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Original Research Article

Evaluation of Cerebral Venous Thrombosis by CT Venography in Patients Attending to Tertiary Care Institute

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Abstract:

Aims: To study the varied findings of Cerebral venous thrombosis (CVT) on CT-Venography in clinically suspected cases.

Method: This clinic-radiological study conducted in 50 patients with signs and symptoms of cerebral venous thrombosis referred for CT-Venography for the duration of 2 years.

Results: The mean age was 32.18 ±13.14 years (2- 76 yrs). 66% of patients were in 3rd decade. Large number of patients (35/50) had subacute onset of symptoms i.e. symptom duration (48 hours -30 days). Headache (31/50), seizures (29/50) altered sensorium (7/50) and focal deficits (23/50) Papilledema (54%) were the major clinical features recorded. Cerebral infarction was the most common abnormality noted on CT scan (72%) which was hemorrhagic in 29% of the cases. Deep seated venous infarction (Thalamus and basal ganglionic structure) was seen in 10% of cases. On CT-Venography, Superior sagittal sinus (sss) (the commonest sinus involved) was involved in 39 patients, (isolated sss in 7 patients) total involvement was seen in 11 patients while in other patients anterior, middle and posterior parts involved with various combination of other sinuses. Transverse sinus was the next most common sinus involved 33 patients, (isolated in 4 patients) followed by sigmoid sinus 22 patients superficial venous system was involved in 5 patients (isolated in 2 patients) while deep venous system was involved in 5 patients. Majority (39) of patients had combination of sinuses and veins involvement, 11 patients had only isolated sinus involvement. When we correlated the clinical profile with the topographic Radiological substrate like involvement of superficial/deep venous system or the pattern of infarction, there was no significant correlation to evolve a pattern of diagnostic significance, correlating with involvement of sinus. CSVT is an important and treatable cause of the stroke; it has risk factors like OCP use, alcoholism, procoagulant state are increasingly recognized in addition to the conventional risk factors like postpartum state. Procoagulant state and infections are the most common predisposing factors for cerebral venous thrombosis in this study. Most of the patients who were followed-up had re canalized the occluded veins. Only one patient expired in acute phase and only one patient presented with recurrent CVT.

Conclusion: In patients with unenhanced CT findings suggestive of venous thrombosis, CT venography can be performed without delay to confirm the diagnosis and to start appropriate therapy immediately there by decreasing morbidity and mortality.

Keywords: Cerebral venous thrombosis, CT-Venography, seizures, Papilledema, superior sagittal sinus.

Introduction

Cerebral venous thrombosis (CVT) is a disorder that is challenging to diagnose. The diagnostic difficulty results in large part from the wide variety of clinical manifestations of this uncommon disorder. [1] CVT may occur at any time from infancy to old age most reported cases were women in association with puerperium. [2] Cerebral vein thrombosis is rare compared to arterial stroke and often occurs in young individuals. [3] Cerebral venous infarction is the most serious consequence of cerebral venous thrombosis. Venous infarctions are often multifocal bilateral affecting both grey matter and sub cortical white matter. The mode of onset is highly variable, anything from sudden to progressive, so that cerebral venous thrombosis can mimic a host of conditions. [4] Given these various clinical presentations, unenhanced CT is usually the first investigation performed. Unenhanced CT may show nonspecific changes and may show the spontaneously hyperattenuating thrombus. CT venography has proved to be a reliable method to investigate the structure of the cerebral veins, with a reported sensitivity of 95% with multiplanar reformatted (MPR) images when compared with DSA as the standard of reference. [5]

Owing to its vascular detail and ease of interpretation, CT venography can provide a rapid and reliable diagnosis of cerebral venous thrombosis. [6,7,8] In patients with suspicion of cerebral venous thrombosis, it can be immediately followed by CT venography, thus decreasing the time to diagnosis. The increased morbidity and mortality associated with cerebral vein thrombosis makes it essential to accurately detect less clinically severe cases of CVT so that the "natural history" of this disorder can be modified. Though the data regarding cerebral vein thrombosis from this part of the country is not scanty, wide spectrum of presentation makes it essential to further continue study regarding this topic.

This study was conducted in a large teaching hospital with a medical college located in the heart of Andhra Pradesh, thereby attracting representative population from all areas and especially the lower strata of society. Results of this study are therefore relevant to the general public in this part of the country. By studying the various radiologic presentations, this study aims to create awareness regarding the condition so that by effective interventions, this menace could be tackled effectively.

