Parietal foramina in adult human skulls: an anatomical study

Anita Fating, Sudhir Pawar

Department of Anatomy, DVVPFs Medical College, Ahmednagar, Maharashtra, India

Abstract

Background: Emissary veins which passes through emissary foramens, being valveless allows bidirectional flow of blood and emissary foramens acts as pathway for transmission of infection.

Aim: Our aim was to find out the frequency of occurrence of parietal emissary foramina in adult human skulls and their distance from the sagittal suture and lambda.

Material and methods: 200 dried human skulls of unknown gender were examined carefully for presence or absence of parietal foramina, whether unilateral or bilateral, whether single or multiple. The distance of parietal foramina from sagittal suture and from lambda were measured with a divider and a measuring scale in mm. Obtained data was recorded. Mean and standard deviation were calculated and tabulated.

Results: Out of 200 skulls examined, parietal emissary foramen only on right side in 22.5%, only on left side in 24%, bilaterally in 36%, absence of parietal emissary foramen in 16.5% and presence of parietal emissary foramen on sagittal suture in 1% of skulls were observed. Presence of unilateral and bilateral parietal foramen were observed in 46.5% and 26% of skulls respectively. Out of 200 right parietal bones, single, double and absent parietal foramen were noted in 56.5%, 2% and 41.5%. Out of 200 left parietal bones, single, double and absent parietal foramen were noted in 59.5%, 0.5 % and 40%. The parietal foramina were found at a distance of 1mm-14 mm from sagittal suture and 16 mm-46 mm from lambda.

Conclusion: This study is very useful for radiologists and neurosurgeons for preventing accidental haemorrhage due to damage of parietal emissary veins.

Keywords: Parietal emissary foramina, sagittal suture, lambda, parietal emissary veins

Introduction:

The frequency of occurrence of the emissary foramina varies from individual to individual and not all of the emissary foramina can be found in every individual[1,2]. The parietal foramina are the openings in the skull vault which are located one on either side of the sagittal suture at the posterior aspect of the parietal bone[3]. Because of resemblance to the Greek symbol 'obelos' (÷) in which line represents the sagittal suture and the dots represent the bilateral parietal foramina, the name obelion is given to a bony point over sagittal suture which is just medial to the parietal foramina. Veins outside the cranium are connected by emissary veins to the intracranial venous sinuses and the foramina of the skull through which they traverse are known as emissary foramina[4]. Through valveless emissary veins blood can flow bidirectionally and serve an important function of equalizing intracranial pressure and can act as safety valves during cerebral congestion. Emissary veins are also considered as important for cooling of brain[5]. The parietal emissary veins connect the scalp veins with the superior sagittal sinus, parietal foramina transmitting these veins are usually found bilaterally on either side of sagittal suture approximately at the junction of posterior and middle third of parietal bone[4,6]. Loose areolar tissue, the fourth layer of scalp is considered as dangerous area of the scalp as it is traversed by emissary veins. The emissary foramina in human get involved in the pathways from which the infection is carried to the cranial cavity.[1] It is an attempt to find out frequency of occurrence of parietal foramina in adult human skulls and their distance from sagittal suture and lambda. This study is very useful for radiologists and neurosurgeons for preventing

Corresponding Author:

Anita Shriram Fating

Department of Anatomy, DVVPFs Medical College, Ahmednagar, Maharashtra, India

E-mail: aanujdeshmukh111@gmail.com

accidental haemorrhage due to damage of parietal emissary veins.

Material and Methods:

The observational study was conducted in the department of Anatomy after obtaining ethical acceptance. 200 intact adult human dried skulls of unknown gender and irrespective of age were observed after collection from bone bank and museum of department of Anatomy. Observations also made during routine osteology classes.

Inclusion criteria:	Adult intact skulls, irrespective of age and gender
Exclusion criteria:	Damaged skulls
	Skulls showing pathological lesions

All skulls were examined carefully for presence or absence of parietal foramina, whether unilateral or bilateral, whether single or multiple. To check patency of foramen a needle was probed into each foramen. The distance of parietal foramina from sagittal suture and from lambda were measured with a divider and a measuring scale in mm[6] No attempt being done to measure diameter of parietal foramina. Obtained data were recorded. Mean and standard deviation were calculated and tabulated using SPSS software [version 16.0].

