Cerebral Vein Thrombosis

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Abstract

Cerebral venous thrombosis is a rare neonatal condition with an incidence of up to 6.4 per 100,000 infants and a mortality rate nearly double that of older children. It encompasses thrombosis of the dural venous sinuses as well as the cerebral veins, often with multivessel involvement. Neonates are particularly susceptible due to an immature hemostatic system, with major risk factors, including congenital heart disease, complicated delivery, hypoxia, and sepsis. Clinical presentation is often nonspecific; however, seizures are the most common manifestation. Cranial ultrasonography with Doppler is the preferred initial imaging modality, while MRI with MR venography is the diagnostic standard for defining thrombus extent and associated parenchymal injury.

Keywords: central nervous system, brain, hematolic

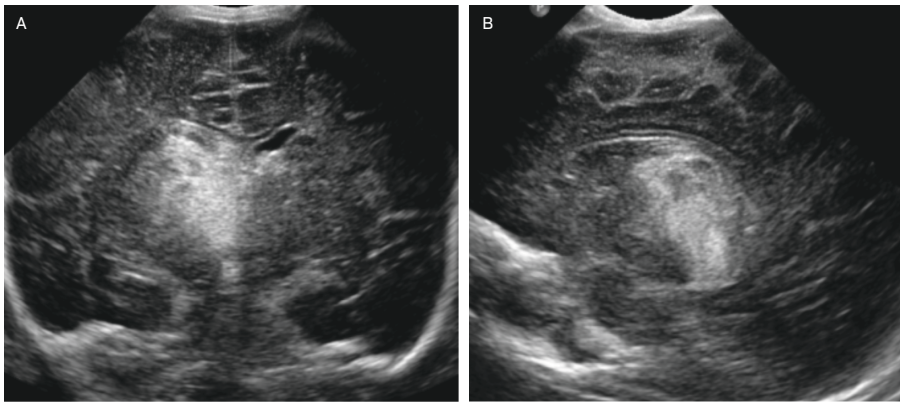
Case Summary

A term neonate was born to a 30-year-old mother with fever (100.7°C), gestational hypertension, and vaginal culture positive for *Mycoplasma* and *Ureaplasma,* confirming chorioamnionitis. At delivery, the APGAR scores were 2 and 9 at 1 and 5 minutes, respectively, and the birth weight was 4.85 pounds. The newborn was afebrile, had grunting respiration with intercostal retraction, tachycardia, and had a seizure at 12 hours of age. Abnormal laboratory values included 9 nucleated red blood cells, an elevated C reactive protein (7.16), and increased bands and neutrophils. This patient was diagnosed with fetal inflammatory response syndrome (FIRS).

Imaging Findings

A head US (HUS) (Figure 1) performed at 22 hours of age showed intracranial hemorrhage involving the area of the right caudate nucleus, thalamus, and intra third ventricular blood. There was associated local mass effect and left-to-right midline shift.

Figure 1. (Head US Coronal (A) and Sagittal (B) performed at 22 hours of age showing intracranial hemorrhage involving the area of the right caudate nucleus and thalamus (arrows) and intra third ventricular blood (not shown). There was associated local mass effect and left to right midline shift.



MRI (Figure 2) performed on day of life 2 showed intraventricular hemorrhage, involving the right lateral ventricle greater than left, and third ventricle, intracerebral hemorrhage involving the right basal ganglia and thalamus and diffusion restriction in the same region.

Diagnosis

Cerebral venous thrombosis (CVT) involving the internal cerebral vein (ICV).

The differential diagnoses related to the imaging findings include cerebral infarction, grade 4 germinal matrix hemorrhage, coagulopathy, birth trauma, hypoxic-ischemic injury with secondary hemorrhage, FIRS, and vascular malformations.

