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Original Article

Anatomic characteristics of foramen vesalius

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Abstract
Objectives: Foramen Vesalius is an inconstant foramen that gives passage to an emissary vein that connects pterygoid venous plexus with cavernous sinus, the importance of which lies in the fact that an infected thrombus from an extracranial source may reach cavernous sinus. This study presents some data on characteristics of foramen vesalius. **Methods:** We studied 70 sides of 35 dried adult human skulls available in the Department of Anatomy, Manipal College of Medical Sciences, Pokhara, Nepal. Variation in number and incidence of foramen Vesalius were noted. Differences between the right and the left side and between the male and the female sex are discussed. **Main Findings:** Foramen Vesalius was present in 23 sides (14 right, 9 left) out of the 70 sides observed, the incidence being 32.85% (20.0% right side, 12.85% left side) of all the sides observed. Incidence of bilateral and unilateral foramen vesalius was 22.85% (8 out of 35 skulls) and 20% (7 out of 35 skulls) respectively. Foramen vesalius was found in 10 sides in males and in 13 sides in females. No remarkable differences were observed in the incidence of foramen vesalius between the sides within same sex but the incidence was more in females compared to male skulls. **Significance of findings:** Anatomic variations of the foramen vesalius could be explained by developmental reasons. Knowledge about characteristics of foramen vesalius and its incidence is not only important for anatomists but equally essential for an operating surgeon.

Key words: foramen vesalius, skull, anatomical variation.

Foramen Vesalius is a small, variable and an inconstant foramen located anteromedial to the foramen ovale and lateral to the foramen rotundum and vidian canal[1]. This foramen is also known as emissary sphenoidal foramen. It opens below and lateral to scaphoid fossa[1]. It transmits an emissary vein, "Vein of Vesalius", through which the cavernous venous sinus and pterygoid venous plexus communicate. Lang reported that a small nerve (nervoulus sphenoidalis lateralis) may also pass through foramen into cavernous sinus[2]. The sphenoidal emissary foramen may transmit accessory meningeal artery in 20% of cases[3]. According to Gray's anatomy, emissary sphenoidal foramen exists on one or both sides in 40% skulls[1]. On wide review of literature, very few reports were found on the incidence of foramen Vesalius. Therefore, to establish some data on the incidence of foramen Vesalius we conducted this study.

Material and Methods

Thirty-five dry, adult skulls were considered for the present morphometric study. These skulls were obtained from preserved sets of bones, received at Department of Anatomy, Manipal College of Medical Sciences, Pokhara, Nepal. Of these 35 skulls, 22 were from male sex and 13 were from female sex. To identify presence of foramen vesalius, the posterior part of greater wing of sphenoid was examined for presence of any foramen between foramen rotundum and foramen ovale. Patency was confirmed by inserting a bristle through each probable foramen. Skulls in poor conditions or skulls with partly broken surroundings of foramen were not considered. The incidence of foramen vesalius was noted. Numeric variation in right and left sides and variation according to sex was calculated.

Observations

Present study was conducted on a total of 70 sides of 35 dry adult skulls (Male: 22, Female: 13). Foramen Vesalius was present in 23 out of 70 sides observed (14 right, 9 left) incidence being 32.85% (20.0% right, 12.85% left) of all the sides observed (Table-1). In 47 out of 70 sides (67.15%) this foramen was absent.

Out of the 23 sides in which this foramen was observed, in 16 sides of 8 skulls this foramen was bilateral (8 right, 8 left) and in 7 sides of 7 skulls it was unilateral (6 right, 1 left). Incidence of bilateral foramen vesalius was 22.85% (8 out of 35 skulls) and incidence of unilateral foramen vesalius was 20% (7 out of 35 skulls). In none of the cases foramen vesalius appeared to be confluent with foramen ovale.

The presence of foramen vesalius, whether unilateral or bilateral, was noted in 42.85% (15 out of 35 skulls, Bilateral in 8, Unilateral in 7) of the skulls. It was totally absent in 57.15 % (20 out of 35) skulls.

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Foramen Vesalius was found in 10 sides in males (n=44 sides of 22 skulls) and in 13 sides in females (n=26 sides of 13 skulls). Out of these 10 sides in males, 6 sides i.e. in 3 skulls it was present bilaterally and in 4 sides i.e. in 4 skulls, it was present unilaterally (3 right, 1 left). Out of 13 sides in females, in 10 sides of 5 skulls it was bilateral and in 3 sides of 3 skulls, it was unilateral (3 right, 0 left) (Table-1).

Fig 1. Photograph showing a well-formed foramen Vesalius situated on left side, medial to foramen ovale in the middle cranial fossa (inset: zoomed + arrow).

