International Journal of Anatomy and Research,
Int J Anat Res 2018, Vol 6(3.2):5568-73. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2018.285

Original Research Article

MORPHOMETRIC STUDY OF THE GREATER PALATINE FORAMEN IN THE DRIED BONES OF EASTERN INDIA

Sudeepa Das [1], Bikash Chandra Satapathy *[2], Rajashree Biswal [3], Manoja Kumar Muni [4].

[1] Assistant Professor, Department of Anatomy, Kalinga Institute of Medical Sciences, KIIT deemed to be University, Bhubaneswar, Odisha, India.

*[2] Assistant Professor, Department of Anatomy, Kalinga Institute of Medical Sciences, KIIT deemed to be University, Bhubaneswar, Odisha, India.

[3] Associate Professor, Department of Anatomy, Sriram Chandra Bhanja Medical College and Hospital, Cuttack, Odisha, India.

[4] Assistant Professor, Department of Anesthesia, Kalinga Institute of Medical Sciences, KIIT deemed to be University, Bhubaneswar, Odisha, India.

ABSTRACT

Introduction: Greater palatine foramen is a very important landmark for administering anesthesia in maxillofacial and dental surgeries. Getting the anesthesia correct each time is a technical manoeuvre, which require sufficient amount of clinical skill and experience. The anatomical landmark has been described by many authors but as per the data in the eastern Indian population it is sparse. This study aims to define the greater palatine foramen according to various landmarks.

Materials and Methods: One hundred and three skulls from two medical colleges of eastern India were studied by the first and second authors separately and consecutively. All the skulls were examined for any broken parts in the hard palate and in the greater palatine foramen region. Only the skulls that were intact in these areas were considered for the study.

Result: The mean distance of the greater palatine foramen to the incisive foramen was 35.45mm in the males and 34.82mm in the females. The average distance between the greater palatine foramen and the midline maxillary suture was 13.22mm in the males and 12.98 mm in the females. In 85.92% cases we found the GPF to be oval in shape and it opened in to the oral cavity antero-medially in 58% of the cases. With respect to the molar teeth, in 42.71% of the cases the greater palatine foramen was present opposite the anterior ½ of the 3rd molar.

KEY WORDS: Greater Palatine Foramen, Greater Palatine Canal, Eastern India, Anaesthesia, Incisive Foramen.

Address for Correspondence: Dr Bikash Chandra Satapathy, Assistant Professor, Department of Anatomy, Kalinga Institute of Medical Sciences, KIIT deemed to be University, Bhubaneswar. PIN-751024, Odisha, India. Mob:8518887315, **E-Mail:** bikash.satapathy@gmail.com

Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research**
	ICV for 2016 90.30
	ISSN (E) 2321-4287 | ISSN (P) 2321-8967
	https://www.ijmhr.org/ijar.htm
	DOI-Prefix: https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2018.285	**Article Information**
	Received: 13 Jun 2018 | Accepted: 17 Jul 2018
	Peer Review: 13 Jun 2018 | Published (O): 10 Aug 2018
	Revised: None | Published (P): 10 Aug 2018

INTRODUCTION

The greater palatine foramen (GPF) is present bilaterally at the posterior angle of the hard palate. In surgeries related to posterior maxilla, blocking the greater palatine nerve (GPN) is important for facilitating various palatal and dental procedures. The GPN emerges from the maxillary nerve in the pterygopalatine fossa and

then it comes to the oral cavity through the GPF in the Greater palatine canal (GPC) [1]. The GPN supplies the soft and the hard tissues of the palate and gives branches in the GPC. The maxilla, palate, palatal glands with its mucoperiosteum and gingiva are innervated by the neurovascular bundle formed by the greater palatine nerve together with the greater palatine artery [1].

