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A Morphological Study on Parietal Foramina and its Clinical Importance

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Background: Parietal emissary foramina, located between middle third and posterior third of the parietal bone, are an important structure which the parietal emissary vein passes through. They act as the drainage passage of the brain, balancing the intracranial and extracranial pressure. They are one of the emissary foramina that is frequently neglected during brain surgery, massive bleeding can occur. The present study was conduted to observe morphological variations parietal foramen.

Materials and Methods: The present study conducted with 96(192 sides) adult dry skull, Only dry neat skulls and parietal bones were included in study. We have used magnifying lens and probes to observe foramen and to check their patency. We observed number of foramina on each side and distance from sagittal suture. The data was presented as Mean±SD and were tabulated.

Results: Single foramen on right side were 68(70.84%) skulls and left were 72(75%). Double foramen on right side were in 2(2.08%) skulls and left side were found in 3(3.12%). Triple foramen on right side were in 1(1.04%) skulls and left side were found in 2(2.08%). No foramen was found on right side were in 25(26.04%) skulls and left side were found in 19(19.80%). We have measured the distance from sagittal suture, on right side parietal foramen was found in 27 skulls in the range between 4.1 -6mm and left side in the same range found in 23 skulls. We found different other ranges also.

Conclusion: This study results may be helpful in practice of neurosurgery, trauma care, anatomy and anthropology.

Keywords: Parietal Foramen, Emissary vein, Scalp, Sagittal Suture.

Introduction

The parietal foramen is a small inconsistent opening located near the sagittal suture in the posterior part of the parietal bone. When it is present, the parietal foramen transmits an emissary vein and is therefore considered one of the emissary foramina of the cranium. Emissary veins drain the neurocranium as well as cephalic structures, and the parietal emissary veins connect the scalp veins with the superior sagittal sinus. Emissary foramina also share an important relationship with the diploic veins of the skull, which may act as a pathway for the spread of infections from the extracranial veins to the intracranial sinuses. Emissary veins transmitting through parietal foramen draining to the superior sagittal sinus, and occasionally a branch of the occipital artery also transmits through parietal foramen. The foramina are variably-present, and often absent. When both parietal foramina are present, the point along the sagittal suture that is intersected by an imaginary line connecting the two parietal foramina is called the obelion[1].

Emissary veins are valveless venous structures that connect the extracranial vessels of the scalp to the intracranial dural venous sinuses and diploic veins. The presence and distribution of the emissary veins vary from person to person, and during childhood, these venous structures are found more frequently and with larger foramina. The valveless nature of these vessels facilitates bidirectional blood flow, which allows for the equalization of intracranial pressures and selective cooling of the brain. During times of pathologically elevated intracranial pressure, the emissary veins may serve as 'safety valves.' Emissary veins may serve as essential sources of perioperative bleeding and thrombosis, as well as have the potential to provide a dangerous pathway for infection to reach deep intracranial structures. The emissary veins also facilitate the cooling of the brain during periods of increased temperature. While in the upright position, warm blood rises and is allowed to leave the intracranial structures and enter the extracranial circulation via their emissary passages. Upon reaching the extracranial circulation, the blood cools by evaporation occurring on the surfaces of the head. Under normal physiologic conditions, blood typically flows through the emissary veins in an extracranial to intracranial direction. However, due to the valveless nature of these vessels, the direction of blood flow may be reversed to equalize elevated intracranial pressures resulting from traumatic brain injury, cerebral congestion, jugular vein obstruction, and similar pathologies[2,3].

The emissary veins derive from the cerebral capillary venous plexus, which has three layers. The superficial layer of vessels drains the extracranial tissues, the middle layer forms the cerebral venous sinuses, and the deep layer forms the veins of the brain. The emissary veins persist as connections between the superficial and middle layers and may be visible as early as the third month of fetal development. When the embryo is no longer able to meet its respiratory, nutritional, and excretory needs, by simply spreading the nutritional fluids, it develops a system of vessels capable of distributing oxygen and nutrients to its tissues and transporting waste products. The venous system arises from the mesoderm[4,5,6].