Materials and Methods

This clinico-radiological study conducted in 50 patients with signs and symptoms of cerebral venous thrombosis referred for CT Venography to the Department of Radio Diagnosis, Government Medical College. The study conducted for a period of 2years from Dec 2020 to Oct 2022.

Method of Collection of Data: CT venography can be defined as a fast thin-section volumetric helical CT examination performed with a time-optimized bolus of contrast medium in order to enhance the cerebral venous system. To visualize the intracranial veins and sinuses, the examination includes the region from the calvarial vertex down to the first vertebral body. We include the atlas (C1) in the study to ensure incorporation of the origin of the jugular internal veins.

Scan Protocol

Machine: Bright Speed scanner (GE Healthcare, Milwaukee, Wis) having a 16-row detector ring.

- Section thickness: 0.625 mm.
- Pitch: 0.9.
- Contrast: Non-ionic medium.
- Dose: 1ml/kg body weight.
- Scan delay: 45sec.
- Rate: 3ml/sec.
- Coverage: C1 to vertex.

Inclusion Criteria:

This study was performed as a hospital based study at Dept. of Radiology, Govt. General Hospital. All patients hospitalized in between the period (2020 to 2022) with the final diagnosis of CVT were included like;

1. All Patients diagnosed by the imaging studies.
2. Any age group presenting with cerebral venous thrombosis.
3. Puerperal and non-puerperal group.

Exclusion Criteria:

1. Patients with contrast allergy.
2. Patients with serum creatinine>1.5.

Results

In the present study of total 50 patients there were 54% female and 46% male patients. Majority of patients were in the 3rd decade of their age (66%). 24% patients were in above 4th decade of their age. 8% patients were <18 years of age. The mean age was 32.18 ±13.14 yrs with maximum age 76, minimum age 2 years. Majority of patients (70%) had duration of symptoms less than 30 days (subacute presentation). Only 4% patients had symptom duration < 24 hrs (acute presentation) and 14% had symptoms present more than a month (chronic presentation).

Majority of patients (86%) were in normal sensorium (GCS-15) while 8% patients were drowsy (10-14-GCS). Glasgow Coma Scale (GCS) was available in all patients. 6% of patients had GCS <10. 62% had headache as a symptom at the time of presentation. 58% patients had a complaint of seizures (most common being partial type of seizures-46%) whereas rest 42% patients had no such complaint. On ophthalmic examination by slit lamp and direct ophthalmoscopy shows that 54% were having papilloedema at the time of admission. Among focal signs, out of 50 patients 54%patients had Idiopathic Intracranial Hypertension type of presentation, 46% patients had focal deficits, 58% patients had seizures, 12% patients had generalized seizures. Focal size in 30% patients and status epilepticus in 4% patients. Hemiplegia in 30%, hemiplegia with aphasia in 6%, Quadriplegia in 4% and cerebellar signs in 6% patients respectively.

Non-contrast CT Findings:

Infarction was present in 72%of them out of which 54% had haemorrhagic infarction. 18% patients had non-haemorrhagic infarction. According to the site, 90% patients had cortical infarction while 10% had deep infarction. One patient had evidence of both cortical and deep infarction.

Table 1: Affected Region

Affected region	No of patients	Percentage
No lesion	14	28.0
Frontal	5	10.0
Fronto temporal	1	2.0
Fronto temporoparietal	1	2.0
Frontal & occipital	4	8.0
Frontal & parietal	3	6.0
Temporal	6	12.0
Temporo occipital	3	6.0
Temporo, parieto occipital	1	2.0
Temporoparietal	2	4.0
Occipital	3	6.0
Occipitall & parietal	5	10.0
Parietal	1	2.0
Diffuse edema	1	2.0
Total	50	100.0

Involvement of the sinuses based on CT venography:

Superior sagittal sinus (the commonest sinus involved) was involved in 39 patients, (isolated SSS in 7 patients).

Total involvement was seen in 11patients while in other patients anterior, middle and posterior parts involved with various combination of other sinuses.

Transverse sinus was the next most common sinus involved 33 patients, (isolated in 4 patients) followed by sigmoid sinus 22 patients. Superficial venous system was involved in 5 patients (isolated in 2 patients) while deep venous system was involved in 5 patients. Majority (39 patients) of patients had combination of sinuses and veins involvement, 11 patients had only isolated sinus involvement.