Finding accurate position of the GPF may resolve various problems in administering local and regional anesthesia during surgeries of the cleft palate, maxillary sinus or palatal free vascular flaps [2]. As anaesthesia is given in the region of the GPF, a thorough knowledge of the position of the GPF is required for the same. Inadequate knowledge regarding localization of the GPF may invite risk due to damage to this neurovascular bundle. Due to easy and clear approach to the median maxillary suture (MMS) and the molar teeth, they serve as important landmarks to locate the GPF during oral surgeries. Several studies have also stated that the GPF usually lies opposite the 3rd molar tooth [3]. Some textbooks of anaesthesia stated regarding the location of the GPF that it may be either anterior or posterior to the 3rd molar tooth or may be present in between the 2nd & 3rd molar tooth [4]. The knowledge regarding the position of GPF prevents the faulty deposition of anaesthesia into the nasopharynx [5] and also it decreases the risk of hematoma formation due to pterygoid venous plexus puncture [6].

Due to the racial and ethnic variations certain geometric differences in the GPF have also been reported. The present study is an attempt to localize the GPF in the eastern Indian population using various palatal landmarks in dry skulls.

MATERIALS AND METHODS

One hundred and twenty skulls of known gender were collected from the osteology section of department of anatomy of KIMS, Bhubaneswar and SCB Medical College, Cuttack. Skulls from MBBS students of KIMS were also included in the study. These bones were then inspected for any damage in the region of hard palate and upper alveolar arch. Only the skulls where these structures were intact were included in this study and others were rejected. So we included only one hundred and three skulls in the study. The greater palatine foramen was studied in relation to different anatomical landmarks and its internal structure.

Inclusion criteria

· Skulls with intact hard palate

Exclusion criteria

· Skulls with damaged hard palate

The morphometric measurements of the greater palatine foramen and distances from various landmarks were measured by a digital callipers which is calibrated with accuracy nearest to 0.1mm. The angle between the median maxillary suture and the line joining the GPF with the incisive foramen was calculated in I C Measure software (https://www.theimagingsource.com). The direction of GPF opening into the oral cavity was studied using a 26 gauge needle.

The following parameters were studied.

· Shape of GPF

· Direction of GPF

· Relation of GPF with the third molar tooth.

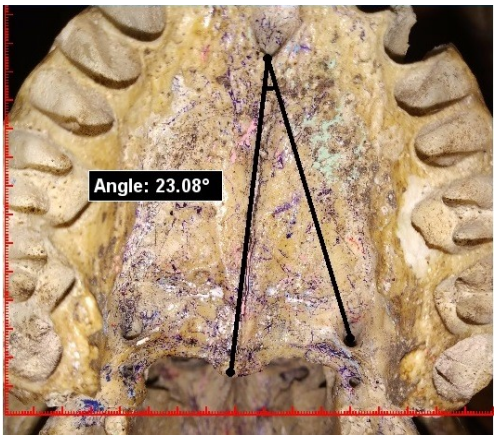
· Antero-posterior diameter and transverse diameter of the GPF.

· DGM=Distance between center of GPF to median maxillary suture (MMS).

· DGP=Distance between center of GPF to posterior border of hard palate (PBHP).

Angle formed by MMS and line joining GPF with incisive foramen.

The data collected were compiled and statistically analysed in Stata software.



RESULTS

Many authors have tried to find out the morphometry and the position of the GPF in respect

to different bony landmarks in different populations. In these studies the GPF has shown a lot of variations in relation to its position and dimension. We calculated all the parameters and these are tabulated in Table 1.

The direction of the GPF was assessed by passing a 26 gauge needle. Most of the skulls showed that the GPF was directed anteromedially followed by anteriorly. Table 3 summarizes the data. Chi-square test failed to demonstrate any gender predisposition, so though anteromedial direction is the most prevalent direction of the GPF, but no direction has more prevalence in any specific gender.

