



ORIGINAL RESEARCH PAPER

MAGNETIC RESONANCE VENOGRAPHY AS A COMPREHENSIVE NON-INVASIVE TOOL IN CEREBRAL VENOUS SINUS THROMBOSIS: A CROSS-SECTIONAL ANALYSIS

Radio-Diagnosis

KEY WORDS: Cerebral Venous Thrombosis; Magnetic Resonance Imaging; Magnetic Resonance Venography; Venous Infarction; Time-of-flight MRV

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ABSTRACT

Background: Cerebral venous thrombosis (CVT) is an uncommon but potentially life-threatening condition with varied clinical presentation. Early diagnosis is crucial to reduce morbidity and mortality. Magnetic resonance imaging (MRI) with magnetic resonance venography (MRV) is a reliable non-invasive modality for evaluating CVT. **Objective:** To evaluate the role of MRV in the diagnosis and follow-up of cerebral venous thrombosis. **Materials and Methods:** A cross-sectional study was conducted on 30 patients with clinically suspected CVT over a period of one year. MRI brain with MRV was performed using a 1.5 Tesla system (Magnetom avanto, Siemens). Routine MRI sequences along with 3D time-of-flight MRV were obtained. The site of thrombosis, parenchymal changes, and collateral formation were assessed. **Results:** Out of 30 patients, 18 (60%) were females and 12 (40%) were males. The most affected age group was 21–40 years (53.33%). Etiology was unknown in 8 patients (26.66%), while among known causes, alcohol consumption (16.66%), postpartum state (13.33%), and dehydration (13.33%) were common. Headache was the most frequent symptom (30%), followed by seizures (23.33%) and focal neurological deficits (16.66%). The superior sagittal sinus was most commonly involved (63.33%), followed by the transverse sinus (40%). Hypoplastic transverse sinus was more common on the left side (76.20%). Hemorrhagic venous infarcts were seen in 36.66% of patients, and collateral formation in 33.33%. **Conclusion:** MRI with MRV is a comprehensive, safe, and non-invasive modality for diagnosis and follow-up of CVT, effectively delineating venous anatomy, extent of thrombosis, parenchymal involvement, and collateral circulation.

INTRODUCTION

Cerebral venous thrombosis (CVT) is an uncommon but important cause of stroke with diverse etiologies and variable clinical presentation, often mimicking arterial infarcts or intracranial mass lesions (1,2). The diagnosis of CVT remains challenging both clinically and radiologically due to its non-specific symptoms and heterogeneous imaging findings (3). Unlike arterial infarcts, venous infarctions are characterized by vasogenic and interstitial edema secondary to venous congestion rather than purely cytotoxic edema (4).

Early and accurate diagnosis is crucial, as effective treatment options such as anticoagulation and, in selected cases, intrasinus thrombolysis can significantly improve outcomes, even when initiated late (5). Despite this, CVT is often underdiagnosed, and its true incidence remains uncertain, with reported mortality rates ranging from 5–15% (1). However, recent studies suggest a decline in mortality to less than 10% with early diagnosis and improved management (6).

Neuroimaging plays a pivotal role in the diagnosis of CVT. Conventional computed tomography (CT) has limitations, missing up to 16–40% of cases and underestimating the extent of venous involvement (7,8). Digital subtraction angiography (DSA), though considered a reference standard, is invasive, time-consuming, and associated with procedural risks (6).

Magnetic resonance imaging (MRI) combined with magnetic resonance venography (MRV) has emerged as a reliable, non-invasive modality for evaluation of CVT, enabling accurate visualization of venous sinuses, extent of thrombosis, parenchymal changes, and collateral circulation (9–11). Advanced MRI techniques such as diffusion-weighted imaging further aid in differentiating cytotoxic and vasogenic edema, thereby guiding clinical management (3,4).

With increasing awareness and advancements in imaging techniques, early diagnosis of CVT has improved, which is

essential for preventing serious neurological sequelae. Hence, evaluation of MRV as a diagnostic tool in CVT is of significant clinical importance.

Aim and objectives

Aim:

To evaluate the role of Magnetic Resonance Imaging (MRI) and Magnetic Resonance Venography (MRV) in the diagnosis and assessment of cerebral venous sinus thrombosis (CVST).