Table 2: Mode of onset, clinical presentation and outcome according to the site of venous occlusion

Sinus	Acute	Subacute	Chronic	Seizure	ICH	Focal Signs
SSS	1	5	2	6	2	4
TS	1	2	0	1	0	1
Cortical vein	0	3	0	2	3	3
TS+SS+IJV	1	4	0	3	2	1
SS+TS+SS	1	8	0	3	3	3
SSS+TS	0	4	3	3	1	3
Sss+Cortical vein	1	2	0	3	3	2
TS+SS	2	3	0	3	1	2
SSS+TS+ Deep	0	2	0	2	2	2
SSS+TS+SS+Deep vein	1	1	2	3	3	1
SS+Cavernous sinus	0	1	0	0		1
Total	8	35	7	29	20	23

Correlation between the site of venous occlusion and clinical parameter: Correlation with etiology showed no constant pattern except that isolated lateral sinus involved in Mastoiditis. Correlation with mode of onset showed no difference in onset whether sinuses alone vs deep venous vs combination of sinuses and veins involved. No significant difference between the presence of thrombus in various sinuses and veins and location of infarction.

When cortical veins are involved patients were presented with seizures and have intracranial hematoma than when only sinuses were involved.

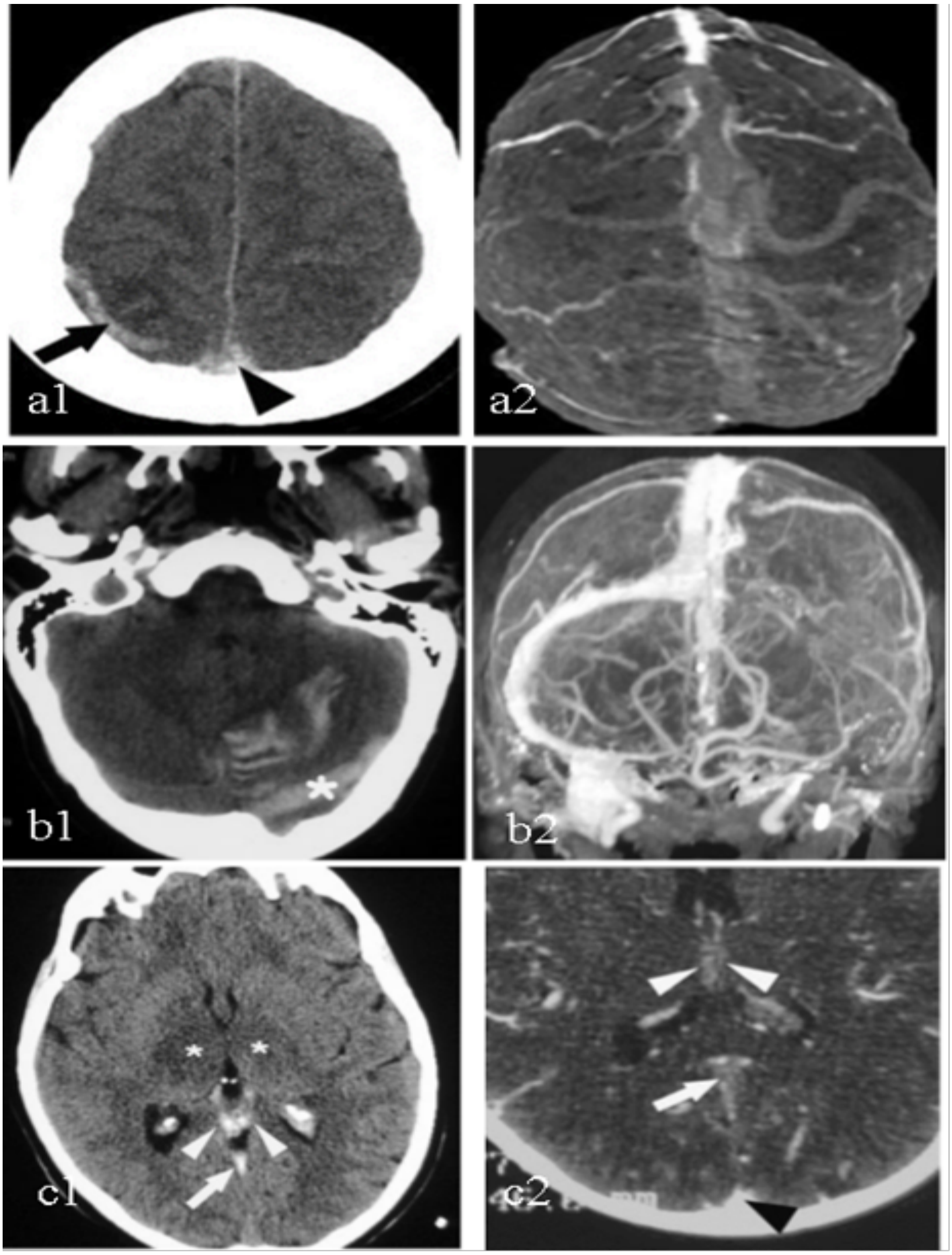

Figure 1: a1. CT Venography showing Thrombosis of the superior sagittal sinusin a 21-year-old woman. Axial unenhanced CT images with a "dense triangle" sign (arrowhead) and a cord sign (arrow), findings suggestive of sinus and cortical vein thrombosis, a2. 3D integral image from CT venography (posterosuperior view) shows filling defects in the superior sagittal sinus and parietooccipital veins, an appearance indicative of thrombosis. b1. Thrombosis of the left transverse sinus in a 43-year-old woman. Axial unenhanced CT images with increased attenuation in the left transverse sinus (cord sign). B2. 3D MIP image from CT venography, the left transverse sinus is not visible. Findings suggestive of left transverse sinus thrombosis. c1. Deep cerebral venous thrombosis in a 40-year-old woman. Axial unenhanced CT image shows an area of low attenuation in both thalami (*) associated with increased attenuation in the straight sinus (arrow) and internal cerebral veins (arrowheads). C2. Axial contrast-enhanced CT image shows filling defects in the straight sinus (arrow) and internal cerebral veins (white arrowheads), an appearance consistent with thrombosis. The normally enhancing superior sagittal sinus (black arrowhead).