Although many are variable, a few constant emissary veins include the vein of the foramen cecum, the mastoid emissary, condyloid, and occipital veins. Although these are rarely responsible for thrombosis of the dural sinuses in association with local inflammatory or infectious processes, the clinical significance is mainly surgical, for a large emissary, if opened and unnoticed during surgery, can entrain air embolism. Diploic veins form an interlacing channel through the diploic space, and again can act as emissary veins insofar as they can communicate the extracranial drainage with the dural sinuses. The meningeal veins drain the dura in roughly the distribution of the meningeal arteries. Small bridging veins, which extend from the cortical surface to the dura, are important in later life, when they are stretched, challenged, and as a result may rupture. This is thought to be the basis for the formation of chronic subdural hematomas seen in this population[7]**.** The present study was conducted to find morphological variations and topographical observations on parietal foramen.

Materials and Methods

The present study conducted with 96(192 sides) adult dry skull, which were collected from departments of Anatomy of multiple medical and dental inistitutions. All the skulls were examined carefully and identified the gender and separated, we found 52(104 sides) skulls as male and sides 44(88 sides) skulls as female[8]. We have observed right and left sides of all the skulls to observe parietal foramen. The skulls which were with pathological changes and damaged were excluded from study. Only dry neat skulls and parietal bones were included in study. All the skulls were examined carefully and the data were recorded. We have used magnifying lens and probes to observe foramen and to check their patency. The morphometric data of the present study was performed by vernier callipers. The data was presented as Mean±SD and were tabulated.

Results

In present study we observed 96 right side and 96 left side parietal foramen. We have recorded the number of foramina each side and noted the skulls with single foramen, double foramen, triple foramen and no foramen. Single foramen on right side were 68(70.84%) skulls and left were 72(75%). Double foramen on right side were in 2(2.08%) skulls and left side were found in 3(3.12%). Triple foramen on right side were in 1(1.04%) skulls and left side were found in 2(2.08%). No foramen was found on right side were in 25(26.04%) skulls and left side were found in 19(19.80%)(Table1 &Figure 1).

Parietal foramen distance was measured from sagittal suture and ranges were recorded. On right side parietal foramen was found in 6 skulls in the range between 0-2mm and left side in the same range found in 8 skulls. On right side parietal foramen was found in 12 skulls in the range between 2.1 - 4mm and left side in the same range found in 15 skulls. On right side parietal foramen was found in 27 skulls in the range between 4.1 -6mm and left side in the same range found in 23 skulls. On right side parietal foramen was found in 12 skulls in the range between 6.1-8mm and left side in the same range found in 16 skulls. On right side parietal foramen was found in 11 skulls in the range between 8.1-10mm and left side in the same range found in 8 skulls. On right side parietal foramen was found in 7 skulls in the range between 10.1-12mm and left side in the same range found in 6 skulls(Table 2).

Number of Parietal foramina	**Right side(n=96)**	**Left side(n=96)**
Single foramen	**68(70.84%)**	**72(75%)**
Double foramen	**2(2.08)**	**3(3.12%)**
Triple foramen	**1(1.04)**	**2(2.08%)**
No foramen	**25(26.04%)**	**19(19.80%)**

Table 1. Number of foramen in the parietal bones(Right and Left)(n=192)

Range	Right(n=75)	Left(n=77)
0-2mm	6(8%)	8(10.4%)
2.1-4mm	12(16%)	15(19.6%)
4.1-6mm	27(36%)	23(30%)
6.1-8mm	12(16%)	17(22%)
8.1-10mm	9(14.65%)	8(10.5%)
10.1-12mm	5(9.35%)	6(7.5%)

Table 2. Distance from sagittal suture (Range)

Figure 1. First skull without parietal foramen, second skull with bilateral foramina, third skull with single foramen.

Discussion

The parietal foramen of the skull is a variable anatomic feature with important implications for venous drainage, infection, and injury. Its topography is clinically relevant for neurosurgeons for intracranial navigation and preoperative planning. Knowledge of the anatomy, position, and presence of emissary veins during surgical procedures can prevent potential complications associated with accidental lesioning of emissary veins, including air embolism, significant bleeding, and venous thrombosis. Calvaria are formed by intramembranous ossification with the parietal bone forming via two ossification centres, located on either side of the midline, which eventually fuse. The formation of the PF, occurring initially as a single defect, is due to the prolonged ossification of the posterior parietal region of the skull leading to a 'V-shaped' notch known as the third fontanelle, or pars obelica. Thus, the defect persists as a small or oval foramen and the formation of the unilateral or bilateral foramina occurs as the third fontanelle closes [1]. In present study we observed the parietal foramen number on each side, distance from sagittal suture were observed. There were some studies which were similar to present studies, their finding was mentioned as follows.