Objectives:

To assess the diagnostic utility of MRV in detecting cerebral venous sinus thrombosis in clinically suspected patients. To evaluate the extent and pattern of involvement of the cerebral venous system in CVST. To study the spectrum of parenchymal changes associated with CVST on conventional and advanced MRI sequences. To identify the prevalence and pattern of clinical presentations in patients with CVST. To analyze the correlation between the site of venous thrombosis and associated cerebral parenchymal changes. To assess the presence and role of collateral venous circulation in cases of CVST.

Materials and Methods:

This cross-sectional observational study was conducted over a period of one year in the Department of Radiodiagnosis. A total of 30 patients with clinically suspected cerebral venous sinus thrombosis (CVST) referred for Magnetic Resonance Imaging (MRI) and Magnetic Resonance Venography (MRV) were included. The sample size was determined based on approximately 80% of the average number of similar cases encountered over the preceding three years. Patients with clinical suspicion and imaging confirmation of CVST were included, while those with contraindications to MRI, such as cardiac pacemakers, cochlear implants, prosthetic valves, or metallic implants, were excluded.

All patients were examined using a 1.5 Tesla MRI scanner (Siemens Magnetom Avanto) with standard head coils. The MRI protocol included T1-weighted, T2-weighted, Fluid

Attenuated Inversion Recovery (FLAIR), and diffusion-weighted imaging (DWI). MR venography was performed using the 2D Time-of-Flight (TOF) technique in axial and coronal planes, and source images were reconstructed into three-dimensional maximum intensity projection (3D MIP) images. Imaging parameters included TR/TE of 500/8 ms (T1), 4300/99 ms (T2), 9000/114 ms (FLAIR), and 3400/97 ms (DWI), with slice thickness of 5 mm, while TOF MRV was acquired with 2 mm slice thickness and a flip angle of 60°.

All images were analyzed for the site and extent of venous sinus thrombosis, absence of normal flow voids, parenchymal changes including hemorrhagic venous infarction, type of edema (cytotoxic versus vasogenic), and the presence of collateral venous channels and flow gaps. Clinical details including demographic profile and presenting symptoms were recorded, and a detailed neurological examination was performed. MRI was conducted without sedation in most patients; sedation was administered selectively under medical supervision when required.

Data were analyzed using descriptive statistics, with categorical variables expressed as frequencies and percentages and continuous variables as mean $\pm$ standard deviation where applicable. Statistical analysis was performed using Microsoft Excel. Patients were followed up clinically and radiologically as indicated to assess disease progression and response to treatment.

RESULTS

A total of 43 patients with clinical suspicion of cerebral venous sinus thrombosis (CVST) underwent MRI with MR venography. Of these, 30 patients (69.8%) were confirmed to have CVST and were included in the final analysis, while 13 patients (30.2%) showed no evidence of thrombosis.

Among the 30 patients, 18 (60%) were females and 12 (40%) were males, with a female-to-male ratio of 1.5:1. The majority of patients were in the 21–40 years age group (53.3%), followed by 41–60 years (26.7%). There was no statistically significant association between age and gender distribution ($p > 0.05$).

The etiology was unknown in 8 patients (26.7%). Among the known causes, alcohol consumption was the most common (16.7%), followed by postpartum state and dehydration (13.3% each). Other causes such as mastoiditis, malaria, fever, oral contraceptive use, intracranial space-occupying lesion, and sepsis were less frequent. No significant association was observed between etiology and gender ($p > 0.05$).

Headache was the most common presenting symptom (30%), followed by seizures (23.3%) and hemiparesis or focal neurological deficits (16.7%). Other symptoms included giddiness, vomiting, altered sensorium, raised intracranial pressure, and cranial nerve palsy. There was no significant correlation between clinical presentation and the number of sinuses involved ($p > 0.05$).

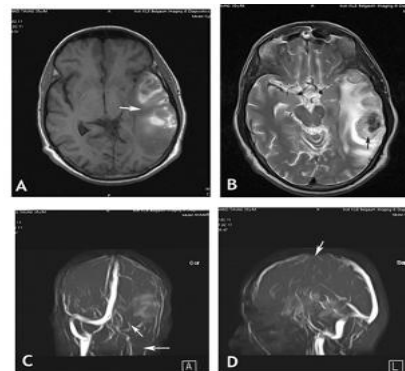
The superior sagittal sinus was the most commonly involved sinus (63.3%), followed by transverse sinus (40%) and sigmoid sinus (36.7%). Involvement of deep venous structures such as internal cerebral vein (10%), vein of Galen (6.7%), and basal vein of Rosenthal (3.3%) was less frequent.

