



DIAGNOSTIC EFFICACY OF MAGNETIC RESONANCE IMAGING IN CEREBRAL VENOUS SINUS THROMBOSIS

Radiodiagnosis

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ABSTRACT

INTRODUCTION: Cerebral Venous Sinus Thrombosis (CVST) is an uncommon condition. It is one of the causes of the stroke with uncertain pathological and physiological properties and differs from arterial strokes. MR venography may be performed without the use of a contrast agent using the time-of-flight (TOF) technique or the phase contrast technique.

AIMS : To study the extent of venous sinus involvement on MRV and associated cerebral parenchymal changes on magnetic resonance imaging (MRI) in patients with clinically suspected CVST.

MATERIAL AND METHODS: All the patients with clinical indication of CVS thrombosis referred to the Department of Radiodiagnosis for scanning on 1.5T SIEMENS (Magnetom Avanto). Every effort was made to make sure of high-quality scans and to avoid artefacts. CSF examination, blood parameter, other radiological investigation and histopathological reports were reviewed and recorded according to the provisional diagnosis.

RESULTS: Out of 44 studied cases 29 (65.9%) patients showed no altered signal intensity areas. Isointense areas were found in 9 (20.4%) cases whereas hyperintense and hypointense signal areas were found in 5 (11.3%) and 1 (2.27%) cases respectively. The sensitivity, 95% confidence interval and positive predictive value of T1 weighted imaging for the diagnosis of CVT was found to be 34.09%, 20.49% to 49.92% and 100%.

CONCLUSION: We demonstrate the role of MR venogram, with different sequences of MRI i.e. T1WI, T2WI, DWI with ADC mapping and susceptibility weighted imaging in early and accurate diagnosis of CVST, as its timely diagnosis has got an impeccable prognosis.

KEYWORDS

INTRODUCTION

Cerebral Venous Sinus Thrombosis (CVST) is an uncommon condition. It is one of the causes of the stroke with uncertain pathological and physiological properties and differs from arterial strokes. Its clinical presentation is varied, often dramatic and imaging features are usually subtle resulting in its underdiagnosis. It often affects young to middle-aged patients, and more commonly women(1). The estimated annual incidence of cerebral venous thrombosis is between two and seven cases per million in the general population(2). The incidence likely was underestimated due to lack of accurate noninvasive imaging methods. It is estimated that five to eight cases may be seen per year at a typical tertiary-care referral center(3).

Multiple causes of venous thrombosis have been described in the literature(2), and, thus, they are too extensive to be memorized(4). An easier way to understand is that they may involve one or more of the following mechanisms i.e. direct involvement of the dural sinuses, possibly with the damage to the vascular endothelium; venous stasis; hypercoagulable states; and increased blood viscosity. Causal factors may be classified as local (related to intrinsic or mechanical conditions of the cerebral veins and dural sinuses) or systemic (related to clinical conditions that promote thrombosis). Local processes that alter the venous flow (e.g., sinus trauma, regional infection such as that in mastoiditis, and neoplastic invasion or compression) may potentiate the development of thrombosis. Systemic causes include protein S and protein C deficiencies, a peripartum state, oral contraceptive use, and hypercoagulable states secondary to malignancy. In as many as 25% of cases, no cause is identified(1).

On MRI, venous thrombus may be directly visualized. On conventional MRI sequences, patent dural sinuses are often seen as a flow void. This is particularly well seen when the imaging plane is orthogonal to the blood flow direction (e.g., coronal images are best for visualization of the superior sagittal, transverse, and sigmoid sinuses). The effect of a flow void may be reduced in a plane parallel to the dural sinus, although such an imaging plane often offers a better depiction of the complete extent of thrombosis in the dural sinus. For example, a sagittal T1-weighted image may show the complete extent of the superior sagittal sinus thrombosis as an abnormally bright signal filling the sinus. The thrombus may manifest as absence of a flow void, which is often best seen on FLAIR images and T2-weighted spin-echo images. The abnormal signal intensity follows the signal charact

eristics of intracranial hemorrhage and may evolve through the stages of oxyhemoglobin, deoxyhemoglobin, methemoglobin, and hemosiderin. On T1-weighted images, thrombus with methemoglobin is seen as hyperintensity. On T2*-weighted gradient-echo images, exaggerated signal loss is often seen because of the increased susceptibility effect of deoxyhemoglobin, methemoglobin, or hemosiderin.