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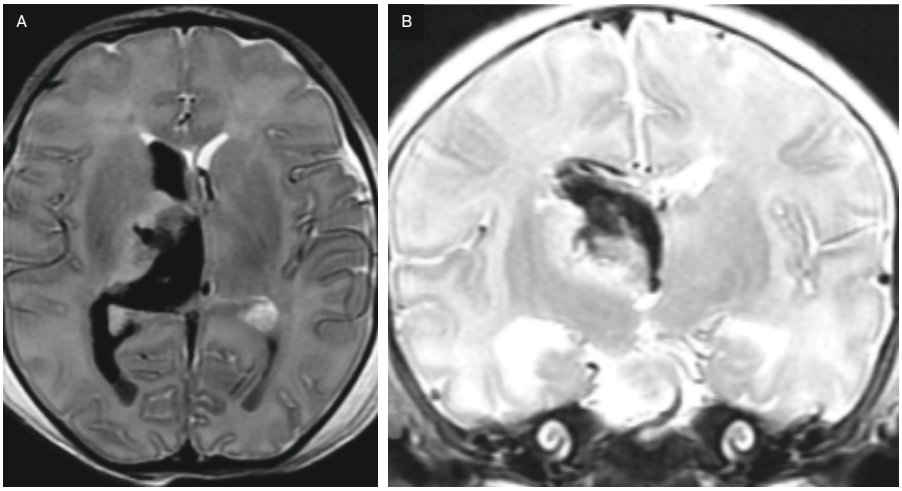
Disclosures: The authors have no conflicts of interest to disclose. None of the authors received outside funding for the production of this original manuscript and no part of this article has been previously published elsewhere.

https://doi.org/10.37549/JPCR-26-0106

Figure 2. MRI performed on day 2 of life. (A, B) Axial and coronal T2-weighted images showing a large hemorrhagic mass bulging into the right frontal horn (arrowhead), bilateral intraventricular hemorrhage (arrow), involving the right lateral ventricle greater than left, and third ventricle, intracerebral hemorrhage involving the right basal ganglia and thalamus and diffusion restriction in the same region.



Discussion

CVT is a rare pediatric condition with an annual incidence of 1.1 per 100,000, increasing to 6.4 per 100,000 in infants and approximately 2.6 to 12/100,000 live births per year.[1] Neonates account for most cases and experience nearly 3 times the mortality rate of older children (9.9% vs 3.5%).[2,3] CVT encompasses thrombosis of the dural venous sinuses (CVST) and cerebral veins (CVT). Venous sinus thrombosis affects large dural conduits, including the transverse (85%) and superior sagittal sinuses (42%). CVST is most common in the first 28 days and represents 30-50% of pediatric cases. CVT affects smaller vessels, including cortical veins (12%), deep medullary veins (4%), and deep cerebral veins such as the ICV and great cerebral vein (vein of Galen) (each 8%). Multivessel involvement is frequent (65%).[4] There is a male predominance accounting for about 60% of cases.

Unlike arterial strokes, which result from abrupt arterial occlusion and produce infarction confined to well-defined arterial territories,[1] venous strokes arise from impaired cerebral venous outflow. The resulting elevation in venous pressure reduces the arteriovenous perfusion gradient, disrupts the blood-brain barriers, and promotes vasogenic edema with frequent hemorrhagic transformation. Consequently, venous infarctions do not conform to arterial boundaries and are more commonly hemorrhagic, reflecting venous hypertension and capillary rupture rather than primary arterial ischemia. Given the extensive collateralization of the cerebral venous system, venous strokes present with an indolent and nonspecific clinical presentation compared with abrupt focal neurological deficits precipitated by arterial occlusion.[5,6]

While CVST is more readily identified on imaging, the deep cerebral venous system is often underrecognized despite its strong association with hemorrhagic injury and poor outcomes. The ICV serves as the principal drainage pathway for the deep white matter, basal ganglia, thalami, and choroid plexus. Numerous deep medullary veins converge into the subependymal veins, including the thalamostriate, septal, and longitudinal caudate veins, which unite near the foramen of Monro to form the paired ICVs. The ICVs course posteriorly within the tela choroidea that forms the roof of the third ventricle, collecting atrial and choroidal tributaries before draining into the vein of Galen and subsequently the straight sinus. Obstruction along this pathway may result in venous congestion, hemorrhagic infarction, and intraventricular hemorrhage.[1]

Neonates are particularly vulnerable to CVT and CVST due to an immature hemostatic system with reduced procoagulant and anticoagulant factors, creating a fragile equilibrium predisposing to thrombosis.[7] Risk factors include congenital heart anomalies (48%), complicated delivery (38%), hypoxia (31%), and inflammation or sepsis (21%).[8]

Clinical presentation is often nonspecific. Up to 27% of preterm infants may be asymptomatic.[4] Seizures are the most common clinical manifestation (52%), followed by lethargy (36%) and irritability (12%).[8] Diagnosis is typically made postnatally, with a median age at diagnosis of 10 days of life.[1] In utero CVT is rare and primarily reported as isolated case reports.

