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Study of posterior condylar foramen in dry human skulls

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Abstract

Introduction: Posterior condylar foramen is the most constantly present emissary foramen in human skull. It is also considered as largest emissary foramen present in humans. Of the two large emissary veins of posterior cranial fossa, one of them i.e. posterior condylar vein passes through posterior condylar foramen. Condylar veins are also important channels of venous drainage for posterior cranial fossa region. Emissary veins are important in equalising intracranial pressure. They can act as safety valves in cerebral congestion.

Method: Material for this study consists of 100 dry adult skulls obtained from two teaching institutes in Maharashtra state. These skulls were carefully observed for posterior condylar foramen. Whether foramen was present unilaterally or bilaterally or was absent on both sides was noted.

Result: Posterior condylar foramen was present on both sides (bilaterally) in 58 skulls. In 15 skulls it was present only on right side where as in 10 skulls it was present only on left side. Foramen was found to be absent on both sides in 17 skulls. When present unilaterally it was more common on right side than left.

Conclusion: Posterior condylar foramen was not only important from anthropological point of view but also important for clinicians and surgeons who deal with posterior cranial fossa region. Condylar vein (posterior) and posterior condylar foramen (canal) both are important surgical landmarks for different skull base approaches described. Enlarged posterior condylar canal can be wrongly interpreted as pathological condition in certain radiological procedures like MRI.

Keywords: Emissary Vein, Posterior Condylar Foramen, Posterior Condylar Vein, Variation, Posterolateral Approach.

Introduction

Emissary veins pass through emissary foramina present in the cranium. They connect dural venous sinuses present inside the cranium to veins present outside (extracranial veins). Some emissary veins are more commonly present while others are rarely found. Emissary veins are important clinically because infections from outside cranial cavity can spread to dural venous sinuses. For example infection can spread from mastoid to sigmoid sinus or from paranasal sinuses to cavernous sinus. A posterior condylar emissary vein connects sigmoid sinus and veins in the suboccipital triangle via posterior condylar canal. An occipital emissary vein usually connects the confluence of sinuses with occipital vein through occipital protuberance. These emissary veins provide an alternative venous drainage when internal jugular vein is blocked or tied.(1) Occipital condyles are convex surfaces covered with hyaline cartilage. They lie at front half of the foramen magnum. Their posterior poles are separated by the diameter of foramen magnum, but their anterior poles are much closure together. Behind the condyle is a shallow fossa floored by thin bone. This fossa shows perforation by posterior condylar canal. It (posterior condylar canal) carries vein from the sigmoid sinus to the suboccipital venous plexus.(2) Two major emissary veins in the region of posterior cranial fossa are occipital vein and posterior condylar vein. Posterior condylar vein connects different venous sinuses within cranium like sigmoid sinus or occipital sinus or marginal sinus to internal vertebral venous plexus. Posterior condylar vein passes through posterior condylar foramen. Posterior condylar foramen is the largest emissary foramen present in retromastoid region. Because these veins are valveless, they allow the blood to flow in both directions in and out of cranial cavity (bidirectional flow) thus also acting as one of the mechanism for cooling of brain. In upright position they act as primary channels of venous drainage.(3) Emissary foramina are less common in lower animals than in Man. In the human skull all three pairs of foramina may be present (parietal, mastoid and condyloid); in lower animals there may be two pairs of foramina, but usually there is only one (single or paired). In Felidae, Proboscidae and Rodents there are no emissary foramina at all. Anthropoids show transitional stage from mammals below them to venous drainage system found in man. Simians approximate human system. Whereas Gorillas show tendency towards parietal foramen, chimpanzees show tendency towards parietal as well as condylar foramen. The condylar foramen, which is the largest and most constant of all the foramina in Man, is even more infrequent in lower animals than the parietal foramen.(4) Posterior condylar vein, emissary vein passing through posterior condylar foramen and posterior condylar foramen both are important surgical landmark for transcondylar fossa approach (also described as supracondylar transjugular approach). Drilling of condylar fossa is most important part of this approach. Occipital condyle and jugular tubercle can be differentiated from outside with the help of posterior condylar canal and posterior condylar vein as anatomical landmarks during this approach. Transcondylar fossa