The position of the GPF was calculated by looking at its position in relation to 3rd molar tooth.So we had 4 categories. The GPF's position was on hard palate, but its position could be behind the 3rd molar, against the posterior half, anterior half of the third molar tooth or it could be anterior to that of the third molar tooth. The findings are summarized in Table No 4.

The transverse diameter of the GPF and the distance between the GPF and the MMS showed statistically significant sexual dimorphism, being larger in the males. Most of the other parameters were larger in males than that of the females, but they were statistically not significant.

Table 1: Various parameters.

PARAMETERS	SIDE	GENDER	MEAN (mm)	t value	p value
AP Diameter	Right	Male	4.64±0.56	0.342	0.732
		Female	4.58±1.013		
	Left	Male	4.68±0.78	2.103	0.038
		Female	5.07±1.04		
Transverse Diameter	Right	Male	3.6±0.64	4.02	0.0001
		Female	3.05±0.66		
	Left	Male	3.48±0.31	10.907	0.0001
		Female	2.78±0.3		
Distance GPF-MMS (DGM)	Right	Male	13.16±0.82	1.326	0.188
		Female	12.88±1.34		
	Left	Male	13.28±0.53	1.058	0.292
		Female	13.07±1.45		
		Female	35.1±2.92		
Distance GPF-PBHP (DGP)	Right	Male	5.22±0.67	8.052	0.0001
		Female	3.95±0.88		
	Left	Male	5.09±0.75	8.986	0.0001
		Female	3.53±0.96		
Angle between MMS and line joining GPF with incisive foramen	Right	Male	23.04±1.7	1.904	0.059
		Female	23.76±1.94		
	Left	Male	22.69±1.33	2.153	0.034
		Female	23.28±1.94		

Table 2: Shape of the GPF.

Side	Shape	Gender		Total	Chi-square	p value
		Male	Female			
Right	Oval	59[67.8%]	28[32.2%]	87	0.8665	0.648
	Round	9[75%]	3[25%]	12		
	Slit	2[50%]	2[50]%	4		
Left	Oval	61[67.8%]	29[32.2%]	90	5.2023	0.074
	Round	8[88.9%]	1[11.1%]	9		
	Slit	1[25%]	3[75%]	4		

Table 3: Direction of the GPF.

Side	Direction	Gender		Total	Chi-square	p-value
		Male	Female			
Right	Anteromedial	40	22	62	1.3653	0.505
	Anterior	21	9	30		
	Anterolateral	0	0	0		
	Vertical	9	2	11		
	Posterior	0	0	0		
Left	Anteromedial	38	19	57	0.5488	0.76
	Anterior	22	11	33		
	Anterolateral	0	0	0		
	Vertical	10	3	13		
	Posterior	0	0	0		

Table 4: Position of the GPF.

Side	Position	Gender		Total	Percentage	Chi-square	p value
		Male	Female				
Right	Behind 3rd molar	9[64.3%]	5[35.7%]	14	13.6	1.2625	0.738
	Anterior 1/2 of 3rd molar	33[71.7%]	13[28.3%]	46	44.6		
	Posterior 1/2 of 3rd molar	17[60.7%]	11[39.3%]	28	27.2		
	Between 2nd and 3rd molar	11[73.3%]	4[26.7%]	15	14.6		
Left	Behind 3rd molar	11[73.3%]	4[26.7%]	15	14.6	2.6972	0.441
	Anterior 1/2 of 3rd molar	25[59.5%]	17[40.5%]	42	40.8		
	Posterior 1/2 of 3rd molar	19[70.4%]	8[29.6%]	27	26.2		
	Between 2nd and 3rd molar	15[78.95]	4[21.1%]	19	18.4		

Table 5: Comparison of antero-posterior and transverse diameter of the GPF.