Indirect evidence of venous thrombosis is often secondary to parenchymal change as a result of venous occlusion. This is like the findings on CT, including brain swelling and hemorrhagic or non-hemorrhagic infarction. Conventional MRI sequences often provide enough information to raise the suspicion or to make a diagnosis of CVT. The diagnosis can then be further confirmed on MR venography or CT venography MR venography may be performed without the use of a contrast agent using the time-of-flight (TOF) technique or the phase contrast technique. Because these techniques use MR flow phenomena for contrast generation, they are subject to flow-related image artifacts. Like CT venography, contrast-enhanced MR venography takes advantage of luminal filling by contrast material rather than relying on the MR flow phenomena as in TOF or phase contrast MR venography. Therefore, contrast-enhanced MR venography is less likely to be affected by complex flow. Recently, gadolinium-enhanced MR venography has been shown to be superior to TOF MR venography and may offer the best evaluation using MRI.

AIMS AND OBJECTIVES

- To study the extent of venous sinus involvement on MRV and associated cerebral parenchymal changes on magnetic resonance imaging (MRI) in patients with clinically suspected CVST.
- To study the pattern of diffusion weighted images and ADC (apparent diffusion coefficient) mapping in patients with cerebral venous thrombosis
- To study the role of susceptibility weighted images in patients with cerebral venous thrombosis

MATERIAL AND METHODS

This observational study was performed on 34 patients clinically diagnosed (i.e. headache, focal seizures with or without secondary generalization, paresis and papilledema) with cerebral venous thrombosis, referred to the Dept. Of Radiodiagnosis and Dept. Of Neurology of GMCH, Udaipur.

Study was performed on MRI machine (SIEMENS - Magnetom Avanto 1.5 Tesla).

INCLUSION CRITERIA:

1. All patients aged >18 years and aged <65 years.
 2. An acute or subacute neurological illness in a patients under appropriate clinical condition whose CT scan or CT venogram or conventional MRI or MR venogram features (direct and indirect signs) are suggestive of cerebral venous thrombosis.
- A. Direct signs
- a. Hyper dense sinus on plain CT
 - b. Cord sign on plain CT
 - c. Empty delta sign on contrast enhanced CT
 - d. Dense triangle sign on plain CT.
- B. Indirect signs
- a. Cerebral edema
 - b. Cerebral infarction not confirming to as arterial territory
 - c. Cerebral haemorrhage.
 - d. Small ventricles
 - e. Bilateral signs
 - f. Gyral enhancement
 - g. Territorial enhancement.
 - h. Erosion of middle ear structures and changes in mastoid region.

EXCLUSION CRITERIA:

1. Radiological features inconclusive of CVST
2. History suggestive of haemorrhagic stroke, atherothrombotic stroke and metabolic encephalopathies.

Patients with history of metallic implants and pacemakers

METHOD OF COLLECTION OF DATA:

CRITERIA FOR PATIENT SELECTION:

All the patients with clinical indication of cerebral venous sinus thrombosis referred to the Department of Radiodiagnosis for scanning on 1.5T SIEMENS (Magnetom Avanto). The procedure was briefly explained to the patient including the risks of contrast examination

TECHNIQUE OF MRI EXAMINATION:

All patients were screened before entry into the MRI scanning room for ferromagnetic objects, cardiac pacemakers, aneurysm clips etc.