Results:

Out of 200 skulls examined, the presence of parietal emissary foramen only on right side was observed in 22.5% of skulls [Fig 1], only on left side was observed in 24% of skulls [Fig 2], bilaterally in 36% of skulls [Fig -3], absence of parietal emissary foramen in 16.5% of skulls [Fig 4] and presence of parietal emissary foramen on sagittal suture was observed in 1% of skull [Fig 5] Presence of unilateral and bilateral parietal foramen were observed in 46.5% and 26% of skulls respectively. [Table 1]

Out of 200 right parietal bones examined, presence of single [Fig 6], double and absent parietal foramen were noted in 56.5%, 2% and 41.5% of right parietal bones. Out of 200 left parietal bones examined, presence of single, double [Fig 6] and absent parietal foramen were noted in 59.5%, 0.5 % and 40% of left parietal bones. [Table 2]

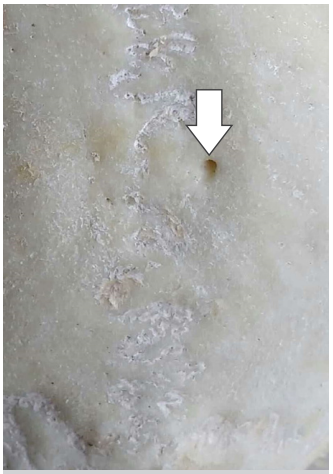

Fig 1: Presence of parietal foramen only on right side

Fig 2: Presence of parietal foramen only on left side

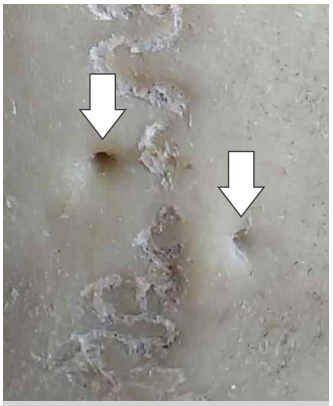

Fig 3: Presence of parietal foramina on both sides

Fig 4: Absence of parietal foramina

Fig 5: Presence of parietal foramen on sagittal suture

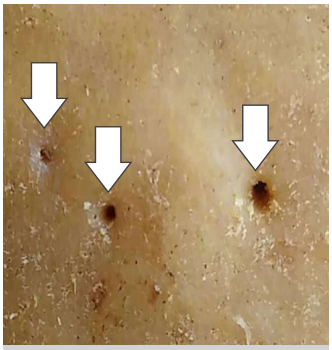

Fig 6: Presence of 2 parietal foramina on left side and 1 parietal foramen on right side

Table 1: Distribution of parietal foramen of skulls (n=200)

Number of skulls having parietal foramen only on right side	45(22.5%)
Number of skulls having parietal foramen only on left side	48(24%)
Number of skulls having bilateral parietal foramen	72(36%)
Number of skulls not having parietal foramen	33(16.5%)
Number of skulls having parietal foramen on sagittal suture	2(1%)
Number of skulls having unilateral parietal foramen	93(46.5%)

Table 2: Side-wise comparison of number of parietal foramen

Parietal bone	Right side (n=200)	Left side (n=200)
Single foramen	113(56.5%)	119(59.5%)
Double foramen	4(2%)	1(0.5%)
No foramen	83(41.5%)	80(40%)

Table 3: Side-wise comparison of distance of parietal foramen from sagittal suture and lambda

Parietal foramen	Right side (n=200)	Left side (n=200)
Distance from sagittal suture(Mean±SD)	6.286 ± 2.235	6.325 ± 2.066
Distance from lambda (Mean±SD)	32.748 ± 5.282	32.854 ± 5.426

