

CEREBRAL VENOUS SINUS THROMBOSIS (CVST) SCORE: A PROGNOSTIC SCORE FOR CLINICAL OUTCOME IN CEREBRAL VENOUS SINUS THROMBOSIS

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ABSTRACT:

Cerebral venous sinus thrombosis is an uncommon but clinically important cerebrovascular disorder caused by thrombotic occlusion of the cerebral veins, dural venous sinuses, or both. Unlike arterial stroke, CVST predominantly affects younger individuals and has traditionally demonstrated a female predominance. Its clinical importance arises from its highly variable presentation, potential for severe neurological deterioration, and the possibility of substantial recovery when diagnosed and treated promptly.[1,2] Contemporary epidemiological studies have suggested that the incidence of CVST is higher than previously recognized, partly because of improved clinical awareness and greater availability of advanced neuroimaging.[3,4]

INTRODUCTION

The pathophysiology of CVST involves impaired cerebral venous drainage resulting from thrombotic obstruction. Increased venous pressure can impair cerebrospinal fluid absorption, causing intracranial hypertension, while cortical venous congestion may lead to cerebral edema, venous infarction, and intracranial hemorrhage. The superior sagittal, transverse, and sigmoid sinuses are frequently involved, whereas thrombosis involving the deep cerebral venous system may be associated with particularly severe neurological manifestations and adverse outcomes.[5]

CVST is associated with a broad range of acquired and inherited risk factors, including pregnancy and puerperium, oral contraceptive use, infection, dehydration, malignancy, and hereditary or acquired thrombophilic states.[4,6] Indian cohorts have demonstrated epidemiological and clinical patterns that may differ from those reported in Western populations, emphasizing the importance of evaluating prognostic models within region-specific populations.[7]

Clinical presentation is heterogeneous and may include headache, seizures, focal neurological deficits, papilledema, visual disturbances, altered consciousness, or coma. Headache is the most frequently reported manifestation, while seizures occur considerably more often in CVST than in arterial ischemic stroke. Magnetic resonance imaging combined with magnetic resonance venography is widely used for diagnostic confirmation and evaluation of associated parenchymal abnormalities.[4]

Although the overall prognosis of treated CVST is generally favorable, a clinically important proportion of patients develop substantial disability or die. Several clinical and radiological characteristics, including impaired consciousness, intracranial hemorrhage, deep venous system thrombosis, extensive parenchymal lesions, malignancy, and advanced age, have been associated with adverse outcomes. The International Study on Cerebral Vein and Dural Sinus Thrombosis (ISCVT) demonstrated that identifiable clinical and imaging variables can help stratify the risk of death or dependency in patients with CVST.[6]

Prognostic scoring systems have consequently been developed to facilitate early risk stratification. However, existing scores differ in their included variables, complexity, outcome time points, and populations in which they were derived and validated. Some have limited external validation, while others incorporate variables that may reduce their ease of use in acute clinical settings.[8,9]

Furthermore, the prognostic importance of quantitative parenchymal lesion burden remains an area of interest because structural brain injury is closely related to the severity of venous congestion and infarction. Therefore, there is a need for a simple clinico-radiological prognostic approach incorporating parameters that can be assessed during the initial evaluation of patients with CVST.

The proposed CVST Score will incorporate four clinical and radiological components: Consciousness (C), Volume of parenchymal lesion (V), Seizures (S), and Thrombus burden (T). The proposed study will evaluate the relationship of this score with clinical outcomes in patients with cerebral venous sinus thrombosis and assess its potential role in early prognostic stratification.

Research Question

Can a clinico-radiological CVST Score based on consciousness, parenchymal lesion volume, seizures, and thrombus burden predict clinical outcome in patients with cerebral venous sinus thrombosis?

Hypothesis

Null Hypothesis (H₀) : There is no significant association between the CVST Score and clinical outcome in patients with cerebral venous sinus thrombosis.

Alternative Hypothesis (H₁) : A higher CVST Score is significantly associated with an unfavorable clinical outcome in patients with cerebral venous sinus thrombosis.

Aim

To assess the prognostic utility of the CVST Score for predicting clinical outcome in patients with cerebral venous sinus thrombosis.

Objectives

Primary Objective

To assess the association between the CVST Score at admission and functional outcome as measured by the modified Rankin Scale (mRS) at hospital discharge.

Secondary Objectives

1. To assess the association between the CVST Score and functional outcome at one-month follow-up.
2. To determine the relationship between the CVST Score and parenchymal lesion volume.
3. To evaluate the association of individual components of the CVST Score—consciousness, lesion volume, seizures, and thrombus burden—with clinical outcome.
4. To evaluate the prognostic performance of the CVST Score for predicting unfavorable clinical outcome and mortality.
5. To assess the discriminatory ability of the CVST Score using receiver operating characteristic (ROC) curve analysis.