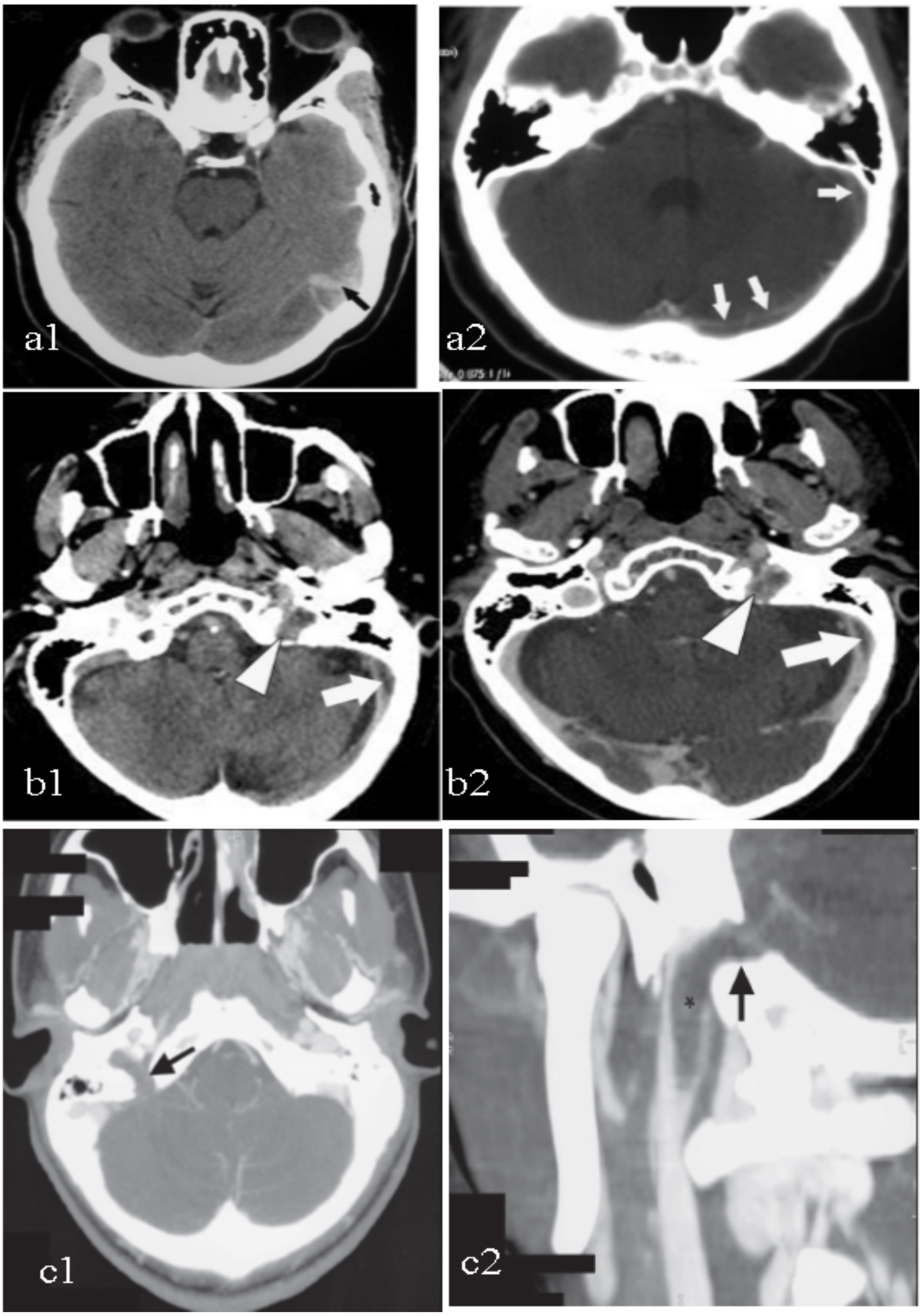

Figure 2: a1. Thrombosis of the left transverse and sigmoid sinuses and temporooccipital veins in a 47-year-old woman. Axial unenhanced CT image showing superficial temporooccipital areas of high attenuation. Findings suggestive of thrombosed cortical veins (cord sign). a2. Axial contrast-enhanced CT image shows thrombosis of the left transverse and sigmoid sinuses. b1. Thrombosis of the left sigmoid sinus and jugular foramen in a 61-year old woman. Axial unenhanced CT image shows low attenuation in the left sigmoid sinus (arrow) and jugular foramen (arrowhead). b2. Axial contrast-enhanced CT image shows thrombi in the left sigmoid sinus (arrow) and jugular foramen (arrowhead). c1. 12-year-old girl with Internal Jugular Vein and sigmoid sinus thrombosis. Axial source image from CT venography. Thrombus in sigmoid sinus (black arrow). c2. Sagittal planar reconstruction of CT venography shows thrombus extending from right IJV (asterisk) into sigmoid sinus (arrow).

Discussion

Cerebral venous thrombosis is condition characterized by thrombosis of intracranial veins and sinuses which results in parenchymal damage and rise in intracranial pressure. Radiological hallmark of this condition is thrombosis of intracranial sinuses and veins with or without haemorrhagic infarction and edema with or without evidence of herniation. In this study, total 50 patients with Radilogical features of cerebral venous thrombosis were evaluated over a period of 2 years. 23 out of 50 patients were male and remaining 27 were female. This was not confirmed in the present series, in which Male to Female ratio is 23: 27. As this data is not consistent with previous Indian studies. [2]

Due to referral bias, these findings of high proportion of CVT cases were not replicated in some other studies viz. Deschiens et al [9] and Daif et al. [10] The possible explanation may be that the etiological factors as well as clinical profile of CVT is in this part of the state different compare to other parts of India. More than 50% of the patients of CVT evaluated were in the third decade of their age (33 out of 50). The mean age of the patients was 32.18 years similar to earlier studies from India. [2] Like all other series, the present one represents a selected group of patients not representative of the numerous causes that have been described. However, it confirms the fact that the frequency of septic CVT (6 out of 50) has markedly declined with the advent of antibiotics. It also confirms the role of oral contraceptives found as the only aetiologic factor in 3 of our patients. [11] This has now led us, as many others to stop oral contraceptives and promptly look for CVT in women presenting with any of the neurological manifestations described in this study, particularly persistent headache, focal deficits or seizures.