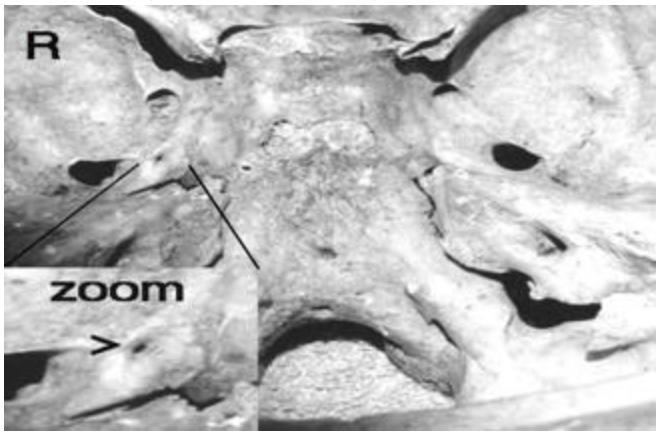

Table 1 Side-wise and Sex-wise incidence of Foramen Vesalius

Distribution ?	Sides Examined?	Right Side	Left Side	Total Skulls (n=35)
Unilateral	Male (n=22)	3	1	7 (20%)
	Female (n=13)	3	0	
Bilateral	Male (n=22)	3		8 (22.85%)
	Female (n=13)	5		
Total Foramen Noticed		14	9	15

Discussion

Foramen vesalius is an inconstant foramen located between the foramen rotundum and foramen ovale. It is situated in the posterior part of greater wing of sphenoid at the transition zone between intracranial and extracranial structures. Vesalius in his famous book, *"De humani corporis fabrica*" describes this foramen with uncommonly subjective language, "because one skull more elegant than the others, belonging to a man of middle age by far the most handsome I have ever seen, displays this foramen"[4].

Developmentally most of the central skull base bones are preformed in cartilage and then ossify by the process of endochondral ossification with a small contribution from membranous bone. At 11 weeks 5 days the entire skull base is preformed in cartilage and then ossification of skull base progresses in an orderly pattern from posterior to anterior. The sphenoid bone is formed by postsphenoid and presphenoid centres that appear at 14 weeks and 17 weeks respectively with a contribution from orbitosphenoid and alisphenoid centres that appear at 16 weeks and 15 weeks respectively[5]. The greater wings are formed from alisphenoid centres. Moreover, it has been shown that the foramen of Vesalius represents the site of fusion between the membrane bone and medial cartilaginous, ala temporalis[6].

The importance of this foramen lies in the fact that it gives passage to vein of Vesalius, an emissary vein. Emissary veins are those which link the intracranial venous sinuses with veins outside the cranial cavity. They pass through the potential space between galea aponeurotica and pericranium. They are of importance in that they are channels along which infected thrombus can reach the interior of cranial cavity from outside it[7]. Since emissary vein passing through foramen vesalius connects pterygoid venous plexus with cavernous sinus, the infected thrombus may reach cavernous sinus.

Surgical importance of foramen Vesalius lies in the fact that during percutaneous trigeminal rhizotomy, needle insertion through the Vesalius foramen (anteriorly and medially to the foramen ovale) the cavernous sinus puncture may occur and has been described in eight cases, with one temporal lobe haematoma reported[8,9]. Sindou, et al. reported a "false path" in 10 of 200 similar procedures: two in the carotid artery canal, one in the jugular foramen, and seven in the Vesalius foramen[9]. According to Lanzierieri et. al., the foramen Vesalius is usually symmetric and asymmetry of the foramen Vesalius can be seen on invasion by nasopharyngeal melanoma, angiofibroma, carotid cavernous fistula with drainage through the emissary vein[10]. Therefore, the knowledge about the symmetry and incidence of foramen Vesalius is not only important from the anatomical point of view but is also essential for the operating surgeon.

In the present study, foramen Vesalius exists in 23 sides of 15 skulls out of 70 sides of 35 skulls examined, the incidence being 32.85%. According to Gray's anatomy, emissary sphenoidal foramen exists on one or both side in 40% skulls[1]. According to a study conducted on Japanese skulls, 21.75% skull (87 out of 400 skulls) had foramen Vesalius, which is less frequent than the present study[11]. Both Bergman and Lang mentioned in separate studies the frequency of foramen vesalius to be 40%, which is more than what was found in the present study[2,3].

According to Vesalius "it is rarely seen in one side of the skull, and much more rarely still on both sides"[4]. In the present study in 22.85% of the skulls, the foramen was present bilaterally. It was present unilaterally in 20% of the skulls (7 out of 35 skulls) out of which 6 were on right and 1 on left side (Table-1). Bergman reported presence of this foramen bilaterally in 17% cases and unilaterally in 13% cases[3]. According to a study conducted in Japanese population, 21.75% had foramen Vesalius, bilateral in 75.36% males, 72.22% females and unilateral in 24.64% males, 27.78% females[11]. Ginsberg and his associates in their study by high resolution CT reported unilateral presence of foramen vesalius in 80% cases[12]. According to the present study and the various previous reports, incidence of bilateral foramen Vesalius is more than unilateral foramen in individual skulls.

Amongst 23 sides in which this foramen was present, 22.7% was in male skulls and 50% in female skulls, i.e. the incidence being more in females. Although according to previous Japanese study[11] no remarkable difference was observed in the ratio between the male and female.

Vesalius in his famous book, "*De humani corporis fabrica*" mentions no remarkable difference was observed between left and right sides[4]. In the present study, we observed in 20.0% skulls it was present on right side and in 12.85% skulls it was on left side of all sides examined. Though this foramen was more frequently observed on right side no significant difference in the frequency of the foramen was observed. Lang reported presence of this foramen in 49% skulls on right side and in 36% on left side[2]. In both of these studies the incidence of the foramen was more on right side. On the other hand, according to Kodama in a Japanese study, no remarkable difference was observed between right and left sides[11]. Variation in foramen Vesalius can be explained by developmental reasons[5,6].

In conclusion, though foramen vesalius is not seen in all the individuals but when present, it is very unlikely to misinterpret a normal well formed foramen as abnormal. It is also important to recognize the variations of a normal foramen and its related neurovascular anatomy due to its significant implications for neurosurgery.

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