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Case Report

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Type 4A torcular Herophili variant in a two-week-old neonate: MR venography findings

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ABSTRACT

The torcular Herophili (confluence of sinuses) shows considerable anatomical variation. Type 4A torcular Herophili is an uncommon configuration characterized by preferential drainage of the straight sinus into the right transverse sinus. Recognizing this variant is important to avoid misinterpretation on magnetic resonance venography (MRV). We report a two-week-old male neonate in whom an incidental torcular Herophili variant was identified on brain magnetic resonance imaging (MRI) and MRV. MRV demonstrated preferential drainage of the straight sinus into a dominant right transverse sinus, while the left transverse sinus was smaller but patent. According to the Kobayashi classification, this finding corresponded to a type 4A torcular Herophili variant. Based on the Gökçe classification, the same configuration was consistent with a type IIA2 partial confluence pattern. This case highlights the importance of recognizing normal torcular Herophili variants in neonatal MRV and differentiating them from pathological conditions such as transverse sinus hypoplasia or cerebral venous sinus thrombosis.

Keywords: Torcular Herophili, confluence of sinuses, MR venography, neonate, dural venous sinus variant, anatomic variation

INTRODUCTION

The torcular Herophili, or confluence of sinuses, is a key anatomical region of the intracranial venous system located near the internal occipital protuberance. It is the junction of the superior sagittal sinus, straight sinus, transverse sinuses, and, variably, the occipital sinus. Although often depicted as a symmetric venous confluence, considerable anatomical variability has been documented in both anatomical and radiological studies.[1-3]

Variations of the torcular Herophili may involve differences in venous drainage patterns, transverse sinus dominance, and the degree of confluence between major dural venous sinuses. These configurations usually represent normal anatomical variants but may occasionally mimic pathological conditions on magnetic resonance venography (MRV), particularly when asymmetrical venous drainage is present.[1,3,4]

Type 4A torcular Herophili is an uncommon configuration characterized by preferential drainage of the straight sinus into the right transverse sinus.[1] Recognition of such variants is important for accurate interpretation of MRV and to avoid diagnostic confusion with venous sinus abnormalities.

We describe the MR venographic findings of a rare torcular Herophili variant in a two-week-old male neonate, detected incidentally on MR venography, and discuss its classification according to the Kobayashi and Gökçe systems. The purpose of this report is to describe the imaging appearance of this venous confluence configuration, clarify its classification according to both the Kobayashi and Gökçe systems, and emphasize the importance of neutral anatomical interpretation in neonatal MR venography.

CASE REPORT

A two-week-old male neonate was referred for brain magnetic resonance imaging (MRI) and MRV because of intermittent irritability and concern for possible intracranial pathology. Physical examination was unremarkable, and no focal neurological deficit was identified. Routine laboratory investigations, including coagulation parameters, were within normal limits. MRI and MRV were requested primarily to exclude cerebral venous sinus thrombosis or other intracranial abnormalities. No previously known intracranial vascular malformation was reported. Brain MRI and MRV were performed on a 1.5-T scanner using a standard neonatal imaging protocol. The examination included axial and sagittal T1-weighted imaging, axial

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T2-weighted imaging, diffusion-weighted imaging, susceptibility-weighted imaging, and three-dimensional time-of-flight (3D TOF) MR venography. Maximum intensity projection (MIP) and three-dimensional volume-rendered reconstructions were generated for evaluation of the dural venous sinuses. Conventional MRI showed no acute parenchymal abnormality, restricted diffusion, intracranial hemorrhage, hydrocephalus, or mass effect. A rare torcular Herophili configuration was identified. The straight sinus drained preferentially into the right transverse sinus rather than forming a symmetric central venous confluence. The right transverse sinus was dominant, while the left transverse sinus was relatively smaller in caliber but remained patent (**Figure**).