approach is most favoured approach for lesions which are in front of medulla.[5] Veins other than jugular can be classified into those within spinal canal (intraspinal) and outside spinal canal (extraspinal). It is assumed that extra jugular pathways of veins have more cross sectional area than that of both internal jugular veins together. Total volume capacity of extrajugular veins can be up to 1 litre which can be sufficient to carry whole venous drainage of brain. Posterior condylar vein is important in this aspect as it is the main connecting channel between dural venous sinuses within cranium to extrajugular system of veins.[6] Posterior condylar canal can be wrongly interpreted as pathological entity despite being present as normal structure in some healthy peoples. Sometimes a prominent posterior condylar canal can be mistaken as neuroma particularly in magnetic resonance imaging with contrast enhanced feature. Venous anastomosis involving prominent posterior condylar vein provides alternative channel of venous drainage and may possibly give false positive Queckenstedt's test.[7] At the age of latter half of 3rd fetal month, condylar emissary veins, both anterior and posterior are easily discernible. Anterior condylar emissary vein usually appears first and receives blood from developing sigmoid sinus and marginal sinus. It traverses through hypoglossal canal and drains into vertebral or paravertebral veins. Appearance of anterior condylar vein is followed by emergence of posterior condylar emissary veins which pass through posterior condylar foramen. At 5 months' gestation, these emissary veins become even larger and are seen on posterior aspect of mastoid (mastoid emissary veins) and along the foramen magnum (condylar emissary veins). At the 6th to 7th fetal month, the condylar emissary veins connect the sigmoid sinus and/or the marginal (occipital) sinus with the vertebral, paravertebral, and/or deep cervical veins.[8] In multidetector row computed tomography (MDCT) study by Tanoue S[9] et al, posterior condylar canal showed two variation in the pattern of how it passes through occipital bone. In one pattern, posterior condylar canal passed from sigmoid fissure through occipital bone to occipital condyle forming entire canal. In the other pattern, posterior condylar canal passed through occipital bone and was exposed to its intracranial surface.[9]

Material and Methods

The material for this study consisted of 100 dry human skulls. The material was obtained from two teaching institutes in the state of Maharashtra (40 skulls from one and 60 from other). Nothing is known about antecedents regarding, community, caste, social status etc., of the specimens. Owing to the difficulty in accurate sexing of skull, no such attempt has been made. It is not unlikely that significant proportion of female skulls may have been included in this study. Skulls showing gross asymmetry or deformity particularly involving foramen magnum and occipital condyle region were rejected as unsuitable. Posterior condylar foramen is canal which is bent and it is sometimes very difficult to assess whether posterior condylar foramen is complete or not. When posterior condylar foramen was present only as pit or small blind canal, it was recorded as absent. Posterior condylar foramen was observed for its presence on one or both sides and whether it was absent on both sides.

Result

Correct identification of posterior condylar canal is important in computed tomography (CT) or magnetic resonance imaging (MRI) studies as posterior condylar canal can be wrongly interpreted as tumour of jugular fossa region or as lymph node which is enlarged. Sometimes large canal can be mistaken for anomalous blood vessel. Posterior condylar canal sometimes transmit ascending pharyngeal branch. Knowledge of posterior condylar canal is also important to surgeons operating in posterior cranial fossa region.

In present study 100 skulls were carefully observed. Posterior condylar foramen was present bilaterally in 58% (58 out of 100 skulls). It was present unilaterally on the right only in 15 skulls (15%). Unilateral left sided foramen was found in 10 skulls (10%). It was absent on both sides in 17 skulls (17%).

Discussion

In embryonic period, condylar vein is an important part of venous circulation of posterior cranial fossa region. It connects intracranial veins to extracranial venous system. During transition from fetal circulation to circulation after birth, some of the veins undergo atrophy, as the gradual changes occur. This atrophic change is accompanied by closure of venous bony canals, which however persist unilaterally in around 70% of adult human skulls.[10] The posterior condylar vein shows three anatomical variations regarding its course, described as type A, B and C. In type A (found in 75%), the posterior condylar vein originates from inferomedial side of sigmoid sinus and pass through occipital bone forming posterior condylar foramen to drain into the suboccipital cavernous sinus. In type B (found in 21%), posterior condylar canal was exposed to intracranial surface of occipital bone. In type C (found in 4%), posterior condylar vein started from anterior condylar confluence and drained into suboccipital cavernous sinus.[9] Role of emissary vein is limited when normal channels of venous drainage are patent. But vein normal channels are obliterated as in jugular vein thrombosis, these accessory channels provides important alternative pathways for venous drainage.[7] In patient with achondroplasia and complex craniosynostosis, venous imaging has confirmed the presence of obstruction at the level of skull base, especially, jugular foramen. In these situations, emissary veins, especially the posterior condylar veins, become important mechanism of venous drainage. Failure to appreciate this fact can lead to fatal complications if these venous channels are obliterated during surgery.[11]