In the present study in addition to conventional risk factors Dehydration (8%) and OCP use (10%) are significant risk factors, 8% of patients have Anemia, whether this is a reflection of high incidence of anemia in Indian population particularly in pregnant females or anemia is a real risk factor needs further evaluation. In 10 out of 50 cases, no cause could be found, however complete etiological workup could not be completed. Headache (31out of 50) with or without vomiting, seizures (29 out of 50). Altered sensorium (7 out of 50) and Focal deficits (23 out of 50) Papilledema, present in 54% of our cases, (was slightly more frequent than in other series) were the major clinical features noted at presentation.

The clinical presentation could be summarized in 3 main patterns, each of them simulating another neurological disease. The most frequent and homogeneous one was the progressive onset of signs of intracranial hypertension corresponding to the "Benign intra-cranial hypertension" or "pseudo-tumor cerebri" syndromes, confirming that sinus thrombosis in 27 out of 50 cases. These syndrome should be diagnosed purely on clinical, CSF and CT scan findings to rule out the possibility of sinus thrombosis. Some had (8 out of 23) the sudden onset of focal deficits simulating arterial strokes but with more frequent seizures (21 out of 29).

The third presentation simulated an abscess (5 out of 50) with deficits and/or seizures with or without intracranial hypertension evolving over a few days to a month. Other less common presentations are headache of sudden onset simulating subarachnoid hemorrhage (1 patient) It is therefore clear that CVT has no single clinical presentation and this is why it is necessary to systematically contemplate this diagnosis in order not to overlook it. Present series' most of the patients had good outcome. Earlier study by Nagaraja et al grouped clinical features of CVT in four categories depending upon the topographical venous involvement.

1. Presentation with seizures, focal deficits and progressively deteriorating consciousness. Thrombosis involves the dural sinuses as well as cortical veins producing cerebral infarction. Seizures may be focal, multi focal or generalized. Paralysis may be unilateral or bilateral and is usually maximal in lower limbs. Later during the course, patient may manifest signs of tentorial or central herniation leading to coma and death.
2. Presentation with symptoms and signs of raised intracranial tension namely headache, vomiting and papilloedema. If thrombosis continues to dural sinuses, the course is usually slow and prognosis is favourable.
3. Occasionally, thrombosis predominantly involves cortical veins and patient may present with features of space occupying lesion.
4. Rarely, thrombosis predominantly involves the deep venous system. Patient manifest symptoms of raised intracranial tension, focal deficits, choreoathetosis, ocular signs and coma. It runs a fulminant course. Cavernous sinus thrombosis is usually due to spread of infection from face, para nasal sinus or intracranial venous sinuses. It has a distinctive clinical picture where patient presents with fever, chills, toxemia with proptosis, chemosis and painful ophthalmoplegia, initially unilateral but often becoming bilateral. Papilloedema and retinal haemorrhages indicate retinal vein thrombosis.

The present series confirms the fact that isolated single sinus involvement was less common than multiple sinuses involvement, in isolated sinus most frequently involved are SSS and LS. Thus in most cases, occlusion involved at least two sinuses or sinus and cerebral veins. Among these, cortical veins were affected slightly more commonly than the deep venous system. These frequent associations probably explain, at least partly, why no good clinicoradiological correlations could be established.

Mode of onset, clinical presentation and outcome according to the site of venous occlusion

Before the introduction of angiography, CVT was diagnosed at autopsy and therefore thought to be most often lethal. In early angiographic series, mortality still ranked between 30% and 50% but in more recent series, it was between 25% and 30% and in the present one it was only 2%. Multiple reasons can explain this decrease, the main one being probably that it is now possible to diagnose "benign" forms of CVT with minimal symptoms and spontaneous recovery. Another reason is that septic thrombosis has, since the use of antibiotics, become both far less frequent and severe. It is also that the introduction of anticoagulant treatment early in the course of the disease has improved the outcome.

Two kinds of sequelae are encountered: blindness or Fieldcut due to optic atrophy, cortical infarcts which should be prevented by early treatment and focal deficits, usually motor, sometimes associated with epilepsy. Seizures are more frequent when the lesion is anterior to the central sulcus and in patients who have focal deficits. In the VENOPORT study early seizures were associated with sensory deficits and parenchymal lesions on admission CT. Our study also showed that 42% (21 out of 50) of the patients had seizures at presentation 5 (25%) only had long term recurrence, all of them had parenchymal abnormality at presentation, most of them well controlled with single Anti-Epileptic Drug (AED).