Patients were subjected to MRI scan of the brain on superconductive SIEMENS – Magnetom Avanto 1.5 Tesla. The head coil was used for the scan. Upper body clothing with metallic trim or any clothing likely to create static electricity were removed. The patients were given disposable earplugs to attenuate the gradient switching noise.

Initial topogram of the head was obtained and sequences were planned according to the MRI seizure protocol. MRI protocol at 1.5T included the entire scanning of brain from nasion to inion.

NON-CONTRAST IMAGES:

- 5 mm thick TSE T1 weighted images axial and sagittal,
- 5 mm thick TSE T2 weighted images axial and coronal
- 5 mm thick TSE T2 weighted FLAIR (Fluid attenuation inversion recovery),
- 5mm thick TSE T2 weighted EPI diffusion weighted & ADC (Apparent
- Diffusion Coefficient) images.
- 2mm thick TSE T2 x weighted SWI images (Susceptibility Weighted images)
- 3-D time of flight imaging sequence

The scans were studied in detail on monitor and finally films were taken for permanent record. Every effort was made to make sure of high-quality scans and to avoid artefacts.

MRI findings with provisional diagnosis (In case of differential diagnosis given in MRI report, the first differential was assumed as MRI diagnosis) and clinical history was recorded as per the proforma.

CSF examination, blood parameter, other radiological investigation and histopathological reports were reviewed and recorded according to the provisional diagnosis.

After proper workup, arriving at the provisional diagnosis, appropriate treatment had to been given to all patients, then after 3 month all

patients were followed with subsequent imaging studied to know the response of previously given treatment and established confirmatory diagnosis.

RESULTS

Table 1: Gender Wise Distribution of Age Groups.

Age Groups	Females		Males		Total	
	No of Cases	Percentage	No of Cases	Percentage	No of Cases	Percentage
20 years or less	3	13%	3	14.2%	6	13.64%
21- 30 years	13	56.5%	1	4.7%	14	31.8%
31-40 years	4	17.3%	8	38%	12	27.27%
41-50 years	1	4.3%	6	28.5%	7	15.91%
> 50 years	2	8.6%	3	14.2%	5	13.64%
Total	23	52.27%	21	47.73%	44	100.00%

Graph 2: MR Venography Findings in Affected Cases.

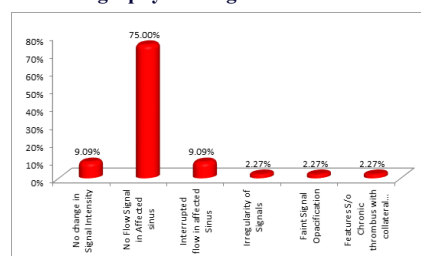


Table 2: Anatomical Site involved in cases of thrombosis.

Involved Sinus	No. Of cases	Percentage	
Superior Sagittal Sinus	28	63.64%	
Straight Sinus	14	31.82%	
Vein of Galen	1	2.27%	
Sigmoid Sinus	6	13.64%	
Internal Jugular Vein	2	4.55%	
Internal Cerebral Veins	1	2.27%	
Transverse Sinus	Right	12	27.27%
	Left	15	34.09%
	Bilateral	8	18.18%

(Overall numbers are more than number of cases as multiple sinuses were involved in many cases)

Table 3: T1 Weighted Imaging Abnormalities in Studied cases.

