



# Venous channels of the falx cerebri in adult Japanese population: delineation using magnetic resonance imaging

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## Abstract

**Purpose** Few studies have characterized the venous channels of the falx cerebri under physiological conditions. The present study aimed to explore the falx cerebri using magnetic resonance imaging (MRI).

**Methods** A total of 91 patients (41 men and 50 women) with an intact falx cerebri and relevant dural sinuses underwent contrast MRI.

**Results** In 15% of the participants, the falx cerebri contained venous channels with a patchy appearance. Seven of these channels were located in the anterior third of the falx, two were in the anterior two-thirds, and 5 were in the middle third. In 19 (21%) participants, the falcine sinus was unequivocally delineated. In 14 of them, connected the posterior third of the superior sagittal sinus and uppermost part of the straight sinus. These sinuses showed variable morphologies, presenting with linear, triangular, multi-channel, and branching appearances. The linear type was the most predominant and found in 50% of these cases. In contrast, in the remaining five participants, the falcine sinuses were coursing posteriorly, connecting the posterior third of the falx cerebri with the superior sagittal sinus.

**Conclusion** The falx cerebri may have a role as a pathway in the intracranial venous circulation. The falcine sinus has several variants with diverse morphologies.

**Keywords** Falx cerebri · Venous channels of the falx cerebri · Falcine sinus · MRI

## Introduction

The falx cerebri is a well-known, two-layered dural partition that divides the cerebral hemispheres. It extends from the crista galli anteriorly to the confluens sinuum posteriorly. The upper margin of the falx cerebri is adjacent to the superior sagittal sinus, while the lower margin forms a free edge and attaches the inferior sagittal and straight sinuses. The falcine sinus, or persistent falcine sinus, is thought to be a normal anatomical structure in the falx cerebri of fetuses that commonly closes after birth and is rarely observed in the adult population [7, 8, 10, 11]. The sinus is commonly located in the posterior third of the falx cerebri [5].

In addition to diverse congenital disorders, such as agenesis of the corpus callosum, occipital encephalocele, Apert's syndrome, osteogenesis imperfecta, and Chiari type 2 malformation, meningioma, arteriovenous malformation/fistula, cerebral venous thrombosis, and hypertrophic pachymeningitis have been documented as the concurrent or causative pathologies [1, 4, 6, 9, 14, 15]. In a rare instance, an asymptomatic case was reported [2]. On the other hand, the venous plexus or channels of the falx cerebri are present as normal structures and have been documented in studies using post-mortem specimens [3, 12, 13]. However, few studies have characterized the venous channels of the falx cerebri under physiological conditions.

The aim of the present study was to explore the falcine sinus using contrast magnetic resonance imaging (MRI).

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## Materials and methods

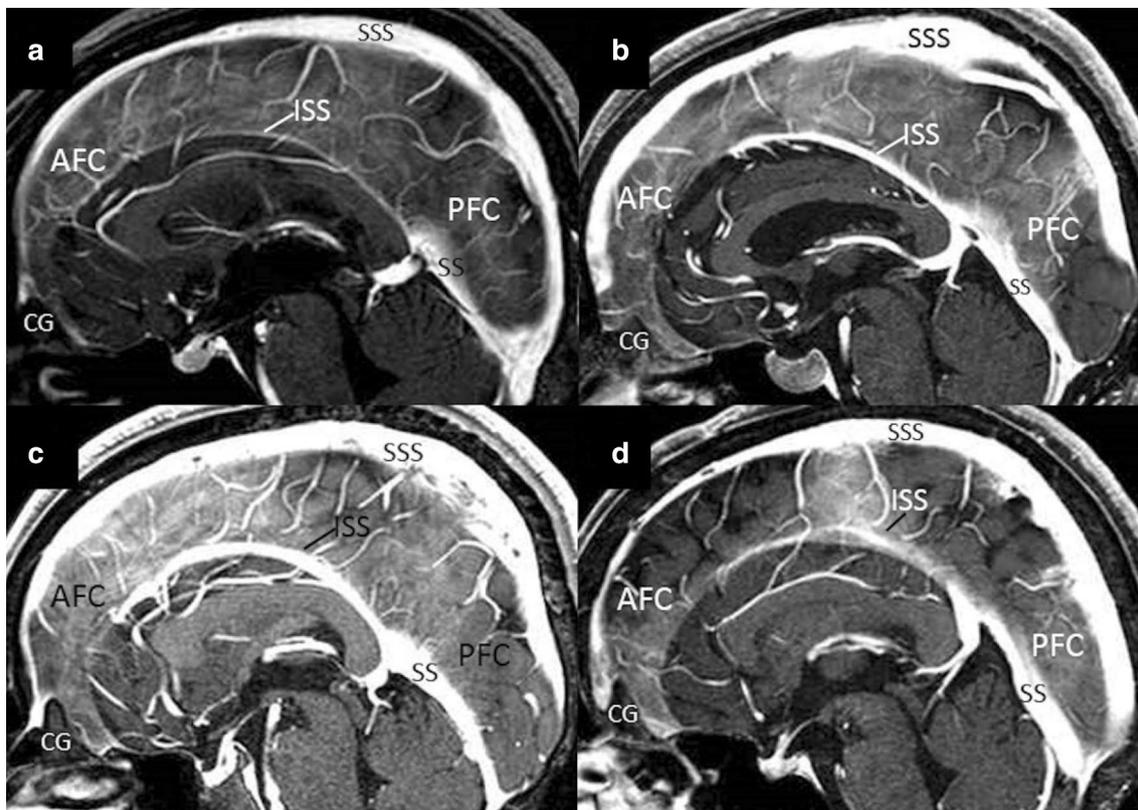
The participants in this study were outpatients presenting at our hospital between April 2010 and November 2015. A total of 91 patients, including 41 men and 50 women between the ages of 18 and 77 years (mean age: 50 years), were recruited. The patients had complaints of headache, dizziness, and tinnitus. Initial examinations with axial T1- and T2-weighted MRI, T2-gradient echo, fluid-attenuated inversion recovery, and diffusion-weighted sequences confirmed that none of the patients had dural sinus or cortical venous thrombosis, cerebral infarction, meningitis, brain tumors involving the falx cerebri or relevant dural sinuses, or traumatic brain injury. Next, the patients underwent contrast examination with an intravenous gadolinium infusion (0.1 mmol/kg) in the axial, coronal, and sagittal planes involving the whole cranial vault. The following parameters were used: repetition time, 4.1 ms; echo time, 1.92 ms; slice thickness, 1 mm; interslice gap, 0 mm; matrix, 320 × 320; field of view, 250 mm; flip angle, 13°; and scan duration, 7 min 25 s. All the scans were obtained using a 3.0T MR scanner (Achieva R2.6; Philips Medical

