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Occurrence and Location of Palatal Spines and Palatal Bridges on Dry Skulls with Dentate and Edentulous Superior Alveolar Arches in a Brazilian Sample

Emelly Barbosa Muniz[1], Rayanne Regina Felix Nascimento[1], Maria Clara Lira Guimarães[1], Rafaella Ferreira Moura[1], Luiz Alexandre Moura Penteado[1], Renata Cristinny de Farias Campina[3], Célio Fernando de Sousa Rodrigues[1,2], Olavo Barbosa de Oliveira Neto[1,2]

[1]CESMAC University Center, Maceió, AL, Brazil
[2]Anatomy Division, Institute of Biological and Health Sciences, Federal University of Alagoas, Maceió, AL, Brazil
[3]Anatomy Department, Federal University of Pernambuco, Maceió, AL, Brazil

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ABSTRACT
Introduction: the accurate location of the mandibular foramen is crucial for the success of an inferior alveolar nerve block. which is necessary in surgical procedures involving lower jaw. This study investigated the usefulness of distance from 2nd mandibular molar tooth to mandibular foramen as other conventionally described landmarks are difficult to delineate many times.
Study was performed on 70 mandibles in the skeleton collection of the Department of Anatomy in Pt. B. D. Sharma PGIMS Rohtak. Mandibular notch and mandibular molar teeth are easily palpable landmarks in the oral cavity. Due to significant variations in eruption of last mandibular molar distance from the 2nd mandibular molar tooth was used in this study. Measurements were taken by using Vernier calipers.
Mandibular canal length was 55.53 + 4.51 mm (Mean + SD) on the right side and 56.02 + 5.07mm (Mean + SD) on the left side. Smallest distance from the mandibular notch was 23.51 + 3.04 mm (Mean + SD) on the right side and 23.37+ 3.34mm (Mean + SD) on the left side. Similarly, the smallest distance from the 2nd mandibular molar was 27.54 + 4.04 mm (Mean + SD) on the right side and 28.01+ 5.00mm (Mean + SD) on the left side.
Smallest distance of mandibular foramen to 2nd mandibular molar tooth can be helpful in more accurate localization of mandibular foramen during inferior alveolar nerve block. Difference in metric data of localization of mandibular foramen between left or right side was not found to be statistically significant.
Keywords: Mandibular foramen; Inferior alveolar nerve; Second mandibular molar.

Introduction

The hard palate is often used in periodontal and peri implant dentistry for connective tissue or free gingival graft harvesting, especially on the alveolar and palatine processes of maxilla, which features a large and thick mucosa[1,2].

An important palpable landmark found in the hard palate is the palatal spine (PS), which is located between the greater palatine grooves on both sides and its occurrence appears to be independent of the presence or absence of teeht[3]. It is described as small prominences that circumscribe two or more palatal grooves in an anteroposterior direction[4]. The literature has already described forms of palatal bone elevations, such as the spinal shape (i.e. palatal spine), in which there is a definitive division of the greater palatine groove, through which the greater palatine neurovascular bundle (GPNVB) passes through, and the bridge form, i.e. palatal bridge (PB), which forms a short canal that protects the GPNVB from accidental injuries by a scalpel blade during connective tissue or free gingival graft harvesting, especially the greater palatine artery, avoiding hemorraghes[2,5,6,7,9–11,13,14].

Literature shows that, even though there are different branching patterns of the greater palatine artery[5,10], it is observed that regardless of the type found, the artery and its branches have an intimate anatomical relationship with the PS, therefore, the dentist must have good anatomical knowledge of the region to understand the path of the greater palatine vascular-nervous bundle, making its path more predictable[2,14–19].

In order to reduce the risk of injury to the greater palatine artery, clinical landmarks have been used, such as the palatal aspect of the cemento-enamel junction and the length of the 15C scalpel blade[9–11]. However, hemorrhage of the greater palatine artery still is the main surgical accident during hard palate graft harvesting and new anatomical landmarks, such as palatal spines and bridges, may aid the surgeon during

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the procedure to reduce the risk of hemorrhages[10,11,13,14].

Thus, the aim of this research was to determine de occurrence and the location of palatal spines and palatal bridges on dry skulls with dentate and edentulous superior alveolar arches.

Materials and Methods

Ethical Aspects and Sample Size Calculation

In accordance with Brazilian Federal Law 8,501, of November 30, 1992, only legally useful dry skulls were used for study purposes, with prior authorization from the Anatomy Department of the Federal University of Pernambuco (UFPE). The study was approved by the Research Ethics Committee as part of an umbrella project of the Health Sciences Center of the Federal University of Pernambuco (CCS/UFPE), with Certificate of Presentation of Ethical Appreciation (CAAE) 30916420.5.0000.5208.

