

ORIGINAL PAPER

Duplication of falx cerebelli, occipital sinus, and internal occipital crest

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Abstract

The incidence of variations of falx cerebelli was studied in 52 adult cadavers of south Indian origin, at Kasturba Medical College Mangalore, after removal of calvaria. In eight (15.4%) cases, we observed duplicated falx cerebelli along with duplicated occipital sinus and internal occipital crest. The length and the distance between each of the falces were measured. The mean length of the right falces cerebelli was 38 mm and the left was 41 mm. The mean distance between these two falces was 20 mm. No marginal sinus was detected. Each of the falces cerebelli had distinct base and apex and possessed a distinct occipital venous sinus on each attached border. These sinuses were noted to drain into the left and right transverse sinus respectively. After detaching the dura mater from inner bony surface of the occipital bone, it was noted that there were two distinct internal occipital crests arising and diverging inferiorly near the posterolateral borders of foramen magnum. The brain from these cadavers appeared grossly normal with no defect of the vermis. Neurosurgeons and neuroradiologists should be aware of such variations, as these could be potential sources of hemorrhage during suboccipital approaches or may lead to erroneous interpretations of imaging of the posterior cranial fossa.

Keywords: falx cerebelli, occipital sinus, duplication, accessory falx, internal occipital crest.

Introduction

The falx cerebelli is a small crescentic fold of dura mater below the tentorium cerebelli, which projects forward into the posterior cerebellar notch. Its base is directed upwards and attached to the posterior part of the inferior surface of the tentorium cerebelli in the midline; its posterior margin is attached to the internal occipital crest and contains the occipital sinus; the apex frequently dividing into two small folds which disappear at the sides of foramen magnum [1].

The occipital sinus is the smallest of the sinuses, lies in the attached margin of the falx cerebelli, occasionally paired [1]. The two sinuses, lying along the attachment of the falx cerebelli, are often fused into a single trunk. Around the margins of the foramen magnum the sinuses communicate with the internal vertebral plexuses and ends in the confluence of sinuses. The occipital sinus receives tributaries from the cerebellum and medulla and drains the choroid plexus of the fourth ventricle [2].

A prominent internal occipital crest descends from the internal occipital protuberance, for attachment of the falx cerebelli, and bifurcates near the foramen magnum; the occipital sinus, sometimes double, lies in the attachment [1].

The falx cerebelli, which may be divided inferiorly to create a V-shaped space, the so-called vermian fossa [3]. The variations of the dura mater and its folds are seldom reported in the literature [4, 5]. Among these are duplication of the hemispheric convexity dura [6] duplication of the spinal dural sheath [7], presence of an

accessory falx cerebri [8], and duplicated, fenestrated or small falx cerebelli [4, 5, 9–12].

Hassan M and Das AC, 1969 [13] found that the falx cerebelli was double in 76 of 100 cadavers. For these variations are often asymptomatic and only incidentally found during human dissection. However, they may be part of more complex intracranial abnormalities such as agenesis of the corpus callosum [6], arachnoid cyst [10], Chiari II malformation [12] and vermian agenesis [11]. The dura mater and its partitions are observed at approximately the 14th gestational week [4, 5, 10]. The developing nervous system induces the formation of the dura mater from surrounding mesenchymal cells [14].

As the formation of the intradural venous sinuses is concurrent with development of the dural folds, any alteration in the morphology of the dural folds may potentially be associated with variations of the venous sinuses. In this study, we present duplicated falx cerebelli associated with a duplicated occipital sinus and internal occipital crest.