REVIEW OF LITERATURE

Cerebral venous sinus thrombosis (CVST) is an uncommon form of cerebrovascular disease with considerable heterogeneity in its clinical presentation, radiological findings, and outcomes. Earlier studies established that CVST differs substantially from arterial stroke in terms of age distribution, risk factors, clinical manifestations, and prognosis. Stam described the clinical spectrum, pathophysiology, diagnosis, and management of cerebral venous thrombosis and emphasized the importance of early recognition and treatment.[1]

Ferro et al., through the International Study on Cerebral Vein and Dural Sinus Thrombosis (ISCVT), provided important information regarding the natural history and prognostic determinants of CVST. The study identified several variables associated with death or dependency, including advanced age, male sex, coma, mental status disturbance, intracranial hemorrhage, deep cerebral venous system thrombosis, central nervous system infection, and malignancy.[6] These findings demonstrated that clinical and radiological parameters available during initial assessment may have an important role in prognostic stratification.

Coutinho et al. reported that the incidence of cerebral venous thrombosis may be higher than previously estimated.[3] Improvements in clinical awareness and the increasing availability of magnetic resonance imaging and venography have contributed to better recognition of the disorder. Silvis et al. subsequently reviewed contemporary concepts related to the epidemiology, diagnosis, pathophysiology, and management of CVST and highlighted its diverse clinical manifestations and radiological characteristics.[4]

The clinical and epidemiological characteristics of CVST may vary among different populations. Wasay et al., in an Asian study of cerebral venous thrombosis, demonstrated the importance of evaluating the disease within regional populations.[7] Indian studies have also contributed substantially to the understanding of CVST. Narayan et al. evaluated the risk factors, clinical profile, and long-term outcome of 428 patients with cerebral sinus venous thrombosis.[10] Dash et al. further discussed CVST from an Indian perspective and highlighted relevant clinical and epidemiological characteristics.[11]

Seizures constitute an important clinical manifestation of CVST. Kalita et al. evaluated the significance of seizures in patients with cerebral venous sinus thrombosis.[12] Although seizures and status epilepticus may reflect acute neurological involvement, their independent contribution to functional prognosis requires evaluation alongside other clinical and radiological variables.

Radiological characteristics and the extent of parenchymal brain involvement may also influence outcome. Venous obstruction can result in cerebral edema, venous infarction, and intracranial hemorrhage, thereby contributing to neurological deterioration.[5] Simaan et al., in a multicenter study, evaluated predictors of outcome in patients with cerebral venous sinus thrombosis and demonstrated the prognostic relevance of imaging characteristics and parenchymal involvement.[13]

Several attempts have therefore been made to develop practical prognostic models for CVST. Arauz et al. described a practical score for prediction of outcome after cerebral venous thrombosis.[9] More recently, Klein et al. reported the IN-REvASC Score for outcome prediction in CVST.[8] Although such scoring approaches may facilitate risk stratification, differences in included variables, complexity, patient populations, and outcome definitions may affect their applicability across clinical settings.

Despite improvements in diagnosis and treatment, adverse outcomes remain clinically important. Coutinho et al., in a systematic review, demonstrated declining mortality in cerebral venous thrombosis over time.[14]

Nevertheless, early identification of patients at increased risk of neurological deterioration, disability, or mortality remains important for clinical decision-making and monitoring.

Based on the available evidence, impaired consciousness, structural brain injury, seizures, and the extent of venous thrombosis represent clinically relevant parameters that may be assessed during the initial evaluation of CVST. However, the literature cited in the present protocol does not establish the proposed combination of Consciousness (C), Volume of parenchymal lesion (V), Seizures (S), and Thrombus burden (T) as a previously validated unified score. Therefore, the proposed study will evaluate the prognostic utility of a clinico-radiological CVST Score incorporating these four parameters for predicting clinical outcome in patients with cerebral venous sinus thrombosis.

Rationale of the Study

CVST has a highly variable clinical course, ranging from relatively mild symptoms to severe neurological disability and death. Although several clinical and radiological factors associated with adverse outcomes have been identified, a simple prognostic tool incorporating readily assessable clinical and imaging parameters may facilitate early risk stratification.

The proposed CVST Score integrates four parameters—Consciousness, parenchymal lesion Volume, Seizures, and Thrombus burden—that can be assessed during the initial clinical and radiological evaluation. Evaluation of the relationship between this score and subsequent functional outcome may help determine whether it can serve as a practical prognostic tool in patients with CVST.

Study Design and Methodology

Study Design

Prospective observational cohort study.