The sample, obtained through sample size calculation, based on the hypothesis of 95% symmetry between contralateral structures of the hard palate, 95% confidence level and standard error of 5%, was of 75 dry human skulls stored in the Anthropology and Osteology Laboratory Forensics (LAOF) of the Anatomy Department of the Federal University of Pernambuco (UFPE).

Eligibility Criteria

Dry human skulls were included without distinction of sex, ancestralism or height. Skulls had to show evidence that the upper third molars had already erupted, totally or partially, or even had already been extracted. In addition, the studied structures or landmarks had to be preserved. Skulls showing damage on the studied structures or with presence of fontanelles, deciduous or mixed dentition, or patent spheno-occipital synchondrosis were excluded.

Variables

The following variables were analyzed:

1) occurrence of the palatal spine;

2) location of the palatal spine;

3) occurrence of palatal bridges on the greater palatine groove;

4) location of palatal bridges on the greater palatine groove.

Visual Analysis

The possible locations of the PS were considered at the alveolar process or at the palatine process of the maxilla. The possible locations of the palatal bridge along the greater palatine groove were classified as: close to the anterior end of the palatal spine; close to the posterior end of the palatine spine; close or to or at the center of the palatal spine; or independently of the palatal spine. Also, through visual inspection, the dental status of the upper alveolar arch was classified as dentate and edentulous, where the skull with bilateral posterior teeth was considered as dentate.

Statistical Analysis

Since all outcomes were categorical, it was not necessary to run a normality test for data distribution. Data were reported using absolute and relative values. The chi-square test was performed to make comparisons. This research considered a significance level of 5% and a confidence level of 95%. All statistical analyzes were performed using GraphPad Prism 6.01 software (GraphPad, San Diego, California, United States).

Results

The PS was present in 80% (60/75) of cases on the right side and 76% (57/75) of cases on the left side. In all cases observed (100%, both sides), the PS was present in the palatine process of the maxilla, with no occurrence on the alveolar process of the maxilla (0%, both sides). There was no statistical difference when comparing antimeres ($p>0.05$). Figure 1 shows the palatal spine and its relation with the greater palatine groove.

Figure 1. Palatal spine (1) and palatal bridge (black arrow) on the greater palatine groove.

Of the 75 skulls analyzed, 11 were from dentate individuals and 64 from edentulous individuals. Of the 60 cases in which the PS was present on the right side, 13.33% (08/60) were in dentate individuals and 86.66% (52/60) in edentulous individuals. On the left side, of the 57 cases in which the PS was present, 14.03% (08/57) were observed in dentate subjects and 85.96% (49/57) in edentulous subjects. When comparing the same side of dentate and edentulous individuals, there was no statistical significance (p>0.05).

The palatal bridge (PB) on the greater palatine groove (Figure 1) was present in 4% (03/75) of cases on the right side and 16% (12/75) of cases on the left side. There was a statistically significant difference when comparing the right and left sides regarding to the occurrence of the PB (p=0.0143). In the three cases that the PB was observed on the right side, its location was distributed as follows: one case at the posterior end of the PS; one case in the center of the PS; one case independent of the PS; and no occurrences on the anterior end of the PS. In the 12 situations that the PB was observed on the left side, its location was distributed as follows: two cases at the anterior end of the PS; four cases at the posterior end of the PS; one case in the center of the PS; and five cases independent of it. Of the three cases in which the PB was observed on the right side, all of them (100%) were in edentulous subjects. Of the 12 cases in which the palatal was observed on the left side, 16.66% (2/12) were in dentate subjects and 83.33% (10/12) in edentulous subjects. When comparing the same side of dentate and edentulous individuals, there was no statistical significance (p>0.05).

Discussion

The present study analyzed 75 upper alveolar arches of dentate and edentulous dry skulls from adult individuals to determine the occurrence and location of palatal spines and palatal bridges. Whereas the PS was present in most skulls (thus considered as a normal structure), the PB was an anatomical variant, for it was present in a few skulls.

Regarding the occurrence of the PS between the right and left sides of skulls with the same dental condition, there was no statistically significant difference (p>0.05). The high occurrence was similar to what was observed in the study by Hassanali & Mwanili (1984), where there was an occurrence of 96.8% (121/125) of palatal spines in hard palates of African skulls.

Table 1 shows that, regardless of the antimere (right or left), the occurrence of the PS is symmetrical, thus providing greater predictability of the location of the GPNVB for the clinician[5-7].