Cranial ultrasonography with Doppler is the preferred initial imaging modality in neonates due to its safety profile, lack of ionizing radiation, and ability to demonstrate abnormal increase in parenchymal echogenicity and mass effect and venous distention with intraluminal hyperechoic thrombus.[9,10] MRI with MR venography (MRV) is the modality of choice for defining thrombus extent and detecting associated parenchymal injury and bleeding. CT and CT venography are acceptable alternatives, though with slightly lower sensitivity (0.79 vs 0.82) and specificity (0.90 vs 0.92).[6]
MRI findings include both direct and indirect signs. Direct visualization of thrombus and intracranial hemorrhage varies by clot age. Acute thrombi (1-4 days) appear iso- to hypointense on T1-weighted images and hypointense on T2-weighted images, potentially mimicking normal flow voids. Subacute thrombi (5-16 days)

demonstrate T1 and T2 hyperintensity due to methemoglobin, while chronic thrombi (>16 days) show variable signal characteristics.[10] Contrast-enhanced or time-of-flight MRV may confirm absent flow in large dural sinuses, though visualization of deep medullary veins remains challenging.[10]

Indirect imaging findings reflect venous congestion and parenchymal injury. Superior sagittal sinus thrombosis often produces parasagittal hemorrhage, whereas transverse sinus thrombosis may result in basal temporal, cerebellar, or tentorial hemorrhage. Cortical vein thrombosis may present as a superficial crescentic hematoma with underlying cortical ischemia.[10]

Deep venous thrombosis produces characteristic imaging patterns that reflect specific venous drainage territories. Thrombosis of the deep medullary vein results in the "iris pattern," characterized by radially oriented hypointense linear structures along the lateral ventricles on T2-weighted or susceptibility-weighted imaging representing venous congestion or thrombosis as these veins converge toward the subependymal veins. Thrombosis of the basal vein of Rosenthal produces the "striato-hippocampal pattern," involving the insula, hippocampus, ventral basal ganglia, ventral thalamus, and choroid plexus of the temporal horn. Thrombosis of the ICVs or straight sinus results in "thalamocaudate pattern," characterized by infarction or hemorrhage of the ipsilateral thalamus, caudate nucleus, and choroid plexus. Bilateral pattern strongly suggests straight sinus thrombosis. In term neonates, the presence of intraventricular hemorrhage with associated thalamic hemorrhage should prompt evaluation of the ICVs as impaired venous drainage of the choroid plexus via the superior choroidal vein into the ICV is a common mechanism underlying intraventricular hemorrhage in this population.[10]

Management is primarily supportive, including seizure control and correction of dehydration, anemia, and infections. Anticoagulation is not routine due to limited evidence; however, current data suggest reduced severity of CVT by nearly 66% (RR, 0.33; 95% CI, 0.18-0.58) and reduction in long-term neurological deficits (odds ratio 0.46, 95% CI 0.23-0.94).[11]

Neonatal CVT carries higher mortality than in older children (9.9% vs 3.5%), and approximately 48% of survivors experience long-term neurological deficits.[3] Poor outcomes are associated with prematurity, traumatic delivery, deep venous involvement, and hemorrhagic infarction, whereas isolated superficial sinus thrombosis and normal neurological examination at presentation predict more favorable outcomes.[12]

Conclusion

CVT is a rare neonatal condition with an incidence of up to 6.4 per 100,000 infants and a mortality rate nearly double that of older children. It encompasses thrombosis of the dural venous sinuses as well as the cerebral veins, often with multivessel involvement. Neonates are particularly susceptible due to an immature hemostatic system, with major risk factors, including congenital heart disease, complicated delivery, hypoxia, and sepsis. Clinical presentation is often nonspecific; however, seizures are the most common manifestation. Cranial ultrasonography with Doppler is the preferred initial imaging modality, while MRI with MRV is the diagnostic standard for defining thrombus extent and associated parenchymal injury.

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