	AP Diameter mean in mm	AP in Right side in mm	AP in Left side in mm	Transverse Diameter in mm	Transverse Diameter on Right in mm	Transverse Diameter on Left in mm
Klosek and Rungruang 2009 [9]	5	-	-	2.7	-	-
Hwang et al 2011 [CT Study] [7]	4.5	-	-	2.2	-	-
Fu et al 2011 [10]	4.6	-	-	2.8	-	-
Piagkou et al 2012 [11]	5.3	-	-	2.7	-	-
Nimigean 2013[2]	4.9±0.9	--	--	3.0±0.5	-	-
Sharma and Garud 2013 [5]	4.72±1.4	--	--	--	-	-
Tomsazewski 2014 [6]	5.1	-	-	3	-	-
Beetge et al 2018 [CT Study] [1]	--	5.35±1.08	5.08±0.94	----	2.81±0.54	2.81±0.78
Present study	4.71±0.82	4.62±0.73	4.81±0.89	3.34±0.59	3.43±0.69	3.26±0.45

Table 6: GPF Position in relation to the 3rd molar tooth.

	Anterior to 3rd Molar Tooth (%)			Anterior ½ of 3rd Molar Tooth /Medial to 3rd Molar Tooth (%)			Posterior ½ of 3rd Molar Tooth /Opposite 3rd Molar Tooth (%)			Distal to 3rd Molar Tooth (%)		
	Right	Left	Total	Right	Left	Total	Right	Left	Total	Right	Left	Total
Saralya and Nayak 2007 [12]	-	-	24.6	-	-	-	-	-	74.6	-	-	0.8
Chrcanovic and Custodio 2010 [4]	-	-	6.2	-	-	-	-	-	54.9	-	-	38.9
Nimigean 2013 [2]	-	-	24	-	-	-	-	-	73	-	-	3
Tomaszewska 2014 [6]	22.3	23.9	23.1	-	-	-	75.4	74	74.7	1.1	1.1	2.2
Present Study	14.6	18.4	16.5	44.6	40.8	42.7	27.2	26.2	26.7	13.6	14.6	14.1

Table 7: Comparison of the direction of the GPF opening in to the oral cavity.

	ANTERIOR (%)	ANTERO-MEDIAL (%)	ANTEROLATERAL (%)	VERTICAL (%)	POSTERIOR (%)
Saralya and Nayak 2007 [12]	41.3	46.2	12.5	-	-
Chrcanovic and Custodio 2010 [80 Skull] [4]	69.4	18.7	0	11.87	-
Murali 2016 [13]	39.6	49.7	10.7	-	-
Patil et al 2016	-	88.2	-	11.4	0.4
Present Study	30.6	57.8	0	11.6	0

Table 8: Comparison of DGM /DGP.

	DGM on the Right Side in mm	DGM on the Left Side in mm	DGP in mm
Saralaya and Nayak 2007 [12]	14.7	14.7	4.2
Chrcanovic and Custodio 2010 [4]	14.7	14.4	3.4
Sharma and Garud 2013 [5]	14.7	14.4	3.4
Patil et al 2016 [8]	14.6	14.9	5.4
Present Study	13.1	13.2	4.4

Table 9: Comparison of the shapes of the GPF.

			Lopes et al [14] [Male=65, Female=29]	Percent	Patil et al [8] [Male=55, Female68]	Percent	Present Study [Male=70, Female=33]	Percent
Male	Right	Oval	38/65	58.5	47/55	85.5	59/70	84.3
		Round	09/65	13.8	07/55	12.7	9/70	12.8
		Slit	18/65	27.7	01/55	1.8	2/70	2.9
	Left	Oval	38/65	58.5	48/55	87.3	61/70	87.2
		Round	09/65	16.9	06/55	10.9	8/70	11.4
		Slit	16/65	24.6	Jan-55	1.8	1/70	1.4
Female	Right	Oval	15/29	51.7	57/68	83.8	28/33	84.8
		Round	06/29	20.7	07/68	10.3	3/33	9.1
		Slit	08/29	27.6	04/68	5.9	2/33	6.1
	Left	Oval	16/29	55.2	60/68	88.2	29/33	87.9
		Round	06/29	20.7	02/68	2.9	1/33	3
		Slit	07/29	24.1	06/68	8.9	3/33	9.1

