International Journal of Research in Medical Sciences
Shrivastav A et al. Int J Res Med Sci. 2016 May;4(5):1683-1687
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20161249

Research Article

Role of magnetic resonance venogram, diffusion and susceptibility weighted imaging in diagnosis of cerebral venous thrombosis

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Received: 05 March 2016
Revised: 09 March 2016
Accepted: 07 April 2016

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ABSTRACT

Background: Cerebral venous thrombosis (CVT) is an uncommon and sometimes critical disease, especially in untreated patients. CVT is an elusive diagnosis because of its nonspecific presentation and its numerous predisposing causes. Accurate diagnosis is difficult but important because effective therapies, including anticoagulants and intrasinus thrombolysis are available. Patients with cerebral venous thrombosis often make dramatic recoveries after anticoagulation. For this reason, accurate diagnosis is important and critical. The aim was to study the extent of venous sinus involvement and associated cerebral parenchymal changes on magnetic resonance venogram (MRV); 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.
Methods: Study was conducted on 34 patients diagnosed to have cerebral venous thrombosis on imaging.
Results: Imaging analyses of 34 patients (19 females, 15 males, and age range 19-75 years) were done. Thrombus on MRV was seen as loss of high flow signal from the sinus in cases of complete occlusion of the sinus and frayed or patchy flow signal in the cases of non-occlusive thrombus. 16 patients with hemorrhagic infarct showed heterogeneous signal intensity on DWI (diffusion weighted imaging) and blooming on SWI (suseptibility weighted imaging) sequence. 13 patients with non-hemorrhagic infarct showed multifocal high signal intensities in DWI with variable ADC values and no blooming on SWI. 5 patients with intracerebral hematoma showed areas of heterogeneous signals on DWI with blooming on SWI, corresponding ADC values were variable.
Conclusions: MRV, diffusion and susceptibility weighted imaging can be used to evaluate the extent of thrombus, discriminate between different types of edema, detect intracerebral hematoma, hemorrhagic and non-hemorrhagic infarcts, and deliver time-saving information for early diagnosis of CVT.

Keywords: CVT, MRV, SWI, DWI

INTRODUCTION

CVT is a cause of stroke with obscure pathophysiologic properties that differ from arterial stroke. Its main mechanisms of pathophysiology are the breakdown of the blood-brain barrier and the coexistence of cytotoxic and vasogenic edema. Cerebral venous thrombosis differs from arterial infarction in several ways. First, the clinical presentation is variable and may range from subacute headache, raised intracranial pressure to severe multifocal deficits, seizures and coma.[1] Accurate diagnosis is difficult but important because effective therapies are available. Patients with cerebral venous thrombosis often

make dramatic recoveries and for this reason accurate diagnosis is important and critical.

METHODS

This prospective study was performed on 34 patients diagnosed to have cerebral venous thrombosis over a period of 18 months from January 2014 to July 2015 in department of radiodiagnosis of R.L. Jalappa Hospital and Research Center attached to Sri Devaraj Urs Medical College, Kolar, Karnataka, India.

After an informed consent was taken, patients in this study were scanned with 1.5 T MRI (Siemens Magnetom Avanto) in the department of radio diagnosis and examined with the following sequences:

T1, T2-weighted sequence.

- Fluid-attenuated inversion recovery (FLAIR) sequence.
- Diffusion-weighted imaging sequence with corresponding ADC mapping.
- Susceptibility weighted imaging sequence.
- 3-D time-of-flight imaging sequence.

ADC values were calculated automatically by the software and then displayed as a parametric map that reflected the degree of diffusion of water molecules through different tissues. Then ADC measurements were recorded for a given region by drawing regions of interest (ROIs) on the ADC map. ADC values of the region of interest were compared with ADC values of the normal brain parenchyma.

Role of diffusion weighted imaging with ADC mapping in distinguishing type of edema, susceptibility weighted imaging to diagnose presence of any bleed and MR venogram to determine the extent of thrombus are also evaluated.

Inclusion criteria

Any patient diagnosed to have cerebral venous thrombosis on CT or MRI.

Exclusion criteria

All patients with metallic implants and pacemakers and claustrophobic patients are excluded.

RESULTS

34 patients who were diagnosed with cerebral venous thrombosis on imaging are included in the present study (Table 1).

The peak incidence of cerebral venous thrombosis is seen in the age group of 21-40 years in both males and females (46.7% and 31.5% respectively) (Table 2).

Table 1: Sex wise distribution in patients with cerebral venous thrombosis.

Sex	No. of cases	Percentage (%)
Males	15	44.1
Females	19	55.9
Total	34	100

In the present study the female: male ratio is 1.3:1.

Table 2: Sex wise and age wise distribution in patients with cerebral venous thrombosis.

