RATIONAL IMAGING

Investigating suspected cerebral venous thrombosis

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The patient

A previously well 22 year old woman presented acutely to the accident and emergency department with collapse after several days of insidious onset headache. No focal neurological signs were seen, but she was sleepy, with generalised apathy. The remainder of the clinical examination was normal. As the patient's father had factor V Leiden deficiency, she was referred for imaging to detect cerebral venous thrombosis.

What tests should I order?

Cerebral venous thrombosis is an uncommon but important diagnosis, as it is potentially reversible when promptly recognised and treated. Diagnosing this condition, which accounts for <1% of strokes, is challenging, as the clinical manifestations and aetiological factors are many and varied.¹ Imaging is mandatory to confirm the diagnosis.

Imaging findings of cerebral venous thrombosis can be direct, with visualisation of the thrombus, or indirect, with oedema, infarction, and haemorrhage as a consequence of ischaemia from obstructed venous flow.

Fig 1 | Axial unenhanced computed tomography shows linear hyperdense thrombus within the internal cerebral veins (arrow) and straight sinus (arrowhead), and subtle low density due to ischaemia within the right thalamus

LEARNING POINTS

Imaging plays a key role in diagnosing cerebral venous thrombosis, a condition that can be mimicked by several other neurological entities

Prompt diagnosis and anticoagulation affects patients' outcome

Diagnostic imaging of cerebral venous thrombosis depends on which modality is readily available, and local experience in image interpretation

CT venography is a sensitive, quick investigation that can be performed immediately after unenhanced CT, reducing time to diagnosis and treatment

Unenhanced scanning

Standard computed tomography (CT) of the brain should be done first to exclude common causes of neurological symptoms, such as subarachnoid haemorrhage and tumours. Parenchymal infarction or haemorrhage inconsistent with an arterial vascular territory should raise the suspicion of venous thrombosis.

In the first two weeks of its development, thrombus may be seen as linear high density in the vein or sinus on the non-contrast scan (fig 1). Polycythaemia or normal non-myelinated brain in infants may mimic this. After two weeks, thrombus is isodense to brain parenchyma and is usually seen only on contrast enhanced scans.

Contrast enhanced scanning

Contrast enhanced scanning will show the thrombus as a filling defect within the vessel, whereas the dura surrounding the clot are enhanced. This radiological "empty delta" sign is found in 25-75% cases, and is more readily detected if the clot is located in the superior sagittal sinus or torcula. Over time, organised thrombus can also enhance, and the empty delta sign is no longer apparent.

CT venography

CT venography may be done if the diagnosis is in doubt or if the initial unenhanced scan suggests venous thrombosis. This technique uses fast, thin slice, helical acquisition following a bolus of iodinated intravenous contrast; the timing of the scan coincides with optimal opacification of the cerebral venous circulation.²⁻⁵ The source images are reviewed, and appropriate software allows subtraction of adjacent bony structures, and excellent multiplanar and three dimensional visualisation of the enhanced veins.

This series provides an update on the best use of different imaging methods for common or important clinical presentations. The series editors are Fergus Gleeson, consultant radiologist, Churchill Hospital, Oxford, and Kamini Patel, consultant radiologist, Homerton University Hospital, London

Computed tomography (CT) and magnetic resonance (MR) venography in diagnosing cerebral venous thrombosis

	CT venography	MR venography
Advantages	Can be performed immediately after standard computed tomography Quick (1-2 minutes) Readily available Fewer motion artefacts Can use if patient has cardiac pacemaker or claustrophobia Good spatial resolution Sensitive test	No radiation exposure (consider use in paediatric or pregnant patient) Use where CT contrast medium is contraindicated Sensitive test
Disadvantages	Exposure to ionising radiation Use of iodinated contrast medium (increased risk of contrast reactions in patients with asthma, renal failure, and allergy to iodine)	Time consuming; image quality more prone to patient movement Not as readily available as CT venography Need to be aware of potential technical pitfalls in diagnosis Cannot be used if patient has cardiac pacemaker; difficult for claustrophobic patients
Sensitivity	Overall accuracy 90-100%, depending on vein or sinus	Comparable to CT venography >90% when various MR sequences are combined with MR venography

Compared with conventional digital subtraction angiography, CT venography is a sensitive (95%), specific (91%), and reliable technique.⁶ It provides better venous anatomy than time of flight MR (magnetic resonance) venography, and detects thrombosis with equal accuracy.^{4,7} A recent study quotes sensitivity of 75-100%, specificity of 81-100%, positive predictive value of 75-100%, and negative predictive value of 89-100% for CT venography, using MR venography as the reference standard.⁷ The difference in range of values depends on the sinus or vein involved; overall accuracy is 90-100%.

Fig 2 | Sagittal T1 weighted (left) and axial FLAIR (right) magnetic resonance imaging: straight sinus shows abnormal high signal (absence of normal black flow void), in keeping with venous thrombosis (arrowheads). Note bilateral ischaemia of the thalami (TH; arrows), uncommon in other neurological conditions but the hallmark of internal cerebral vein thrombosis

Fig 3 | Sagittal time of flight MR venogram: normal flow in the superior sagittal sinus shows high signal (arrowheads), but the straight sinus is absent (arrow) due to thrombosis

USEFUL READING

Leach JL, Fortuna RB, Jones BV, Gaskill-Shipley MF. Imaging of cerebral venous thrombosis: current techniques, spectrum of findings and diagnostic pitfalls. *Radiographics* 2006;26(suppl 1):S19-43
Rodalleg MH, Krainik A, Feydy A, Helias A, Colombani JM, Julles MC, et al. Cerebral venous thrombosis and multidetector CT angiography: tips and tricks. *Radiographics* 2006;26(suppl 1):S5-18

The main advantage of CT venography is that it can be done immediately after the unenhanced CT scan, thereby enabling a prompt diagnosis.

MR venography

Normal blood flow results in a “black” signal void within vessels on standard magnetic resonance imaging (fig 2). Phase contrast, time of flight (fig 3), and contrast enhanced MR venography are commonly used for detecting cerebral venous thrombosis. Parenchymal changes, including microhaemorrhages, can be detected earlier with magnetic resonance imaging than with computed tomography (table).^{8,9}

Differences in intensity of the signal within cerebral vessels depend on the evolution of the thrombus, physiology of normal flow, and artefacts of imaging. Knowing the potential pitfalls in diagnosis is essential when interpreting the images.

Patient outcome

The patient was initially imaged with unenhanced computed tomography, cerebral venous thrombosis was diagnosed promptly, and intravenous heparin, the mainstay treatment, was started.¹ She subsequently had MR venography to define the extent of the thrombus and any associated parenchymal changes and was also found to have factor V Leiden deficiency. We give anti-coagulants even if a haemorrhagic venous infarct is seen on imaging, and thrombolysis is advocated only if the patient clinically deteriorates despite adequate intravenous heparin.¹

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