Single sinus involvement was seen in 36.7% of patients, while two and three sinus involvement were observed in 26.7% each, and four sinus involvement in 10%. There was no statistically significant association between the extent of sinus involvement and clinical severity ($p > 0.05$).

Hypoplastic transverse sinus with flow gaps was identified in 70% of patients. Left-sided hypoplasia was more common (76.2%) compared to the right side (23.8%), and this

difference was statistically significant ($p < 0.05$). Hemorrhagic venous infarction was present in 36.7% of patients, while 63.3% showed no hemorrhagic changes. Although hemorrhagic infarction was more frequently associated with multiple sinus involvement, the association was not statistically significant ($p > 0.05$).

Collateral venous channels were observed in 33.3% of patients and were more commonly seen in cases with extensive sinus involvement; however, this association did not reach statistical significance ($p > 0.05$).



A 35 year old male patient presents with seizures and altered sensorium Fig 8A&B. T1 and T2 weighted images showed hemorrhagic venous infarct in left temporo-parietal regions. Fig 8C&D. Coronal and sagittal 2D TOF MIP images showed absence of flow signals in left transverse sinus, sigmoid sinus (Arrows) and Superior sagittal sinus (Arrow).



A 30 year old female with post partum seizures Fig 9A. T2 weighted image showed hemorrhagic venous infarct and Fig 9B. Coronal 2D TOF MIP image showed absence of flow signals in left transverse sinus suggestive of thrombosis.

DISCUSSION

Cerebral venous sinus thrombosis (CVST) is a relatively uncommon but important cause of stroke with highly variable clinical presentation, often mimicking other neurological conditions. In the present study, a female predominance (60%) with a female-to-male ratio of 1.5:1 was observed, which is consistent with previous studies by Ameri and Bousser (1.29:1) and reflects the influence of gender-specific risk factors such as puerperium and hormonal changes (6).

The peak incidence in the present study was noted in the 21–40 years age group, aligning with earlier reports that describe CVST as a disease predominantly affecting young and middle-aged adults (12). The etiology remained unidentified in 26.7% of cases, which is comparable to previously reported rates of 20–30% (5,6). Among identifiable causes, alcohol consumption, postpartum state, and dehydration were the most frequent, highlighting the multifactorial nature of CVST.

Headache was the most common presenting symptom (30%), followed by seizures and focal neurological deficits. This is in agreement with prior studies that describe headache as the most frequent and often earliest symptom (13,14). The superior sagittal sinus was the most commonly involved sinus (63.3%), followed by transverse and sigmoid sinuses, consistent with established literature (15).

Single sinus involvement was most frequent; however, multiple sinus involvement was also common, reflecting the variable extent of disease. Hemorrhagic venous infarction was observed in 36.7% of cases, which falls within the reported range in literature (16). Although more frequent in

patients with multiple sinus involvement, this association was not statistically significant.

Hypoplasia of the transverse sinus, particularly on the left side, was frequently encountered and represents an important diagnostic pitfall in MR venography due to potential flow gaps. Collateral venous channels were seen in one-third of patients, suggesting compensatory mechanisms in chronic or extensive thrombosis.

MRI combined with MR venography proved to be a reliable, non-invasive modality for diagnosis, allowing assessment of both venous anatomy and parenchymal changes. Diffusion-weighted imaging further aids in differentiating cytotoxic and vasogenic edema, thereby contributing to prognostication and management (3,4).

CONCLUSION

Cerebral venous sinus thrombosis predominantly affects young adults with a female preponderance and presents with nonspecific clinical features, most commonly headache. Superior sagittal sinus is the most frequently involved site. MRI with MR venography is a highly effective, non-invasive modality for early diagnosis and evaluation of disease extent. Recognition of anatomical variants such as transverse sinus hypoplasia is essential to avoid diagnostic errors. Early diagnosis facilitates timely management, reducing morbidity and improving clinical outcomes.

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