	T1WI	T2WI
No change in Signal Intensity	65.9%	47.72%
Isointense Signals in Affected Area	20.4%	2.27%
Hypointense Signals in affected area	2.2%	2.27%
Hyperintense Signals in affected area	11.3%	47.72%

Table 4: Various Imaging in studied cases

		No. of cases	Percentage
Diffusion Weighted Imaging	No Restriction	25	56.82%
	Restriction seen in affected areas	19	43.18%
ADC Imaging	Normal	25	56.82%
	Corresponding drop of signal	19	43.18%
Susceptibility Weighted Imaging	Blooming Noted in affected areas	20	45.45%
	No Blooming of focus	24	54.55%

DISCUSSION

Few studies^(3,4) reported that cerebral venous thrombosis is an uncommon form of stroke, usually affecting young adults. In our study a total of 62% patients were female patients. Among them 58% of the patients (18 patients) belong to reproductive age group. Ameri A, Bousser MG⁽⁴⁾ in their study reported a female to male ratio of 1.29:1 in CVT and that 61% of women were between the age group 20-35 years. However, in our study conducted on 44 patients there were 23 males (58%) and 21 females (42%) with a M:F ratio of 1:0.91. The analysis of the age groups of the studied cases showed that the most

common affected age group was between the age of 21-30 years (29.55%) followed by 31 – 40 years (27.27%) and 41-50 years (13.64%). Relatively a smaller number of patients were found to have been affected in the age group below 20 years (13.64%) or above 50 years (13.64%). The mean age of the studied cases was found to be 35.27 ± 14.03 years. The most common age group in male patients was found to be 31-40 years (18.18%) and 41-50 years (13.64%) while in females the most common age group was found to be 21-30 years (27.27%).

Studies by Walecki J et al⁵ and Altinkaya N. et al⁶ that mainly focus on the use of unenhanced MRI sequences for the evaluation of CVST have shown that the T2-weighted GRE sequence has a higher sensitivity for the characterization of thrombosis, compared with other unenhanced MRI sequences, such as T1-weighted unenhanced, T2-weighted, DWI, and T2 weighted FLAIR sequences⁵⁽⁶⁾. The results of the present study showed in majority of the affected cases there was no change in signal intensity on T1 weighted images. Out of 44 studied cases 29 (65.9%) patients showed no altered signal intensity areas. Isointense areas were found in 9 (20.4%) cases whereas hyperintense and hypointense signal areas were found in 5 (11.3%) and 1 (2.27%) cases respectively. The sensitivity, 95% confidence interval and positive predictive value of T1 weighted imaging for the diagnosis of Central Venous thrombosis was found to be 34.09%, 20.49% to 49.92% and 100%.

Out of 44 studied cases 21 (47.72%) patients showed no altered signal intensity areas. Hyperintense signal areas were found in 21 (47.72%) cases whereas isointense and hypointense signal areas were found in 1 (2.27%) patients each. The sensitivity, 95% confidence interval and positive predictive value of T2 weighted imaging for the diagnosis of Central Venous thrombosis was found to be 52.27%, 36.69% to 67.54% and 100%.

In a previous study by Yildiz ME et al. and Chu K et al¹⁰, DWI has been shown to be helpful in the absence of a T2-weighted GRE sequence⁷, but it has shown low sensitivity for the visualization of clots, these findings are like the results of the present study. DWI can be useful in the evaluation of abnormal findings associated with DVST, such as parenchymal infarction or susceptibility related signal occurring next to the thrombosed vein. In our present study on diffusion weighted imaging there was no restriction noted in 25 (56.82%) cases whereas varying degrees of restriction was seen in 19 patients (43.18%) in areas affected. The sensitivity, 95% confidence interval and positive predictive value of Diffusion weighted imaging for the diagnosis of Central Venous thrombosis was found to be 43.18%, 28.35% to 58.97% and 100%.

On apparent diffusion coefficient corresponding drop of signal there was seen in 19 patients (43.18%) in areas affected. No changes were noted in 25 (56.82%) cases. The sensitivity and positive likelihood ratio of ADC imaging for the diagnosis of Central Venous thrombosis was found to be 43.18% and 0.43. The sensitivity and positive likelihood ratio of ADC imaging for the diagnosis of Central Venous thrombosis was found to be 79.55% and 0.80.