Study Setting

The study will be conducted in the Department of Neurology, Jawaharlal Nehru Medical College and Acharya Vinoba Bhave Rural Hospital, Datta Meghe Institute of Medical Sciences, Wardha, Maharashtra, India.

Study Population

The study will include consecutive adult patients admitted with radiologically confirmed cerebral venous sinus thrombosis (CVST) who fulfill the eligibility criteria.

Sample Size

The minimum required sample size will be 61 patients. Based on institutional and regional data, approximately 50 CVST cases are expected during the study period. Assuming a 10% frequency of poor outcome, a precision of $\pm 5\%$, 95% confidence level, design effect of 1, and an additional 10% allowance for potential loss to follow-up or incomplete data, the minimum required sample size will be 61 patients.

Inclusion Criteria

Patients fulfilling the following criteria will be considered eligible:

1. Age ≥ 18 years.
2. Clinical features suggestive of CVST, such as headache, seizures, focal neurological deficits, altered sensorium, papilledema, or manifestations of raised intracranial pressure.
3. Diagnosis of CVST confirmed by magnetic resonance venography (MRV).
4. Computed tomography venography (CTV) or digital subtraction angiography (DSA) may be used when MRI is contraindicated.

Exclusion Criteria

Patients with the following conditions will be excluded:

1. Isolated cortical venous thrombosis without dural sinus involvement.
2. Concurrent arterial ischemic stroke.
3. Aneurysmal subarachnoid hemorrhage.
4. Traumatic intracranial hemorrhage.
5. Primary hypertensive intracerebral hemorrhage.
6. Cerebral amyloid angiopathy.
7. Absolute contraindication to anticoagulation.

Detailed Study Procedure

All eligible patients with clinical features suggestive of cerebral venous sinus thrombosis (CVST) will undergo detailed clinical evaluation and appropriate neuroimaging for confirmation of diagnosis. After confirmation of CVST and fulfillment of the eligibility criteria, demographic, clinical, laboratory, and radiological information will be recorded using a standardized proforma.

The CVST Score will be calculated at admission using four components: Consciousness (C), Volume of parenchymal lesion (V), Seizures (S), and Thrombus burden (T). Functional outcome will be assessed using the modified Rankin Scale (mRS) at hospital discharge and at one-month follow-up.

Clinical Assessment

At admission, a detailed clinical history and comprehensive neurological examination will be performed using a standardized proforma. Demographic characteristics, presenting symptoms, duration and mode of onset, and recognized risk factors will be documented.

Presenting manifestations to be recorded will include:

- Headache
- Seizures
- Focal weakness
- Visual disturbances
- Vomiting
- Altered consciousness

Neurological assessment will include evaluation of higher mental functions, cranial nerves, motor and sensory systems, cerebellar functions, and signs of meningeal irritation. The Glasgow Coma Scale (GCS) will be recorded at admission, and fundoscopy will be performed to assess for papilledema.

Laboratory Assessment

Routine hematological and biochemical investigations will include:

- Complete blood count
- Erythrocyte sedimentation rate
- Coagulation profile
- Blood glucose
- Renal function tests
- Liver function tests
- Serum electrolytes

The study protocol will also include thrombophilia evaluation comprising protein C, protein S, antithrombin III, factor V Leiden, prothrombin G20210A mutation, factor VIII, antiphospholipid antibodies, and homocysteine, as specified in the source manuscript.

Neuroimaging Assessment

All patients will undergo brain imaging using magnetic resonance imaging (MRI) or non-contrast computed tomography (NCCT), followed by MRV or CTV for diagnostic confirmation.

Radiological assessment will include:

- Site and extent of venous sinus involvement
- Number of sinuses involved
- Deep cerebral venous involvement
- Internal jugular vein extension
- Cerebral edema
- Venous infarction
- Hemorrhagic transformation

Parenchymal lesion volume, including infarction, hemorrhage, and surrounding edema, will be quantified using the ABC/2 method on axial imaging at the slice showing maximum lesion extent.

CVST Score

A clinico-radiological prognostic score will be calculated at admission using four components: Consciousness (C), Volume (V), Seizures (S), and Thrombus burden (T).

The score will incorporate clinical and radiological parameters available during the initial assessment.