Systems; Best, The Netherlands). Imaging data were transferred to a workstation (Virtual Place Lexus64, 64th edition; AZE; Tokyo, Japan) and analyzed independently by two of the authors (S.T. and H.I.). In the present study, venous channels connecting the falx cerebri and intracranial dural sinuses were considered the falcine sinuses.

The present study was performed in accordance with our institution's guidelines for human research. Informed consent was obtained from all patients prior to participation in the study.

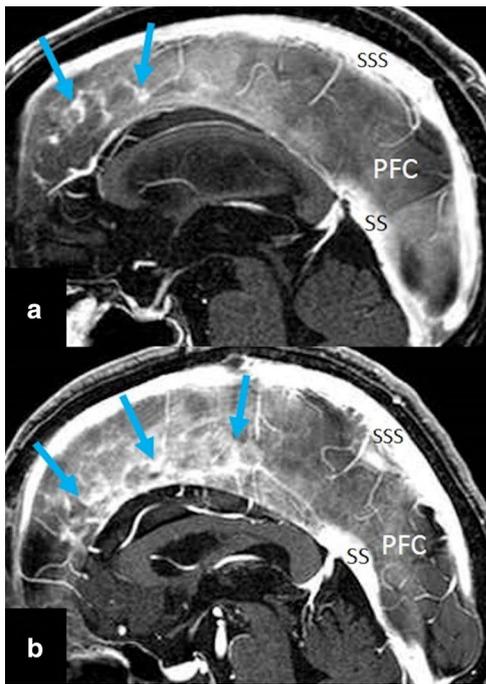
## Results

The falx cerebri was delineated in all participants. It showed variable morphologies extending anteriorly from the crista galli to the confluens sinuum posteriorly (Fig. 1). In 14 of the 91 (15%) participants, venous channels with a patchy appearance were identified in the falx cerebri, communicating with the superior and inferior sagittal and straight sinuses. Seven of these venous channels were located in the anterior third of the falx cerebri, two were in the anterior two-thirds, and five were in the middle third (Fig. 2). In 19 of the 91 (21%)



**Fig. 1** a–d Post-contrast midsagittal T1-weighted magnetic resonance images of different patients showing the falx cerebri presenting with variable morphologies, extending from the crista galli anteriorly to

the confluens sinuum posteriorly. *AFC* anterior third of the falx cerebri, *CG* crista galli, *ISS* inferior sagittal sinus, *PFC* posterior third of the falx cerebri, *SS* straight sinus, *SSS* superior sagittal sinus