The occurrence of the PS also did not demonstrate statistical significance (p>0.05) when different dental situations were compared in the same antimere, as shown in Table 2. This shows that the dental situation had no influence on the presence of the PS, that is, the probability of its presence is similar for a dentate or edentulous arch. These results collaborate with the results reported by Benninger *et al.*, 2012.

Table 1. Occurrence of the palatal spine.

	Right side (%)	Left side (%)
Present	60 (80%)	57 (76%)
Absent	15 (20%)	18 (24%)
p-value	>0.05	

Table 2. Occurrence of the palatal spine on dentate and edentulous skulls.

	Dentate (%)	Edentulous (%)
Right side	08 (13,3%)	52 (86,66%)
Left side	08 (14,03%)	49 (85,96%)
p-value	>0.05	

Regarding its location, the PS was located, in all cases observed, in the palatine process of the maxilla. This result corroborates with Yu *et al.*, 2014, which showed the presence of the palatine spine in the palatine process of the maxilla. Moreover, they established that the relationship between the course of the greater palatine artery had an intimate topographic relationship with the PS, regardless of the branching pattern of the artery.

The PB was considered in the present research as a bony prominence that may arise from the PS itself or independently of it, in order to form a bony roof that helps to delimit a short greater palatal canal. This variable showed a statistically significant difference (p<0.05) when comparing antimeres, with a higher occurrence predicted on the left side (Table 3). As in the present study, Hassanali & Mwanili D (1984) showed that the PB presented itself as an anatomical variation, not being observed in the majority of cases. In their study, there was an occurrence of 19.2% (22/125) of a bridge-like bony prominence over the greater palatine groove in African skulls. Furthermore, these authors reported that there is a possible relationship with ethnicity, but more consistent studies are needed to confirm these data.

Table 3. Occurrence of palatal bridges. * = indicates a significant result.

	Right side (%)	Left side (%)
Present	03 (4%)	12 (16%)
Absent	72 (96%)	63 (84%)
p-value	0.0143*	

As seen in Table 4, the occurrence of the PB was not altered when the superior alveolar arch was dentate or edentulous, showing no statistical difference (p>0.05), thus becoming more predictable due to symmetry between the antimeres[7].

The presented data points out that, because of its low occurrence and various possibilities of location, the PB should not be used as a standard landmark to protect the GPNVB during connective tissue or free gingival graft harvesting, although, when present, it

Table 4. Occurrence of the palatal spine on dentate and edentulous skulls.

	Dentate		Edentulous	
	Right side	**Left side**	**Right side**	**Left side**
Present	0 (0%)	02 (16,66%)	03 (100%)	10 (83,33%)
p-value	>0.05			

can be useful in preventing accidental hemorrhage. On the other hand, the PS, due to its high occurrence and easy palpability, even through the mucoperiosteum of the hard palate, can be used as a normal and predictable anatomical landmark of the hard palate to help locate the GPNVB and, summing up to other already existing and classically consolidated clinical landmarks, help surgeons in preventing hemorrhagic accidents of the greater palatine artery.

Conclusions

The palatal spine was located on the palatine process of the maxilla in all cases and can be considered as a normal structure, i.e., found in most cases on both sides;

The palatal bridge can be considered as an anatomical variant;

Both the palatal spine and the palatal bridge (when present) occurred more often in edentulous skulls.

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Ethics Statement

The authors state that every effort has been made to follow all local and international ethical guidelines and laws that pertain to the use of human cadaveric donors in anatomical research (Iwanaga *et al.*, 2022).

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Mini Curriculum and Author's Contribution

1. Emelly Barbosa Muniz - Undergraduate student in Dentistry. Contribution: preparation & draft of manuscript. ORCID: 0000-0001-5845-4978

2. Rayanne Regina Felix Nascimento - Undergraduate student in Dentistry. Contribution: preparation & draft of manuscript. ORCID: 0000-0003-1116-5751

3. Maria Clara Lira Guimarães - Undergraduate student in Dentistry. Contribution: preparation & draft of manuscript. ORCID: 0000-0002-8414-8234

4. Rafaella Ferreira Moura - Undergraduate student in Dentistry. Contribution: preparation & draft of manuscript. ORCID: 0000-0001-5931-327X

5. Luiz Alexandre Moura Penteado – DDS, MSc, PhD. Contribution: preparation & draft of manuscript, critical review & final approval. ORCID: 0000-0001-6683-7450

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

7. Célio Fernando de Sousa Rodrigues – MD, MSc, PhD. Contribution: critical review & final approval. ORCID: 0000-0002-1361-8139

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

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