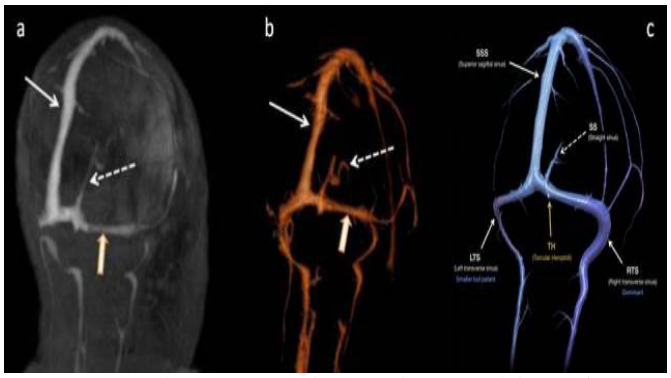


Figure. MRV demonstrating the torcular Herophili configuration (posteroanterior view)

(A) Maximum intensity projection and (B) three-dimensional volume-rendered MRV images show preferential drainage of the straight sinus (dashed white arrows) into the right transverse sinus (solid arrow). The right transverse sinus is dominant, and the torcular confluence is indicated by white arrows. The left transverse sinus is relatively smaller but patent. This pattern corresponds to type 4A in the Kobayashi classification and type IIA2 partial confluence in the Gökçe classification. (C) Three-dimensional schematic illustration of the venous anatomy in the present neonate, showing preferential drainage of the SS into the dominant RTS, with a smaller but patent LTS. The SSS joins the torcular TH, and venous continuity is preserved. SSS: Superior sagittal sinus, SS: Straight sinus, LTS: left transverse sinus, RTS: Right transverse sinus, MRV: Magnetic resonance venography, Th: Herophili

According to the classification proposed by Kobayashi et al.,[1] this configuration corresponded to a type 4A torcular Herophili variant. According to the classification of Gökçe et al.,[4] the same venous anatomy was most consistent with a type IIA2 partial confluence pattern, as the superior sagittal sinus and straight sinus drained separately into the transverse sinus system while maintaining normal venous continuity. The imaging findings were interpreted as an incidental anatomical variant without evidence of venous sinus thrombosis or other intracranial abnormality. The finding was documented in the radiology report as a normal variation of dural venous sinus anatomy for future reference. Ethical approval was waived by the institutional review board because this study represents a single anonymized case report. Written informed consent for publication of clinical and imaging data was obtained from the patient's parents.

DISCUSSION

The torcular Herophili is one of the most anatomically variable regions of the intracranial venous system. Although classical anatomical descriptions depict a symmetric confluence of the superior sagittal sinus, straight sinus, and bilateral transverse sinuses, numerous anatomical and radiological studies have demonstrated considerable variability in venous drainage patterns, transverse sinus dominance, and the degree of confluence between the major dural venous sinuses. These configurations usually represent normal developmental variants rather than pathological abnormalities and should be recognized during routine MR venography.[1-4]

Kobayashi et al.[1] systematically evaluated the confluence of sinuses using contrast-enhanced MR venography and demonstrated several reproducible drainage patterns, including preferential drainage of the straight sinus into one transverse sinus. Gökçe et al.[4] further expanded this concept by proposing a practical classification system based on MR venography and digital subtraction angiography, emphasizing that preservation of venous continuity is the key feature distinguishing anatomical variants from pathological conditions. Bayaroğulları et al.[3] similarly showed that asymmetric transverse sinus drainage is common in pediatric MR venography and generally reflects normal developmental anatomy rather than disease.

The venous anatomy observed in the present neonate corresponds to a Kobayashi[1] type 4A torcular Herophili configuration and a Gökçe[4] type IIA2 partial confluence pattern. Bayaroğulları et al.[3] evaluated pediatric MR venography and demonstrated that asymmetric transverse sinus drainage commonly represents a normal developmental variant; however, they did not specifically illustrate a neonatal Kobayashi type 4A configuration. Similarly, the studies by Kobayashi et al.[1] and Gökçe et al.[4] primarily evaluated adult populations or mixed-age cohorts rather than neonates. Although this anatomical configuration has been incorporated into established classification systems, reports specifically illustrating this variant during the neonatal period remain exceptionally limited. To our knowledge, no previous publication has provided a dedicated MR venographic illustration of a Kobayashi type 4A torcular Herophili configuration in a neonate. Although similar anatomical variants have been included within broader pediatric series, the principal contribution of the present report is not the identification of a new anatomical variant but the demonstration that this configuration can already be recognized during the neonatal period using routine MR venography, thereby extending the documented age spectrum of this recognized venous anatomy.