P value for sagittal suture= 0.888, not significant

P value for lamboid suture= 0.877, not significant

The parietal foramina were found to be located at a distance ranging from 1mm-14 mm from sagittal suture on right side and 2 mm to 13 mm on left side. The distance of parietal foramen from lambda was ranged from 16 mm-46 mm. The data on distance of the parietal foramina from sagittal suture and lambda were statistically analysed using student 't'-test to find out the statistical difference between the parietal bones of two sides. No statistically significant differences ($p<.05$) was found between the parietal bones of two side. [Table 3]

Discussion

The location of the parietal emissary foramina are on either side of the sagittal suture coinciding with junction of the middle 1/3rd and posterior 1/3rd of the parietal bone. Frequency of its occurrence varies from 50%-80%[2,7,8]. The emissary foramina are less frequent in lower animals and in some species they are absent while it is considered as typical character in the human beings [1].

As per the observation of Boyd GI the unilateral parietal foramen is seen more common on the right side than the left (20.7%:15.2%)[1]. The prevalence of parietal foramen was shown to be higher by Murlimanju BV et al as compared to that of Yoshioka N et al.[7] and Boyd GI[1] studies. It may be due to racial variations and the study material used by Yoshioka N was different than us. The incidence of occurrence of parietal emissary foramina was different in various studies, it may be because of racial or ethnic variations (table 4). The difference in occurrence of the parietal foramen is due to difference in ossification process of the anterior fontanelle according to Yoshioka N et al.[7]

Table 4: Comparison of data about parietal foramen by various researchers

Name of Researchers	Year	Population group	Sample size	Unilateral	Bilateral	Absent
Boyd GI[1]	1930	British	1500 skulls	40.5	19.9	39.6
Yoshioka N[9]	2006	USA	20 adult cadavers	20	40	40
Murlimanju BV[8]	2015	South Indians	58 skulls	32.7	55.2	12.1
Rajpurohit GK[11]	2017	South Indians	20 skulls	25	40	20
Shantaram V[12]	2018	South Indians	78 skulls	18.59	37.18	44.23
Present study	2019	Maharashtrians	200 skulls	46.5	26	16.5

The distance of the foramen from the sagittal suture was ranged from 0.5 mm to 13 mm and 1 mm to 15 mm on the right and left side respectively as observed by Murlimanju BV[6] whereas, in the present study they were found to be located at a greater distance on right side as compared to left. In most of the studies distance of parietal foramen from lambda was not measured. The position of the parietal foramen in newborns was found to be 2 cm anterior to the lambda while in adults, this foramen was located 2-5 cm anterior to the external occipital protuberance as observed by Wysocki J et al. [10].

In the present study, presence of parietal foramen on

the sagittal suture was found to be in 1% while it was 5.9% and 3.4% in study by Boyd[1] and Murlimanju BV[6] respectively. Racial and geographical variations may be the reason for these differences.

An anastomotic vessel between the middle meningeal artery and extra cranial arteries were transmitted from each parietal foramen. A branch from anastomostic vessel between superficial temporal and occipital arteries was transmitted through parietal foramen and joined with a branch of middle meningeal artey in 55% of cadavers. An anastomosis between the middle meningeal artery and a small artery in the pericranium passing through the parietal emissary foramen had been observed in remaining cadavers (45%). These were the observations by Yoshioka et al[7] after studying 40 parietal regions from 20 adult cadavers. As in the present study dried skulls were used, we could not able to study the vessels passing through parietal foramina and their anastomosis.

The parietal foramina are larger in Australian and New Zealand people than the other races as reported by Boyd GI[1].The possibility of an enlarged parietal foramen should be kept in mind during the clinical examination and the surgical procedures.[6] Absence of parietal foramina is one of the reason for not developing intracranial complications in some of the cases inspite having severe scalp sepsis. [1]

The emissary foramina and the diploic veins of the skull, which are involved in the spread of infection from the extra cranial veins to intracranial sinuses shows important relationship. The infection at the diploic, meningeal and cerebral veins which communicate along with the emissary veins can cause possible complications of osteomyelitis of the cranial vault, meningitis and cerebral abscess.[1] In association with enlarged parietal foramina many pathological conditions like cerebral venous and cortical anomalies and skull fractures have been reported[11-13]. The present study is of immense help to the radiologists to differentiate parietal foramen from pathological conditions like lytic lesions and the burr holes caused by the neurosurgical procedures as parietal foramina usually have a well defined margin. To perform safe radical surgery detailed knowledge of the morphological variations in the foramina of the skull vault is vital.[14] The misinterpretation would lead to complications like bleeding and the treatment failure.