Age (years)	Males		Females		Total no. of cases
	Cases	%	Cases	%	
0-20	0	0	5	26.3	5
21-40	7	46.7	6	31.5	13
41-60	4	26.6	5	26.3	9
>61	4	26.6	3	15.7	7
Total	15	100	19	100	34

Out of 34 patients, in 9 patients the cause was unknown and postpartum was the commonest cause for CVT which is seen in 9 patients (26.4%). The next common cause was oral contraceptive pills constituting 6 patients (17.6%), followed by dehydration and alcohol, each constituting of 3 patients (8.6%) (Table 3).

Table 3: Distribution of patients depending on the cause in patients with cerebral venous thrombosis.

Cause	No.of patients	Percentage
Unknown	9	26.4
Postpartum	9	26.4
Dehydration	3	8.6
Oral contraceptive pills	6	17.6
Intracranial space occupying lesion	1	2.9
Alcohol	3	8.6
Fever	2	5.8
Sepsis	1	2.9
Total	34	100

Headache was the commonest clinical feature seen in 10 patients (29.4%), the next common clinical feature being seizures in 9 patients (26.4%) followed by hemiparesis in 7 patients (20.5%) (Table 4).

Hemorrhagic infarct was the most common associated manifestation seen in 16 patients (47%) followed by non-hemorrhagic infarct in 13 patients (38.2%) and intracerebral hematoma in 5 patients (14.8%) (Table 5).

Transverse sinus is most commonly involved in cerebral venous thrombosis which is seen in 19 patients (27.8%). The next commonest sinus involved is superior sagittal sinus in 15 patients (21.7%) followed by straight sinus in 10 patients (14.4%) (Table 6).

A 23 year old female patient in postpartum status presented with seizures and altered sensorium (Figure 1a -1d).

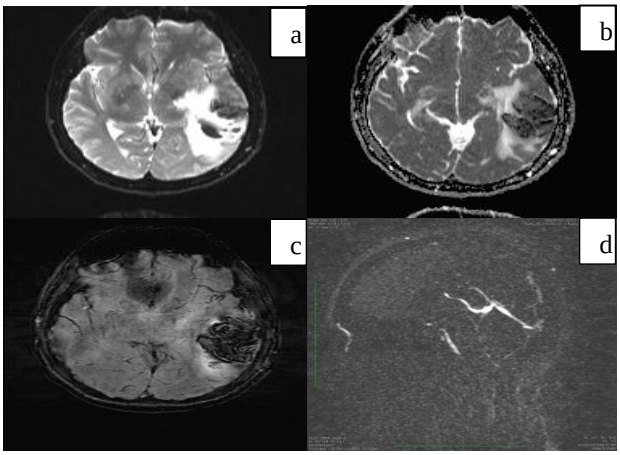

Figure 1a and b: DWI and ADC images showing infarct in left temporo-parietal regions; (c):SWI showing blooming within the area of infarct confirming it to be a hemorrhagic infarct; (d) Sagittal 2D TOF image showed absence of flow signals in superior sagittal sinus, transverse sinus and sigmoid sinus.

A 35 year old male patient presented with right sided hemiparesis (Figure 2a-e).

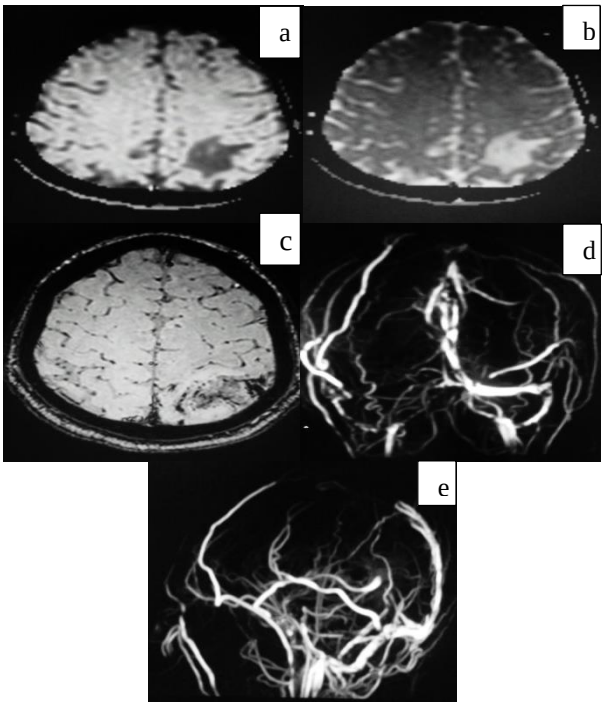

Figure 2: (a) and (b): DWI and ADC images showing infarct in left parietal lobe; (c) SWI showing blooming within the area of infarct and confirms it to be a hemorrhagic infarct; (d) and (e): MRV shows multiple filling defects in superior sagittal sinus, right transverse, sigmoid sinuses and proximal IJV.