Recognition of this venous anatomy has important practical implications. Neonatal MR venography is frequently performed to exclude cerebral venous sinus thrombosis in infants presenting with nonspecific neurological symptoms. In this setting, asymmetric venous drainage or transverse sinus dominance may be incorrectly interpreted as transverse sinus hypoplasia or venous thrombosis if normal anatomical variants are not considered.[1,3-5] In the present case, the straight sinus drained preferentially into the dominant right transverse sinus, whereas the left transverse sinus was smaller but remained patent, without associated parenchymal abnormalities or imaging findings suggestive of thrombosis. Preservation of venous continuity and the absence of secondary MRI abnormalities supported the diagnosis of a normal developmental variant rather than pathology.

Beyond diagnostic interpretation, accurate recognition of torcular Herophili variants is relevant for neurosurgical planning, posterior fossa interventions, endovascular procedures, and longitudinal radiological follow-up. Recent

cadaveric investigations have also demonstrated substantial morphological diversity of the dural venous sinuses, reinforcing that considerable variability represents normal anatomy rather than pathological alteration. Knowledge of individual venous drainage patterns facilitates appropriate interpretation of future neurovascular imaging studies and reduces the likelihood of unnecessary investigations or inappropriate treatment. Anatomical case reports describing uncommon torcular configurations, including circular torcular Herophili and other rare drainage patterns, further illustrate the wide spectrum of normal venous anatomy.[2,6,7]

A systematic assessment of the torcular region may improve diagnostic confidence on MR venography. Important imaging features include the drainage pattern of the straight sinus, drainage of the superior sagittal sinus, transverse sinus dominance, preservation of venous continuity, the presence of an occipital sinus or accessory venous channels, and the absence of secondary imaging findings suggesting venous obstruction.[1,3,4] Such a structured approach is particularly valuable in neonatal and pediatric imaging, where developmental asymmetry and relatively small venous caliber may complicate interpretation.

The present report has several limitations. It describes a single incidental anatomical observation without long-term imaging follow-up, and no additional vascular imaging such as contrast-enhanced MR venography, CT venography, or digital subtraction angiography was performed because these investigations were not clinically indicated. Nevertheless, routine brain MRI combined with three-dimensional time-of-flight MR venography adequately demonstrated the characteristic venous drainage pattern and allowed confident classification according to both the Kobayashi and Gökçe systems.

CONCLUSION

The present case demonstrates that a Kobayashi type 4A/Gökçe type IIA2 torcular Herophili configuration can be readily identified on routine MR venography during the neonatal period. Although this represents a recognized anatomical variant rather than a new entity, its dedicated MR venographic documentation expands the documented age spectrum of this normal venous configuration and reinforces its relevance in neonatal neuroimaging. Awareness of this anatomical variant, together with systematic evaluation of venous continuity and drainage patterns, may help avoid misdiagnosis of cerebral venous sinus thrombosis or transverse sinus hypoplasia, improve diagnostic confidence, and support appropriate clinical management.

ETHICAL DECLARATIONS

Informed Consent

Informed consent was obtained from the legal guardians of the pediatric patient described in this report. Where developmentally appropriate, assent was also sought from the child.

Peer Review Process

This report underwent external peer review.

Conflict of Interest

The authors declare no conflicts of interest.

Financial Disclosure

This case report did not receive any financial support.

Author Contributions

Concept: MHA, SA, NB; Design: MHA, SA, NB; Control: MHA, SA, NB; Data Collection and/or Processing: MHA, SA, NB; Analysis and/or Interpretation: MHA, SA, NB; Literature Review: MHA, SA, NB; Article Writing: MHA, SA, NB; Critical Review: MHA, SA, NB.

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