DISCUSSION

Hwang et al in 2011 [7] studied 55 CT scans and found that the transverse diameter of the GPF in male is significantly larger than that of the female. Patil et al [8] in 2016 studied 123 dry skulls in which both the transverse diameter and AP diameters were significantly largerin males. But in our study only the transverse diameter in males was statistically significantly larger than that of the females. The anterior posterior diameters did not show any sexual predispositions in our study.

All the studies found the anteroposterior diameter of the GPF to be larger than that of thetransverse diameter.

Table 6 compares the position of the GPF in

various other studies with that of our present study.Saralya and Nayak [12] studied 132 unsexed skulls which reported that in 74.6% cases the GPF lies opposite 3rd molar. In the Brazilian population Chrcanovic and Custodio studied 80 human skulls found this position in 54.87% cases [4]. In our study we found in most of the cases the GPF lies medial to the anterior ½ of 3rdmolar tooth (42.7%). This incidence is almost same in both the sexes and the values were also statistically insignificant. These findings corroborate the result of various literature that suggest that the most common location of the GPF is medial to the 3rd molar tooth.

Table 7 illustrates and compares the direction of the GPF opening into the oral cavity in earlier studies with that of our present study. Saralya and Nayak [12] studied 132 skulls in the west side of southern India and inferred that in 49.2% cases the GPF opens antero-medially. Murali et al studied 137 skulls in south India and reported that in 49.7% cases the direction of opening of the GPF is Anteromedial [13]. In both the above studies the skulls were not separately studied for gender variations. Table no 1 details our study data where we found in 57.8% cases the direction is antero-medial, in 30.6% it is anterior and in rest 11.6% it is vertical. In no skull we could find the GPF opening antero-laterally or posteriorly.

Table 1 shows that the distance from GPF to MMS (DGM) on the left side (13.28±0.53 mm in males, 13.07±1.45 mm in females) and on right side (13.16±0.82mm in males, 12.88±1.34mm in females) having no statistical significance in the sexes. In Table No 8 DGM on both the sides and DGP are compared with studies from other authors. According to Patil et al 2016 [8] showed no statistical significance with regards to sexual dimorphism.

The distance of GPF from PBHP(DGP) in our study on right side is 5.22±0.67mm in males, 3.95±0.88mm in females and on left side it is 5.09±0.75mm inmales,3.53±0.96 mm in females .Both the sexes when compared showed statistical significant values(p-0.0001 on right side & p-0.0001 on left side). Gender wise shape difference of the GPF on either side has been studied by Lopes et al and Patil et al in. Table 9compares our data with these studies.

As shown in Table 1 in our study, the angle between MMS and the line joining the incisive foramen with the GPF was found on right side to be, 23.04±1.7mm in males, 23.76±1.94mm in females and on the left side, 22.69±1.33mm in males, 23.28±1.94mm.This angle formed was more acute in males, but we could not find any statistically significant gender predisposition in these data. Awareness regarding this angulation variations, will be helpful in various maxillofacial surgeries thereby reducing the number of attempts for introducing the anesthetic agents.

CONCLUSION

Clinicians require accurate assessment of the position of greater palatine foramen for giving posterior palatal anaesthesia. Our study found out that there is quite a lot of variations in the position of the GPF. Through these data comparison of the skulls of different regions and populations can be done. In the eastern Indian region it was found that the greater palatine foramen position is quite consistent and lies at about 3-4mm anterior to the posterior palatal border. Our study will help in establishing an anatomical parameter database in the eastern Indian population, which will be of immense help to the researchers in future. For maxillary nerve block procedure the needle could be inserted in smallest possible route by knowing the direction of opening of the greater palatine foramen. Hence the clinicians and the anesthetists need to be aware of all these variations for providing optimum anaesthesia during the vital surgical manoeuvres.