Superior sagittal sinus is considered the most commonly involved sinus in cerebral venous sinus thrombosis, as stated by various studies conducted previously. This, however, has been correlated in our study as well. The analysis of the cases based on Sinus involved on the basis of MR venography showed that the most commonly affected sinus was superior sagittal sinus (SSS). It was found to have been affected, as evidenced by signal abnormalities on MR venography, in 28 (63.64%) cases. After SSS the most commonly affected sinuses were left transverse sinus (34.09%), straight sinus (31.82%) and right transverse sinus (27.27%).

CONCLUSION

Compared with a conventional sequence, the GRE T2* WI sequence not only improves the detection rate of microbleeds but also reveals the progression of the bleeding lesion. Our study mainly focus on the use of unenhanced MRI sequences for the evaluation of CVST have shown that the T2-weighted GRE sequence has a higher sensitivity for the characterization of thrombosis, compared with other unenhanced MRI sequences, such as T1-weighted unenhanced, T2-weighted, DWI, and T2 weighted FLAIR sequences.

This study demonstrated the role of MR venogram, with different

sequences of MRI i.e. T1WI, T2WI, diffusion weighted imaging with ADC mapping and susceptibility weighted imaging in early and accurate diagnosis of CVST, as its timely diagnosis has got an impeccable prognosis.

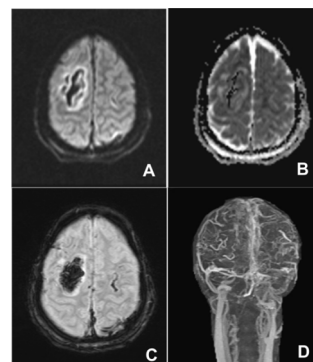


Figure 1: a) There is an abnormal signal intensity lesion in right frontal and left parieto-temporal region appearing hyperintense on DWI b) with corresponding drop on ADC c) the lesion in the right frontal and left parieto-temporal region shows blooming on SWI d) No flow signal in SSS, SS, left TS, distal right TS, left S'S, left parietal cortical veins on MRV imaging

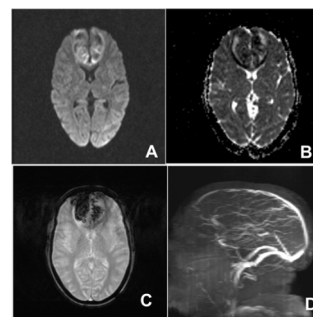


Figure 2: a) There are abnormal signal intensity lesions in bilateral frontal (parafalcine) region appearing hyperintense on DWI b) with corresponding drop on ADC c) there is blooming in bilateral frontal region, parasagittal region and along SSS on SWI d) No flow signal in anterior SSS on MRV imaging

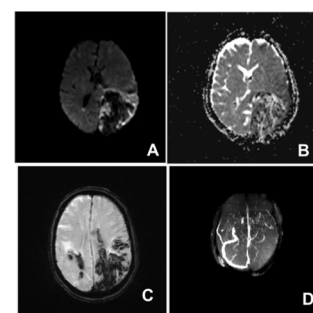


Figure 3: a) There are abnormal signal intensity lesions in left parieto-occipital region appearing hyperintense on DWI b) with corresponding drop on ADC c) the lesion in left parieto-occipital region shows blooming on SWI d) No flow signal in left TS and S'S on MRV imaging

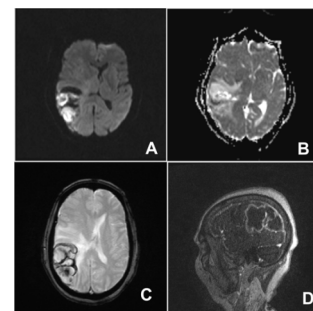


Figure 4: a) There are abnormal signal intensity lesions in right

parieto- occipital region appearing hyperintense on DWI b)with corresponding drop on ADC c)the lesion in right parieto- occipital region shows blooming on SWI d)No flow signal in right TS and S'S on MRV imaging.

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