Factors classically considered of bad prognosis are the rate of evolution of thrombosis, the presence of coma, the age of patients, with a high mortality rate in infancy and in the aged and the involvement of cerebral veins. [12-17]

Most of the patients who were followed up had re canalized the occluded veins Only one patient expired in acute phase, Only 1 patient presented with recurrent CVT**,** sequelae were both more frequent in patients with focal symptoms than in patients with benign intracranial hypertension. The outcome was otherwise most unpredictable: some acute cases, even with coma, made a remarkably rapid and complete recovery whereas chronic cases often recovered more slowly and with more frequent sequelae. It is apparent from the study of literature and from the present series that the natural history and prognosis of CVT are highly variable.

A Cochrane meta-analysis of 22 trials, including nearly 9000 patients, convincingly showed that treatment with Low Molecular Weight Heparin (LMWH) results in significantly less thromboembolic recurrences, fewer major hemorrhagic complications, a higher recanalization rate, and a lower mortality than Unfractionated Heparin (UFH). [18]

The superior safety and efficacy of LMWH in leg-vein thrombosis is probably attributable to its pharmacokinetic properties. [19,20] Contrary to LMWH, UFH requires frequent activated partial thromboplastin time measurements and dose adjustments, which have proven to be difficult to implement in practice.

A British audit of 45 consecutive patients who received UFH during admission showed that patients were adequately anticoagulated less than a quarter of the time. Most of the time, patients were below the therapeutic range, but overdosing also occurred frequently. There is a robust correlation between sub-therapeutic activated partial thromboplastin time values and the risk of recurrent thrombosis, and the likely effect of overdosing.

In present study also UFH in 74% of patients and LMWH in 24% of patients, based on the idea that an adequate level of anticoagulation is achieved more rapidly with UFH, and then change to LMWH after a few days. UFH has an increased risk of hemorrhagic complications. Other studies have demonstrated that it often takes 24 hours until patients are adequately anticoagulated with UFH, even if a treatment algorithm is used. Thus, the theoretical advantage of more rapid anticoagulation with intravenous UFH is probably rarely realized in practice. The decision to change the type of heparin has been motivated by several reasons. For example, if a patient deteriorates, most notably in the case of a hemorrhagic complication, treating neurologist may decide to switch to another type of heparin. In addition, a switch to LMWH can be made if a patient had improved enough to be mobilized or discharged because LMWH does not require intravenous access.

In this study, attempt was made to correlate the clinical profile with the topographic Radiological substrate like involvement of superficial / deep venous system or the pattern of infarction. There was no significant correlation to evolve a pattern of diagnostic significance, correlating with radiological findings. However predictably, patients with deep venous system involvement and having ganglionic infarction had significantly less incidence of seizures. Patients with involvement of SSS had higher incidence of seizure and lower incidence of headache than those who didn't have SSS involvement. As most of the patients had extensive involvement of cerebral sinovenous system, contribution of degree of involvement of anatomical structures to a particular clinical profile cannot be reliably predicted. For example, high incidence of seizures in patients with SSS involvement may be attributed to the thrombosis from SSS spreading to cerebral veins causing cortical lesions and seizures but when a group of patients with only cerebral venous thrombosis without any sinus thrombosis was analyzed, seizure incidence was not high. Similarly patients with papilloedema did not differ in Radiological findings when compared to the patient group without papilloedema.

CT venography has proved to be a reliable method to investigate the structure of the cerebral veins, with a reported sensitivity of 95% with multiplanar reformatted (MPR) images when compared with digital subtraction angiography (DSA) as the standard of reference. [5] Owing to its vascular detail and ease of interpretation, CT venography can provide a rapid and reliable diagnosis of cerebral venous thrombosis. [6,7,8] The possibility of multiplanar reformations with CT venography is very helpful in detecting sinus and cortical venous thrombosis. CT venography with the integral display algorithm can provide excellent demonstration of filling defects in the superficial venous sinuses and cortical veins. Volume rendering display can be helpful to demonstrate collateral pathways in cortical vein thrombosis. The most reliable criterion with which to establish the diagnosis of cavernous sinus thrombosis is the presence of a large filling defect of non–fat attenuation with sinus expansion. [21]

CT Venography versus Other Imaging Modalities

Unlike primary intracerebral hemorrhage and arterial cerebral infarction, which typically manifest as acute neurologic deficits (strokes) and whose diagnosis relies on demonstrating the parenchymal lesions, the diagnosis of cerebral venous thrombosis relies on demonstrating thrombi in the cerebral veins and or sinuses.

