

Inclusion criteria were: dry human skulls with no distinction of sex, ancestralism or stature, with evidence of eruption of the superior third molars, or with evidence of dental extraction of these teeth. It also should be bone integrity of the studied structures of the hard palate and landmarks of reference. Skulls with evidences of anatomical features that indicate non-adult individuals (deciduous or mixed dentition, opened spheno-occipital synchondrosis, and presence of fonticles) were excluded from analysis.

Variables

The following variables were considered:

Distance from the center of the GPF to the median palatine suture (M1);

Distance from the center of GPG to the point where the median palatine suture encounters the transverse palatine suture (M2);

Distance from the GPG to the median palatine suture, using as reference the center of the thicker portion of the inferior margin of the zygomatic body at the level of the maxillary process of the zygomatic bone (M3);

Distance from the GPG and median palatine suture using as reference the medium point between the median point of M3 and the center of the posterior margin of the incisive foramen (M4);

Classification of the dental status of the superior alveolar arch. A skull was considered as dentate if posterior teeth were present, bilaterally.

Figure 1 illustrates and summarizes these measures.

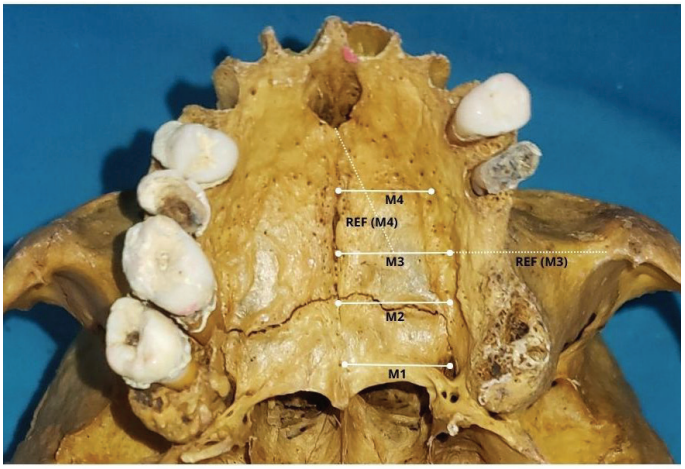

Figure 1. Inferior view of skull base illustrating the measures reported on methodology section. REF(M3) = reference line for M3; REF(M4) = reference line for M4.

Image Acquisition

Skulls were photographed using the inferior view of the skull base and wit h a standardized focal distance of 10 centimeters (Figure 2). A rectangular millimeter paper was set at the foramen magnum to obtain the calibration of the software Image J (National Institute of Health, Bethesda, Maryland, USA), which was used for image processing and analyzes.

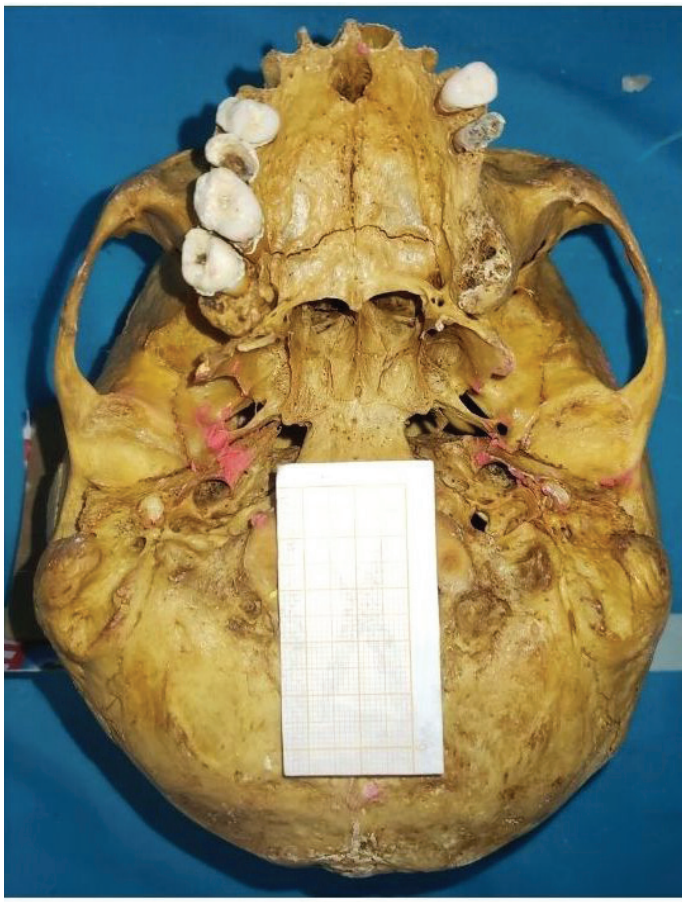

Figure 2. Inferior view of skull base showing an example of image acquisition for posterior processing on Image J.

Statistical Analysis

For bilateral comparisons of continuous variables, the Shapiro-Wilk normality test was used to verify data distribution. Next, the Student's t paired test (for normal data distribution) or the Wilcoxon test (for non-normal distribution of data).