Table 1: Comparison with previous studies (in %)

Study	Bilateral	Right	Left	Absent
Ginsberg LE	55.9	9.8	9.8	26.5
Boyd G I	46.6	16.5	13.8	23.1
Muthukumar et al[12]	20	32	8	40
Present study	58	15	10	17

In the study conducted on 34 gross skulls, Ginsberg LE[7] found posterior condylar canal to be present bilaterally 19 skulls (55.9%). In 6 skulls (17.6%), posterior condylar canal was present on one side only (unilateral). Unilateral distribution was equal on right and left side on gross examination study. Posterior condylar canal was found to be absent in 26.5%. On CT examination study conducted by same author, posterior condylar canal was identified in 81% (94 out of 116 patients), of which in 31% (36 of 116 patients) it was bilateral and 50% (58 out of 116) it was unilateral. In unilateral cases, posterior condylar canal was more common on left side (28.4%) than right side (21.6%). Posterior condylar canal cannot be detected in 20% cases.[7]

Boyd G[4] found posterior condylar foramen to be present on both sides in 46.6% of skulls, a higher percentage than in the case of any other foramen. It is absent on both sides in only 23.81 percent. In unilateral cases, posterior condylar foramen was more common on right side (16.5%) than on left side (13.88%). Posterior condylar foramen was the largest emissary foramina of all, with its bore varying from 1 to 2 mm. It was less than 1 mm. in only 10% of cases and in 15 % is more than 2 mm. Bore was somewhat wider on the right side as the right transverse sinus is larger on right side.

In 50 dry skulls studied by Muthukumar et al.[12] condylar canal was present in 60% of the skulls studied. The condylar canal was absent on the right side in 4 skulls and the left side in 16 skulls.

In present study, posterior condylar foramen was more common on right side than left as it was found in the study by Boyd. Explanation for more right side occurrence is that right side venous system has more straight connection with heart so the more chances of finding emissary foramen on that side.[13]

Neurosurgeons need to be careful during suboccipital craniotomy as occipital sinus and condylar veins serves function of collateral pathways in occlusive disease of veins. Multidetector row CT images with contrast enhancement are useful to evaluate relation between craniocervical junction veins and bony structures.[9] Condylar veins can also be used as access route to dural arteriovenous fistulas involving hypoglossal canal and transverse- sigmoid dural arteriovenous fistulas with occlusion of jugular vein. Condylar vein itself can be involved in arteriovenous fistula.[14,15] So understanding of normal anatomy and variations of posterior condylar vein and foramen are of clinical importance while considering endovascular treatment for arteriovenous fistulas of posterior cranial fossa region.

Conclusion

Infection of the cranial cavity may pass by lymphatic, by sheaths of cranial nerves, by emissary veins or by direct continuity of spread through bone. Well-known aphorism of Treves states, "If there were no emissary veins, injuries and diseases of the scalp would lose half their seriousness." The emissary veins are important agents in equalising intracranial pressure, and in conditions of cerebral congestion it would appear that they can act as safety valves. An enlarged emissary foramen must be differentiated from other deficiencies of skull cap. In an approach to cerebellar fossa serious haemorrhage may occur at condylar emissary foramina.[4]

As posterior condylar canal is commonly present its recognition is important to understand alternative pathways of venous drainage and to avoid confusion during imaging studies such as magnetic resonance imaging and computed tomography. Wrong interpretation of posterior condylar canal as jugular glomus tumour can result in unnecessary surgical intervention.[7] Posterior condylar foramen, posterior condylar emissary vein and occipital emissary vein are important structure for posterolateral surgical approach to foramen magnum region.[16] Posterior condylar vein which passes through posterior condylar foramen forms an important pathway for alternative venous drainage when normal route through sigmoid-jugular complex is impeded. In far lateral transcondylar approach, extensive dissection of paravertebral muscles is done and it may lead to injury to vascular structure of the region.[17]

Posterior condylar foramen is one of the largest emissary foramen present in human skull. It transmits posterior condylar vein, one of the major emissary vein of posterior cranial fossa region. It was found to be present in up to 83% in the present study. Occurrence of posterior condylar foramen ranges from 60%-80% in different studies done, making it one of the constant foramen present in posterior cranial fossa region. While considering surgical or endovascular treatment of skull base diseases, knowledge of anatomical relationship and variation of posterior condylar foramen and posterior condylar vein is necessary. Knowledge of these structures is also important while making radiological diagnosis. We are hopeful that this study will be helpful to clinicians and surgeons dealing with the region of posterior cranial fossa.

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