In study of Shmarhalov A[9] conducted a cross-sectional observational study of parietal foramen with 42 random cadaveric adult human skull roofs. The results of this study were 85.7% (n = 36) of the calvaria had the parietal foramen, 54.8% (n = 23) had bilateral location of parietal foramen, 30.9% (n = 13) had unilateral presence of parietal foramen (right side: 23.8%, n=10 and left side: 7.1%, n=3), and 14.3 % (n = 6) demonstrated bilateral absence of parietal foramen. Al-Shuaili A et al[10] study on 440 head computed-tomography scans. The overall prevalence of parietal foramen was 72.3% (318/440). The bilateral presence of parietal foramen was identified in 34% of skulls. Unilateral right-side prevalence was 18.2%, while left prevalence was 13.2% (p = 0.62). The prevalence of unilateral accessory parietal foramen on the right side was 1.8%, while it was 1.1% on the left (p = 0.69). Parietal foramen within the sagittal suture/or intra-sutural PF was observed in 6.8% of skulls, with a frequency of 9.4% in men and 5.4% in women (p = 0.29). The diameter of the parietal foramen was 1.45 ± 0.74 mm on the right side, and 1.54 ± 0.99 mm on the left side (p = 0.96). There were 2% of incomplete parietal foramen. The parietal foramen was located over the SSS in 70.3% on the right side and 53.8% on the left side. No significant differences were observed between the parietal foramen topography parameters and sex or laterality.

The study conducted in 280adult dry skulls by Liu D[11] the total incidence of the parietal foramen was 82.86%, slightly higher on the right side than on the left side. The single-foramen type was the most prevalent. The mean diameter of the parietal foramen on the left and right sides were 1.02 ± 0.72 mm and 1.07 ± 0.67 mm, respectively, and the diameter of the parietal foramen on the sagittal suture was 1.77 ± 0.44 mm. The mean vertical distance between the parietal foramen and the sagittal suture was 5.90 ± 2.78 mm and 5.85 ± 2.75 mm on the left and right sides, respectively. The shape of the sagittal suture in the parietal foramen area was primarily dentate shaped, with an average arc length of χ = 124.36 ± 7.76 mm, of which the majority were completely healed type. The intracranial and extracranial communication was 39.97%, and the majority of the parietal foramen were anteromedial direction.

Naidoo J[1] study was conducted with100 dry adult calvaria to determine the frequency of parietal foramen, the diameter of the parietal foramen, as well as topography of the parietal foramen. They found a total of 32% of calvaria had parietal foramen present bilaterally; whilst 35% of calvaria had unilateral parietal foramen. The study also reports 5% calvaria in which parietal foramen were present on the sagittal suture. The mean diameter recorded was 1.55 mm (0.74-3.08 mm), and the mean distance between the lateral margin of the PF and the sagittal suture was 9.02 mm (4.44-18.20 mm). Murlimanju BV[12] study included 116 parietal reported the emissary foramen was present in 83 parietal bones (71.5%). It was present at the junction between the middle 1/3 and posterior 1/3 region of the parietal bone. The foramen was observed solitary in 73 parietal bones (62.9%), double in 8 bones (6.9%), and triple in 2 parietal bones (1.7%). The foramen was not observed in 33 parietal bones (28.4%). The bilateral absence of parietal emissary foramen was seen in 7 skulls (12.1%). It was absent unilaterally in 19 skulls (32.7%). The accessory foramina were seen in only 8 skulls (13.8%). The mean distance of the foramen from the sagittal suture was 6.7±2.9 mm and 6.8±2.8 mm on the right and left sides respectively. The prevalence of parietal emissary vein in the present study was 71.5%. Our present study results also similar to previous studies mentioned above.

Conclusion: An anatomical variation in parietal foramen is not uncommon. It is important to have detailed information on anatomical variations in different population groups to facilitate surgical and radiological interventions. The morphological characteristics and distribution of

PF reported in this study have clinical implications for imaging diagnosis, intracranial navigation of vascular disorders, and treatment.

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