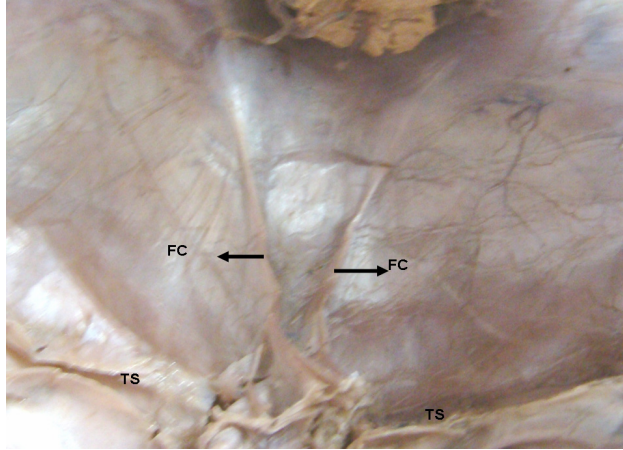
Material and Methods

During routine dissection of the head region of the 52 adult cadavers of South Indian origin, at Kasturba Medical College, Mangalore, after removal of calvaria, in eight cases we observed duplicated falx cerebelli along with duplicated occipital sinus and internal occipital crest.

The length and the distance between each of the falces were measured.

☐ Results

In eight cases (15.4%), the duplicated falces cerebelli were found. The mean length of the right falces cerebelli was 38 mm and the left was 41 mm. The mean distance between these two falces was 20 mm. No marginal sinus was detected. Each of the falces cerebelli had distinct base and apex and possessed a distinct occipital venous sinus on each attached



border. These sinuses were noted to drain into the left and right transverse sinus respectively. After detaching the dura mater from inner bony surface of the occipital bone, it was noted that there were two distinct internal occipital crests arising and diverging inferiorly near the posterolateral borders of foramen magnum. The brain from these cadavers appeared grossly normal with no defect of the vermis (Figures 1–3).

Figure 1 – Case no. 1a. Falx cerebelli: The interior of cranial cavity showing dura mater intact. The duplicated falx cerebelli (FC) is shown with arrows. The transverse sinus (TS) is also marked in the figure.

Figure 2 – Case no. 1b. Internal occipital crest: The interior of the cranial cavity is shown after pulling apart the dura mater. The prominent duplicated internal occipital crest (IOC) as well as the internal occipital protuberance (IOB) is seen in the figure.

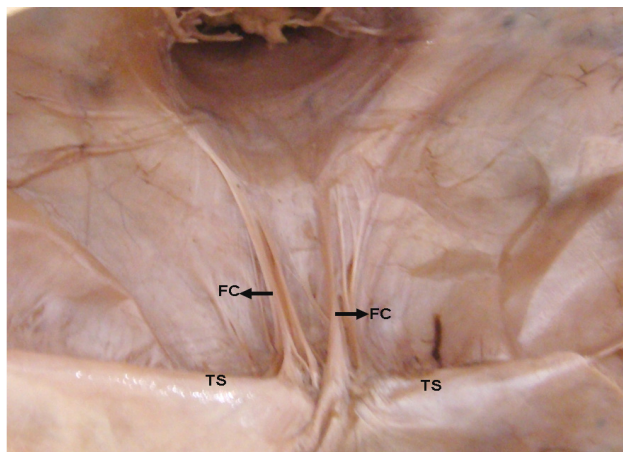
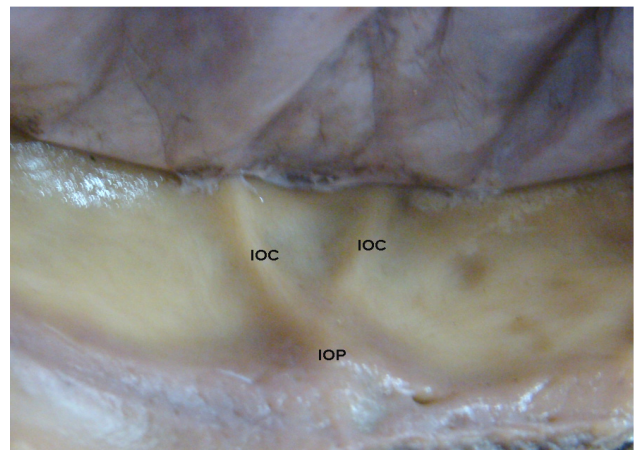


Figure 3 – Case no. 2. Falx cerebelli: The interior of cranial cavity showing dura mater intact. The duplicated falx cerebelli (FC) is shown with arrows. The transverse sinus (TS) is also marked in the figure.