A 70 year old female presented with sudden loss of consciousness (Figure 3a-e).

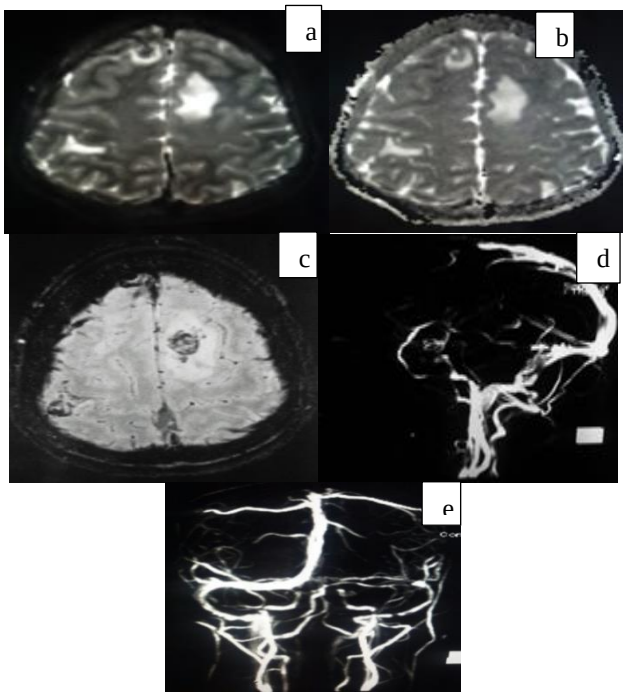

Figure 3a, b and c: DWI images shows hyperintensities in bilateral frontal lobes, ADC confirms no restriction. SWI shows blooming within the concerned areas and confirms it to be hemorrhages; (d) and (e): MRV shows non visualization of anterior part of superior saggital sinus and hypoplastic left transverse sinus.

A 56 years old male presented with left sided hemiparesis (Figure 4a-d).

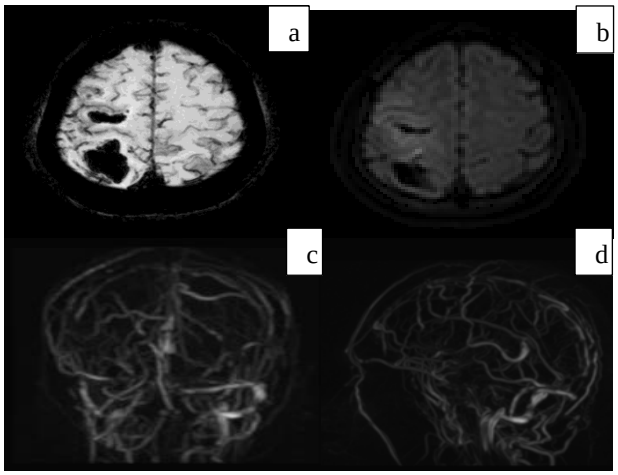

Figure 4a and b: SWI and DWI showing haemorrhagic infarcts in the right frontal and parietal lobes; (c) and (d): MRV shows loss of normal flow voids with filling defects in post contrast images in superior sagittal, right transverse, sigmoid sinuses, internal jugular vein and distal straight sinuses.

Table 4: Distribution of patients based on clinical history in patients with cerebral venous thrombosis.

Clinical feature	Cases	Percentage
Headache	10	29.4
Hemiparesis	7	20.5
Giddiness	3	8.8
Seizures	9	26.4
Vomiting	3	8.8
Coma	1	2.9
Raised intracranial tension	1	2.9
Total	34	100

Table 5: Distribution of patients with cerebral venous thrombosis depending on associated manifestations.

Associated manifestation	No.of cases	Percentage
Haemorrhagic infarct	16	47
Non-haemorrhagic infarct	13	38.2
Intracerebral haematoma	5	14.8
Total	34	100

Table 6: Distribution of sinuses involvement in patients with cerebral venous thrombosis.

Sinus	No.of cases	Percentage
Superior sagittal sinus	15	21.7
Inferior sagittal sinus	3	4.3
Straight sinus	10	14.4
Transverse sinus	19	27.8
Cavernous sinus	2	2.8
Vein of galen	4	5.8
Cortical veins	4	5.8
Sigmoid sinus	6	8.7
Internal jugular vein	6	8.7

DISCUSSION

Cerebral venous thrombosis refers to occlusion of venous channels in the cranial cavity, including dural venous thrombosis, cortical vein thrombosis and deep cerebral vein thrombosis. They often co-exist and the clinical presentation among them is very similar and nonspecific. Furthermore, the diagnostic imaging features can be subtle.[2] This disorder is potentially lethal but treatable, oftenly it was overlooked in both clinical and radiologic in routine practice. MR Venogram, SWI and DWI with ADC mapping is a useful method to establish the diagnosis. These imaging modalities may reveal either direct sign (visualization of intraluminal clot) or indirect signs (paranchymatous change, intracranial hemorrhage). By using of effective treatment will improve the prognosis of the patient.