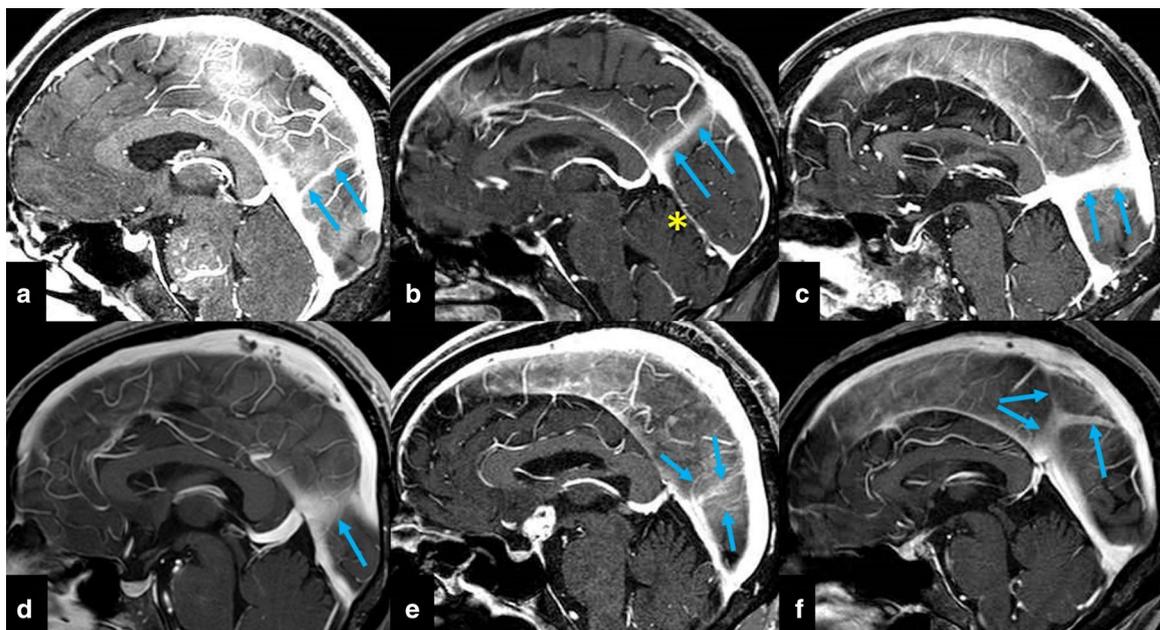


**Fig. 2** **a, b** Post-contrast midsagittal T1-weighted magnetic resonance images of different patients showing venous channels with a patchy appearance and distributing in the anterior third **a** and two-thirds **b** of the falx cerebri. In **b** the patchy venous channels communicate with the inferior sagittal and straight sinuses. Arrows: patchy venous channels in the falx cerebri

**Table 1** Location and type of identified 14 falcine sinus

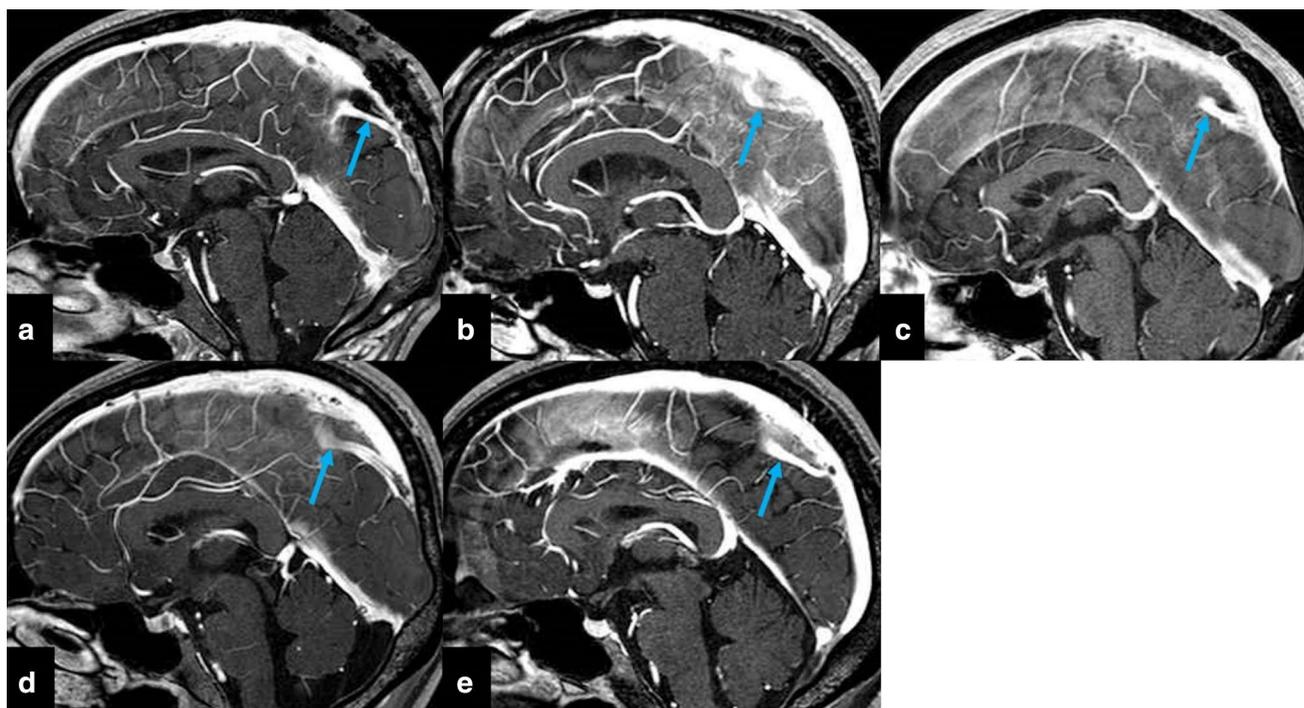
	Number
Location	
Anterior third	7 (50%)
Anterior two-thirds	2 (14%)
Middle third	5 (36%)
Posterior third	0
Type	
Linear	7 (50%)
Triangular	3 (21%)
Multi-channel	2 (14%)
Branching	2 (14%)