The morphology of the superior alveolar arch was classified in triangular, rectangular, open parabolic and closed parabolic, by means of visual inspection., which was also used to determine the status of the superior alveolar arch and to classify it as dentulous or edentulous. For these outcomes, the chi-squared was used for all comparisons.

Continuous outcomes were reported as in millimeters as means and standard deviations. The present research established a 95% confidence level and a 5% significance level. All statistical analyzes were performed using the software GraphPad Prism 6.01 (GraphPad, San Diego, California, EUA).

Results

Of the 75 eligible skulls, there were 28 dentulous and 47 edentulous. Analyzes were performed considering different sides (i.e. right and left) of skulls with the same dental situation (only dentulous or only edentulous) and both situations, simultaneously and generically. Also, we performed comparisons between

the same sides (i.e. only the right or only the left sides) of skulls with different dental situations (dentulous versus edentulous).

Comparison Between the right And Left Sides

This analysis considered the measures between the right and left sides in three situations: 1) exclusively from dentulous skulls; 2) exclusively from edentulous skulls; and 3) from both, simultaneously, altogether.

Data regarding this analysis are summarized on Table 1, in which one may see two variables (M3 and M4) presented statistically significant values ($p<0.05$) for comparisons between the means of the right and left sides. For outcome M3, the general comparison and the comparison in edentulous skulls showed difference of approximately 0.5 millimeter between antimeres.

Comparison between dentulous and edentulous skulls

This analysis considered a comparison between measures of the same side of skulls with different dental situations (i.e. dentulous or edentulous). Two variables (M1 and M3) presented statistical differences on the right side and two variables (M3 and M4) on the left side ($p<0.05$).

The data regarding this analysis is fully available on Table 2.

Discussion

The present study analyzed 75 dry human skulls of adult individuals from a Brazilian sample with the same or with different dental situations (i.e. dentulous or edentulous), analyzing possible asymmetries between sides and the influence of the presence of teeth on the GPG anatomy.

Regarding morphometric data between the right and left sides of skulls with the same dental situations, in despite of statistically significant differences of M3 and M4, the small differences identified may not imply on importance from a clinical point of view[5-7]. For outcome M3, the general comparison and the comparison in edentulous skulls showed difference of approximately 0.5 millimeter between antimeres. This shows that, despite a small anatomical asymmetry, one might consider that there is a clinical symmetry for all analyzed variables, in this comparison. This means that, if the skulls are dentulous or edentulous, the right and left sides are symmetric, considering possible clinical situations where this anatomical knowledge may be of use[5-8].

The analysis between measures of the same side of skulls with different dental situations (i.e. dentulous or edentulous) showed that statistical differences occurred for M1 and M3 on the right side and M3 and

Table 1. Analyzed outcomes considering the right (R) and left (L) sides of skulls with the same dental condition (dentulous or edentulous). Values were presented in means (in millimeters – mm) and standard deviations. * = indicate a statistic significant value.

	All			Dentulous			Edentulous		
	R	L	p-value	R	L	p-value	R	L	p-value
M1	16.59 (1.98)	16.68 (1.95)	0.2055	16.29 (2.19)	16.37 (2.02)	0.4821	16.76 (1.83)	16.86 (1.90)	0.3242
M2	12.30 (1.92)	12.46 (2.15)	0.3132	12.30 (1.83)	12.55 (1.79)	0.3197	12.30 (1.99)	12.40 (2.349)	0.6153
M3	9.62 (1.98)	10.12 (1.84)	0.0005*	10.14 (2.11)	10.55 (1.97)	0.0682	9.31 (1.84)	9.85 (1.72)	0.0028*
M4	6.83 (2.20)	6.74 (2.22)	0.4365	6.84 (2.24)	7.28 (2.18)	0.1791	6.83 (2.19)	6.42 (2.18)	0.0392*

Table 2. Analyzed variables considering the same side of skulls with different dental conditions (dentulous and edentulous). Values were presented as means (in millimeters – mm) and standard deviations. * = indicate a statistic significant value; R = right side; L = left side.

	Dentulous	Edentulous		Dentulous	Edentulous	
	R	R	p-value	L	L	p-value
M1	16.29 (2.19)	16.76 (1.83)	0.0350*	16.37 (2.02)	16.86 (1.90)	0.0775
M2	12.30 (1.83)	12.30 (1.99)	0.9961	12.55 (1.79)	12.40 (2.34)	0.4196
M3	10.14 (2.11)	9.31 (1.84)	0.0097*	10.55 (1.97)	9.85 (1.72)	0.0075*
M4	6.84 (2.24)	6.83 (2.19)	0.979	7.28 (2.18)	6.42 (2.18)	0.0159*

M4 on the left side ($p<0.05$). For M1, which indicates the distance between the center of the greater palatine foramen and the median palatine suture, there was 0.5 millimeter of difference between means of the right side, which, again, indicates a numerical difference, but may not indicate a clinical asymmetry, with possible clinical repercussions.[5-8] Similarly, one must see that the same occurred for outcomes M3 and M4. On both occasions, the differences were smaller than 1 millimeter.