Conflicts of Interests: **None**

REFERENCES

[1]. Beetge M-M, Todorovic VS, Oettlé A, Hoffman J, van Zyl AW. A micro-CT study of the greater palatine foramen in human skulls. J Oral Sci.2018;60(1):516.

[2]. Nimigean V, Nimigean VR, Buþincu L, Sãlãvãstru DI, Podoleanu L. Anatomical and clinical considerations regarding the greater palatine foramen. Rom J Morphol Embryol. 2013;54(3 Suppl):779–83.

[3]. Aoun G, Nasseh I, Sokhn S, Saadeh M. Analysis of the greater palatine foramen in a Lebanese population using cone-beam computed tomography technology. J Int Soc Prev Community Dent. 2015 Dec;5(Suppl 2):S82-8.

[4]. Chrcanovic BR, Custódio ALN. Anatomical variation in the position of the greater palatine foramen. J Oral Sci. 2010;52(1):109–13.
[5]. Sharma NA, Garud RS. Greater palatine foramen—key to successful hemimaxillary anaesthesia: a morphometric study and report of a rare aberration. Singapore Med J. 2013 Mar;54(3):152–9.
[6]. Tomaszewska IM, Tomaszewski KA, Kmiotek EK, Pena IZ, Urbanik A, Nowakowski M, et al. Anatomical landmarks for the localization of the greater palatine foramen - a study of 1200 head CTs, 150 dry skulls, systematic review of literature and meta-analysis. J Anat. 2014 Oct 1;225(4):419–35.
[7]. Hwang SH, Seo JH, Joo YH, Kim BG, Cho JH, Kang JM. An anatomic study using three-dimensional reconstruction for pterygopalatine fossa infiltration via the greater palatine canal. Clin Anat. 2011 Jul;24(5):576–82.
[8]. Patil M, Sheelavant S. Greater palatine foramen-morphometry, sexual dimorphism and clinical perspective. Natl J Clin Anat. 2016;5(4):219–27.
[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 Apr 28;31(4):245–50.
[10]. Fu J-H, Hasso DG, Yeh C-Y, Leong DJM, Chan H-L, Wang H-L. The Accuracy of Identifying the Greater Palatine Neurovascular Bundle: A Cadaver Study. J Periodontol. 2011 Jul;82(7):1000–6.
[11]. Piagkou M, Xanthos T, Anagnostopoulou S, Demesticha T, Kotsiomitis E, Piagkos G, et al. Anatomical variation and morphology in the position of the palatine foramina in adult human skulls from Greece. J Craniomaxillofac Surg. 2012 Oct;40(7):e 206-10.
[12]. Saralaya V, Nayak SR. The relative position of the greater palatine foramen in dry Indian skulls. Singapore Med J. 2007 Dec;48(12):1143–6.
[13]. Murali P, Sundarapandian S, J MKS. Relative anatomical position of greater palatine foramen with reference to intraoral landmarks in south Indian population. Int J Anat Res. 2016;4(1):1912–5.
[14]. Lopes PTC, Vieira dos Santos AMP, Pereira GAM, Oliveira VCBD. Morphometric Analysis of the Greater Palatine Foramen in Dry Southern Brazilian Morphometric Analysis of the Greater Palatine Foramen in Dry Southern Brazilian Adult Skulls. Int J Morphol. 2011;29(2):420–3.

How to cite this article:

Sudeepa Das, Bikash Chandra Satapathy, Rajashree Biswal, Manoja Kumar Muni. MORPHOMETRIC STUDY OF THE GREATER PALATINE FORAMEN IN THE DRIED BONES OF EASTERN INDIA. Int J Anat Res 2018;6(3.2):5568-5573. **DOI:** 10.16965/ijar.2018.285