Conclusions: The present study has provided data about frequency and number of parietal foramina. It also provided information about distance of parietal foramina from sagittal suture as well as from lambda. Few researchers studied distance of parietal foramina with reference to sagittal suture and from lambda. The findings in the present study is useful for radiologists, neurosurgeons and anatomists.

Limitations: Sexual differences about parietal foramina could not be determined in the present study as the skulls of unknown gender were used.

Implications: The present study is useful for radiologists for proper interpretation of diagnosis, also it is useful for anatomist for research purpose.

Acknowledgement: Authors would like to thank Dr. Pritish Raut, Associate Professor of SPM for his assistance in statistical analysis.

References

1. *Boyd GI. The emissary foramina of the cranium in man and the anthropoids. J Anat. 1930;65:108-21.*
2. *Freire AR, Rossi AC, De Oliveira VC, Prado FB, Caria PH, Botacin PR. Emissary foramens of the human skull: anatomical characteristics and its relations with clinical neurosurgery. Int J Morphol. 2013;31:287-92.*
3. *Currarino G. Normal variants and congenital anomalies in the region of the obelion. AJR Am J Roentgenol 1976;127:487-94*
4. *Standring S. Skull and Mandible. In: Gray's Anatomy: Anatomical Basis of Clinical Practice Standing S (Ed). 39th International Edition, Elsevier Churchill Livingstone, Edinburgh. 2005. pp 461.*
5. *Mortazavi MM, Tubbs RS, RiechSI, Verma K, Shoja MM, Zurada [2] A, et al. Anatomy and pathology of the cranial emissary veins: a review with surgical implications. Neurosurgery. 2012;70:1312- 19.*
6. *Murlimanju BV. Saralaya VV, Somesh MS, Prabhu LV, Krishnamurthy A, Chettiar GK, et al. Morphology and topography of the parietal emissary foramina in South Indians: an anatomical study. Anat Cell Biol. 2015; 48:292-98.*
7. *Yoshioka N, Rhoton AL Jr, Abe H. Scalp to meningeal arterial anastomosis in the parietal foramen. Neurosurgery.2006; 58:58(1):123-26.*
8. *Wysocki J, Reymond J, Skarzyński H, Wróobel B. The size of selected human skull foramina in relation to skull capacity. Folia Morphol (Warsz). 2006;65:301-08.*
9. *Rajpurohit GK and Babu Y. Morphrmetric analysis of the emissary foramens of the skull. Int J Recent Sci Res. 2017;8(3):16227- 29.*
10. *Shantharam V, Manjunath KY.Anatomical study of parietal emissary foramina in human skulls. International Journal of Anatomy, Radiology and Surgery. 2018; 7(1): 11-14.*
11. *Reddy AT, Hedlund GL, Percy AK. Enlarged parietal foramina: association with cerebral venous and cortical anomalies. Neurology. 2000;54(5):1175-78.*
12. *Edwards LS, Sachs JR, ElsterAD. Skull fractures through parietal foramina: report of two cases. J Comput Assist Tomogr. 2012;36(3):308-09.*
13. *Agarwal P, Pandey M, Baranwal S, Roy K. Large midline persistent parietal foramina with occipital encephalocele and abnormal venous drainage. J Cleft Lip Palate Craniofac Anomal. 2015;2:66-69.*
14. *Berge JK and Bergman RA. Variations in size and in symmetry of foramina of the human skull. Clin Anat. 2001;14(6):406-13.*

Conflict of interest: Nil

Source of funding: Nil

Date of submission: November 25th 2020

Date of acceptance: January 12th 2021