A limitation of the present study was due to the nature of sample, i.e., dry human skulls, which do not feature the presence of soft tissues. Hence, future studies of anatomical dissection or with analyzes on magnetic resonance imaging may be helpful for new outcomes to be considered associated to soft tissue landmarks. As for hard tissue landmarks, for edentulous individuals, measures could be obtained from the GPG in cone-beam computed tomography or even in dry skulls, but using different points (at least three) and the residual crest of the alveolar process (e.g. molar, pre-molar and canine region); for dentulous skulls, the same measures could be considered to the cemento-enamel junction of the same teeth.

Conclusion

Within the methodological scope of the present study, we conclude that, despite statistical significances, there were no important asymmetries regardless of the presence or absence of teeth.

Acknowledgements

The authors acknowledge the contributions of the Forensic Osteology Lab (LAOF, Federal University of Pernambuco, Recife, Pernambuco, Brazil) for giving us access to the space as well as to the skulls to perform the present study.

References

1. Teixeira LMS, REHER P, REHER, VGS. Anatomia Aplicada à Odontologia. 2nd ed. Rio de Janeiro: Guanabara Koogan; 2008.
2. Madeira MC. Anatomia da Face. 7th ed. São Paulo: Sarvier; 2010.
3. Goss CM. Gray Anatomia. 29th ed. Rio de Janeiro: Guanabara Koogan; 1988.
4. Drake RL, Vogl W, Mitchell A. Gray's Anatomy for Students. London: Churchill Livingstone; 2005.
5. Chambrone LA, Chambrone L. Subepithelial connective tissue grafts in the treatment of multiple recession-type defects. J Periodontol 2006;77 909–916
6. Reiser GM, Bruno JF, Mahan PE, *et al*. The subepithelial connective tissue graft palatal donor site: anatomic considerations for surgeons. Int J Periodontics Restorative Dent 1996;16:131–141
7. Newman MG, Takei HH, Klokkevold PR, *et al*. Carranza's Clinical Periodontology. 10th ed. Philadelphia/Amsterdam:Saunders/ Elsevier; 2007:1008–1014
8. Sullivan HC, Atkins JH. Free autogenous gingival grafts. I. Principles of successful grafting. Periodontics 1968; 121–129.
9. Klosek SK, Rungruang T. Anatomical study of the greater palatine artery and related structures of the palatal vault: considerations for palate as the subepithelial connective tissue graft donor site. Surg Radiol Anat 2009;31(4):245-250.
10. Monnet-Corti V, Santini A, Glise JM, *et al*. Connective tissue graft for gingival recession treatment: assessment of the maximum graft dimensions at the palatal vault as a donor site. J Periodontol 2006.77:899–902
11. Li KK, Meara JG, Alexander A. Location of the descending palatine artery in relation to the Le Fort I osteotomy. J Oral Maxillofac Surg 1996;54:822–825
12. Methathrathip D, Apinhasmit W, Chompoopong S, *et al*. Anatomy of greater palatine foramen and canal and pterygopalatine fossa in Thais: considerations for maxillary nerve block. Surg Radiol Anat 2005;27:511-516.

Mini Curriculum and Author's Contribution

1. Fernanda Vieira Gomes Aranda - Undergraduate student in Dentistry. Contribution: preparation & draft of manuscript. ORCID: 0000-0003-0462-4171

2. Clarissa de Oliveira Lisboa - Undergraduate student in Dentistry. Contribution: preparation & draft of manuscript. ORCID: 0000-0002-2469-1948

3. Célio Gabriel Freire Galindo - Undergraduate student in Dentistry. Contribution: preparation & draft of manuscript. ORCID: 0000-0002-0561-2140

4. Maria Letícia Monteiro da Silva - Undergraduate student in Dentistry. Contribution: preparation & draft of manuscript. ORCID: 0000-0003-2738-0181

5. Estácio Luiz Valente Filho – DDS. Contribution: critical review & final approval. ORCID: 0000-0003-2641-4191
6. Fernando José Camello de Lima – DDS, MSc, PhD. Contribution: preparation & draft of manuscript, critical review & final approval. ORCID: 0000-0003-1593-7747

7. Renata Cristinny de Farias Campina – MSc, PhD. Contribution: preparation & draft of manuscript, critical review & final approval. ORCID: 0000-0001-8256-7040

8. Olavo Barbosa de Oliveira Neto – DDS, MSc, PhD. Contribution: preparation & draft of manuscript, critical review & final approval. ORCID: 0000-0003-1280-659X

Received: January 20, 2023
Accepted: February 10, 2023

Corresponding author
Olavo Barbosa de Oliveira Neto
E-mail: olavo.neto@icbs.ufal.br