☐ Discussion

The falx cerebelli is a sickle-shaped dural fold that usually harbors a single occipital venous sinus at its posterior attachment. There is usually only one midline-located falx cerebelli, which may be divided inferiorly to create a V-shaped space, the so called “vermian

fossa”. Normally, the falx cerebelli is between 2.8 and 4.5 cm in length and is approximately 1–2 mm thick [3].

Following the literature, Hassler and Schlenker (1982) [10], has reported duplicated falx cerebelli. Shoja MM *et al.* (2007) [15] has reported separate cases of duplicated falx cerebelli and triplicate falx cerebelli and aberrant venous sinus. In one case of duplicated falx

cerebelli the falces were larger in size, reaching a maximum width of 25 mm and there were two occipital sinuses draining into the ipsilateral transverse sinus as well as two distinct internal occipital crests. Compared to the above case, our study shows still larger right 38 mm and left 41 mm length falces cerebelli.

In another case, Shoja MM *et al.* (2006) [5] found a duplicated falx cerebelli associated with a constellation of other intracranial variations such as a Menefle type I accessory middle cerebral artery, a duplicated anterior communicating artery and a persistent intracranial (olfactory) artery. Hassler W and Schlenker M (1982) [10] reported a midline posterior fossa arachnoid cyst with a falx cerebelli on either side.

Loughenbury PR *et al.* (2005) [7] reported the duplication of the spinal dural sheath from C2 to L5. However, their case involved an arachnoid cyst between the two falces cerebelli and no mention was made of the occipital sinus.

Duplicated occipital sinuses have been reported in the literature. The occipital sinus varies markedly in its size, however, and may have an aberrant course; it is therefore always a potential source of difficulty in posterior approaches to the fossa. While this sinus can usually be ligated and divided with ease in a bilateral or midline approach to the contents of the posterior cranial fossa, it is sometimes quite large, and may even replace one of the sigmoid sinuses. In such cases, the marginal sinuses are also large, since they serve as exits for blood from the occipital sinus, and these sinuses then also offer difficulties in surgery. Even when the transverse and sigmoid sinuses are normal in their arrangement, the occipital sinus may be enlarged. Occasionally, instead of running in the midline, it deviates to one side to join the sigmoid sinus as this passes through the jugular foramen; if such deviated occipital sinus is large it may offer a definite hazard in approaches to the posterior fossa [16].

Browder J *et al.* (1975) [17] have stated that the doubling of occipital sinuses in adults represents the end result of previously existing multi-channeled venous pathways in the midline suboccipital dura mater of the infant. However, no mention was made by these authors of duplication of the falx cerebelli. The dura mater and its partitions associated with the rhombencephalon may be observed at approximately the 14th gestational week, which is the approximate time at which the cerebellar vermis appears as a distinct entity [10].

Lang J (1991) [3] reported that the occipital sinus may be tripled. It is of note that Knott JF (1881) [18] reported that in 44 cadavers he found no trace of the occipital sinus in two and a doubled sinus in nine cases, one lying on either side of a single internal occipital crest. Patients with the Chiari II malformation may not have a falx cerebelli or internal occipital crest. This may be due to a crowded posterior cranial fossa [12].

Michaud J *et al.* (1982) [11] have reported a case of agenesis of the vermis in which the falx cerebelli was notably small. Our study is an addition to the literature of variations of the dural partitions such as the falx cerebelli. Anatomical variations of the dural venous sinuses in the region of the confluence of the sinuses

may present problems with diagnostic and operative procedures [19]. Knowledge of such an aberrant venous sinus is important in order to prevent inadvertent injuries during craniotomies of this region [17, 20]. Moreover, this additional venous structure may act as a collateral to drain posterior cranial fossa venous blood in such conditions as transverse or sigmoid sinus thrombosis. Neurosurgeons and neuroradiologists should be aware of such variations, as these could be a potential source of hemorrhage during suboccipital approaches or may lead to erroneous interpretation during imaging of the posterior cranial fossa.

☞ Conclusions

Even though the duplicated falx cerebelli is very rare, anatomical variations of the dural venous sinuses in the region of the confluence of the sinuses may present problems with diagnostic and operative procedures. The clinician who operates intracranially or interprets radiological imaging should be aware of the anatomical variations found within the posterior cranial fossa.

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