Parenchymal hemorrhages were seen in 16 patients with cerebral venous thrombosis. James L et al concluded in a study in 2006 that the mechanism of hemorrhage is multifactorial. Hemorrhage may be precipitated by continued arterial perfusion in areas of cell death, as can be seen at reperfusion in arterial ischemia. Elevation of venous pressure beyond the limit of venous wall is also believed to be a cause.[3]

Favrole et al reported that the movements of water molecules are more or less restricted within the venous clot according to the stage of thrombus formation in CVT. Some authors have suggested that the migration of fibroblasts into the clot and incorporation of collagen may render the fibrin less accessible to fibrinolytic enzymes.[4] Others argue that this resistance may be related mainly to an abnormal fibrin polymerization.[5]

Diffusion weighted imaging and ADC measurement of intracranial hematoma were recently reported by Atlas et al, however in our study ADC values of hematoma was avoided. The reason being, the determining factors of ADC values in hematoma may be due to paramagnetic effect of the methemoglobin rather than the true restriction of water movement.[6]

CVT is believed to be more common in women than men. In a series of 110 cases, Ameri and Bousser found a female-to-male ratio of 1.29:1. Ferro et al made the same observations in a prospective study from 1995 to 1998. This slight preponderance in females is probably due to specific causes such as oral contraceptives, pregnancy and puerperium.[7] This preponderance of females did not exist before the era of the oral contraceptive pills. Female predominance was also seen in our study where female to male ratio was 1.3: 1.

Carrol et al found seizures in 29.83% of patients, Srinivasan and Natarajan found seizures in 66% patients.[8,9] Mehta SR et al found seizures in 26.6%. In our study 26.4% of patients had convulsion of which generalized tonic clonic type was commonest. Our study had 21% patients with hemiplegia. Hemiplegia was the commonest form noticed in various series.[10]

In a recent study done by Khaladkar SM et al the most common sinus involved was superior sagittal sinus with almost equal involvement of transverse and sigmoid sinuses and the deep venous system was affected in 17.5% patients, and superficial venous system affected in 2.5% of cases. Most of the patients had involvement of more than one sinus.[11] Commonest association was noticed between superior sagittal sinus and transverse sinuses. Greiner et al concluded that in veno-occlusive stroke, the superior sagittal sinus followed by transverse, sigmoid, and straight were generally involved.[12] Transverse sinus was the most common sinus involved in 27.8% cases followed by superior saggitalsinus in 22% cases, straight sinus in 14.4% and sigmoid sinus in 9% cases. Overall, 66.7% cases showed involvement of more than one sinus.

CONCLUSION

Cerebral venous sinus thrombosis is a challenging condition because of its variability of clinical symptoms and signs. It is very often unrecognized at initial presentation. All age groups can be affected. The prognosis of cerebral venous sinus thrombosis is generally favorable, that makes early and accurate diagnosis of CVT very crucial.

Our study demonstrated the role of MRI with MR venogram, diffusion weighted imaging with ADC mapping and susceptibility weighted imaging in early and accurate diagnosis of cerebral venous thrombosis.

Thrombus on MRV was seen either as loss of high flow signals from the sinus in cases of complete occlusion of the sinus or frayed and patchy flow signal in the presence of non- occlusive thrombus. MRV is also useful for demonstrating recanalization of thrombosed venous sinuses. DWI with ADC maps can be used to discriminate between types of edema for tissue viability and to provide information about stages and diagnostic clues in CVT.

Though both vasogenic and cytotoxic edema are associated with the pathological condition in the early phase of CVT, vasogenic edema develops more frequently. Our study showed coexistence of increased and decreased ADCs in hemorrhagic infarcts. Increase in ADC suggests predominance of vasogenic edema and decrease in ADC suggests cytotoxic edema.

Susceptibility-weighted imaging is an important technique that allows accurate detection of early hemorrhagic transformations within acute infarctions. It also detects chronic microbleeds and intracerebral hematomas, thus alarming the treating physician about the devastating complication of anticoagulant and revascularization therapies.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Shrivastav A, Sakalecha AK, Hegde P. Role of magnetic resonance venogram, diffusion and susceptibility weighted imaging in diagnosis of cerebral venous thrombosis. Int J Res Med Sci 2016;4:1683-7.