Components of the CVST Score

Component	Clinical/Radiological Parameter	Points
C – Consciousness	GCS 13–15	0
	GCS 5–12	1
	GCS 3–4	2
V – Lesion Volume	<30 mL	0
	30–60 mL	1
	>60 mL	2
S – Seizures	No seizure	0
	≥1 seizure	1
	Status epilepticus	2
T – Thrombus Burden	1 sinus involved	1
	>1 sinus involved	2
	Internal jugular vein involvement	3

Basis of Formation of the CVST Score

The CVST Score was formulated using four clinically and radiologically relevant parameters—level of consciousness (C), parenchymal lesion volume (V), seizures (S), and thrombus burden (T). These parameters

were selected because they represent important indicators of neurological severity and extent of disease in CVST. Each component was graded according to increasing severity, with higher points assigned to more severe clinical or radiological involvement. Consciousness was graded using the Glasgow Coma Scale (GCS), lesion volume was quantified using the ABC/2 method, seizure severity was categorized from absence of seizures to status epilepticus, and thrombus burden was graded according to the extent of venous sinus involvement and internal jugular vein extension. The individual component scores were added to obtain the total CVST Score, ranging from 1 to 9, with a higher score representing greater disease severity.

The total CVST Score will range from 1 to 9 points, according to the scoring system specified in the source manuscript. Patients will subsequently be categorized into:

Low	CVST	Score:	1–3
High CVST Score: 4–9			

The scoring categories and point allocation were based on the scoring system specified in the source manuscript

Definition of Status Epilepticus

Status epilepticus will be defined as continuous seizure activity lasting more than 5 minutes or two or more discrete seizures without complete recovery of consciousness between episodes.

Treatment

All patients will receive standard treatment for CVST.

Anticoagulation will be initiated with weight-adjusted low-molecular-weight heparin, followed by oral anticoagulation as appropriate. Antiepileptic therapy will be administered to patients with seizures, while measures for raised intracranial pressure will be used when indicated.

Decompressive craniectomy will be considered in patients with severe clinical deterioration despite medical management.

Outcome Assessment

Functional outcome will be evaluated using the modified Rankin Scale (mRS) at:

1. Hospital discharge
2. One-month follow-up

Functional outcomes will be categorized as:

- Favorable outcome: mRS 0–3
- Unfavorable outcome: mRS 4–6

The association between the admission CVST Score and subsequent functional outcome will be evaluated.

Statistical Analysis

Statistical analysis will be performed using SPSS version 27.0. Continuous variables will be presented as mean $\pm$ SD or median (IQR), and categorical variables as frequencies and percentages. Appropriate t-test/Mann–Whitney U test and chi-square/Fisher’s exact test will be used for group comparisons. Spearman’s correlation will assess the association between CVST Score and mRS. Logistic regression and ROC curve analysis will evaluate prognostic performance. A p-value <0.05 will be considered statistically significant.

Ethical Considerations

The study will be conducted in accordance with applicable ethical principles for research involving human participants. Approval from the Institutional Ethics Committee (IEC) will be obtained before initiation of the study.

Written informed consent will be obtained from eligible participants or their legally authorized representatives, as applicable. Confidentiality and privacy of participants will be maintained throughout the study. Participant information will be used only for the purposes of the proposed research.

Participation will be voluntary, and participants will have the right to withdraw from the study without affecting their routine clinical care.

Expected Outcome

The proposed study is expected to determine whether the CVST Score, incorporating Consciousness, parenchymal lesion Volume, Seizures, and Thrombus burden, can be used for early prognostic stratification in patients with cerebral venous sinus thrombosis.

The study will also evaluate the relationship of the total CVST Score and its individual components with functional outcome and assess the discriminatory performance of the score for identifying patients at increased risk of adverse clinical outcomes.

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Proforma

A. Demographic Details

- Study ID:
- Age:
- Sex:

B. Clinical Presentation

- Headache:
- Seizure:
- Status epilepticus:
- Focal weakness:
- Visual disturbance:
- Vomiting:
- Altered consciousness:
- Papilledema:
- Glasgow Coma Scale (GCS):

C. Neuroimaging Findings

- Imaging modality:
- Venography:
- Sinus/sinuses involved:
- Number of sinuses involved:
- Deep cerebral venous involvement:
- Internal jugular vein involvement:
- Cerebral edema:
- Venous infarction:
- Hemorrhagic transformation:
- Parenchymal lesion volume (ABC/2):

Appendix II: CVST Score Sheet

Component	Category	Score
Consciousness (C)	GCS 13–15	0
	GCS 5–12	1
	GCS 3–4	2
Volume (V)	<30 mL	0
	30–60 mL	1
	>60 mL	2
Seizures (S)	No seizure	0
	≥1 seizure	1
	Status epilepticus	2
Thrombus burden (T)	1 sinus involved	1
	>1 sinus involved	2
	Internal jugular vein involvement	3

Appendix III: Outcome Assessment**At Hospital Discharge**

- mRS Score:
- Favorable outcome (mRS 0–3):
- Unfavorable outcome (mRS 4–6):
- In-hospital mortality:

At One-Month Follow-up

- Follow-up completed:
- mRS Score:
- Favorable outcome (mRS 0–3):
- Unfavorable outcome: (mRS 4–6)