participants, the falcine sinus was unequivocally delineated. In 14 of them, were found to connect the posterior third of the superior sagittal sinus and uppermost part of the straight sinus. The falcine sinuses showed variable and inconsistent morphologies presenting with linear, triangular, multi-channel, and branching appearances (Fig. 3). The linear type with variable thickness and curvatures was the most predominant and was found in 7 of the 14 (50%) participants, followed by the triangular type, which was found in 3. The multi-channel and branching types of falcine sinuses were each identified in 2 participants (Table 1). In 13 of the 14 patients with the falcine sinus, the thickness of the straight sinus appeared normal. In one participant, the straight sinus was hypoplastic (Fig. 3b).



**Fig. 3** **a–f** Post-contrast midsagittal T1-weighted magnetic resonance images of different patients showing the falcine sinus presenting with variable and inconsistent morphologies, connecting the posterior third of the superior sagittal sinus and uppermost part of the straight

sinus. **a–c** Various linear types, **d** triangular type, **e** multi-channel type, **f** branching type. Arrows: falcine sinus. Asterisk in **b** hypoplastic straight sinus



**Fig. 4** Post-contrast midsagittal T1-weighted magnetic resonance images of different patients showing the falcine sinuses with various morphologies, coursing posteriorly and connecting the posterior third of the upper falx cerebri and superior sagittal sinus (a–e, arrow)

In contrast, the remaining five of the identified falcine sinuses coursed posteriorly, connecting the posterior third of the upper falx cerebri and the superior sagittal sinus (Fig. 4).

## Discussion

In the present study, 15% of the participants had patchy venous channels of the falx cerebri communicating with the superior and inferior sagittal, and the straight sinuses. Based on the distribution over the falx cerebri, these veins were thought to correspond to the “venous channels” or “venous plexus” documented in previous studies [3, 12, 13]. Furthermore, in 21% of the participants, the falcine sinus was unequivocally delineated. The falcine sinuses were observed to connect the posterior third of the superior sagittal sinus with the uppermost part of the straight sinus or the posterior third of the falx cerebri with the superior sagittal sinus. These falcine sinuses showed variable morphologies with the linear type being the most predominant. In most of the cases, the thickness of the straight sinus appeared normal and was not hypoplastic. Based on these results, the prevalence of the falcine sinus was assumed to be more frequent than estimated previously [8, 10]. Furthermore, the falcine sinus was thought to be a normal variant with diverse morphologies, functioning as the venous pathway in the intracranial venous circulation. Although the falcine sinuses have been mainly

documented in association with pathological conditions [1, 6, 9, 14, 15], they may not always have a pathognomonic implication even when identified in adulthood. In addition, knowledge of the morphological variability of the falcine sinus can be a help for understanding the clinical symptoms and planning treatment strategies of pathologies affecting it.

The present study has certain limitations. First, the sample size and heterogenous age distribution of our retrospective investigation was insufficient for validating our results. The study sample comprised only adults and no pediatric participants. Moreover, for highly variable and inconsistent morphologies of the falcine venous channel, a quantitative analysis was not adopted. Nonetheless, we believe that the outcomes reported in this preliminary study can aid in enhancing the knowledge of the venous channels of the falx cerebri.

## Conclusion

The falx cerebri may play a role as a pathway in the intracranial venous circulation. The falcine sinus has several variants with diverse morphologies.

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**Author contributions** ST proposed the project of study. HI and YY collected the imaging data. HO and HI analyzed the imaging data. ST wrote the manuscript. All the authors equally contributed to the study.

### Compliance with ethical standards

**Conflict of interest** The authors have no conflicts of interest concerning the materials or methods used in this study or the findings presented in this paper.

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