Comparison with DSA:

DSA has been the key procedure in the investigation of intracranial venous disease for many years but is an invasive procedure with well-known associated risks. The partial or complete lack of filling of veins or sinuses is the best angiographic sign of cerebral venous thrombosis.

However, this sign is difficult to interpret in locations such as the anterior third of the superior sagittal sinus, the left transverse sinus, and the cortical veins because of common variants. With the advent of CT venography and MR imaging, DSA is now rarely required for diagnosis.

However, in patients with subarachnoid hemorrhage and cerebral venous thrombosis, DSA should be considered to rule out other causes of rebleeding, such as distal aneurysm and dural arteriovenous fistula, before anticoagulant therapy is administered. CT-venography has several advantages over DSA. It is less invasive and less expensive, and the time to diagnosis in the initial work-up of a patient is shorter.5 In a comparative study of CT venography with DSA in imaging cerebral venous anatomy and pathologic conditions, MPR images from CT venography were superior to DSA images in showing the cavernous sinus, inferior sagittal sinus, and basal vein of Rosenthal.

Comparison with MRI:

Advantages:

Reported advantages of CT venography compared with MR imaging techniques are

- Rapid image acquisition (reduction of motion-related artifacts)
- No contraindication to pacemaker and ferromagnetic devices
- Increased imaging resolution
- Fewer equivocal imaging findings
- No flow related artifacts have been reported with use of a contrast material bolus and acquisition in the venous phase.
- Shows sinuses or smaller cerebral veins with low flow as compared with MR venography (2D phase contrast, 3D phase contrast, and 2D time of flight)

Limitations of CT venography

- Exposure to ionizing radiation
- Adverse reactions to iodinated contrast medium
- limited visualization of skull base structures in 3D display

The use of MR imaging in the diagnosis of cerebral venous thrombosis demands knowledge of the different stages of thrombus evolution and pitfalls.

The main sign of cerebral venous thrombosis with a standard MR imaging protocol is the lack of expected signal flow void on standard spin-echo T1- and T2-weighted images.

Diagnosis of cerebral venous thrombosis at the acute stage can be challenging because the hypointense signal of acute intraluminal thrombus mimics a normal flow void on T2-weighted images. The absence of flow void on T1-weighted images at this early stage must be carefully sought because thrombus is isointense to brain tissue. Then, time-dependent increasing hyperintensity of intraluminal thrombus seen on spin-echo images corresponds to the release of extracellular methemoglobin. After 30 days, the thrombus gradually becomes isointense on T1-weighted images. Pitfalls of MR imaging in the diagnosis of cerebral venous thrombosis include flow-related enhancement (entry section phenomenon) and refocusing of slow flow (even echo rephasing or use of flow-compensation gradients), which may mimic intraluminal thrombus, or paramagnetic blood products (intracellular deoxyhemoglobin or methemoglobin) mimicking a normal signal void on long repetition time images.

A thrombus shows identical signal appearance in all section orientations. T2*-weighted imaging is able to demonstrate areas of hypointensity in thrombosed veins and sinuses, but the exact sensitivity of T2*-weighted imaging remains unknown.

Moreover, the susceptibility effect of T2*-weighted imaging does not always indicate intravascular thrombosis or blood products, since arterial flow voids, calcifications, and the bone surfaces of the skull commonly result in susceptibility artifacts.

Diffusion-weighted imaging of intravascular clots might be of value in prediction of the risk of persistent venous occlusion. MR imaging is more sensitive than CT in demonstrating the parenchymal lesions. In MR venography, thrombosis is suggested by absence of normal flow signal in a sinus or a vein.

However, this finding may also be attributed to artifacts. In 2D time-of-flight imaging, flow gaps result from slow intravascular blood flow, in plane flow, and complex blood flow patterns. Most of the artifactual loss of vascular signal seen with the use of 2D MR venography occurs in nondominant transverse sinuses. Depiction of flowing blood with time-of-flight imaging is limited when short T1 substances such as methemoglobin are present.

In 2D phase contrast imaging, if blood flow is sufficiently slow, the motion-induced phase shifts may be inadequate to distinguish the flow from stationary tissue. Post contrast 3D magnetization-prepared rapid gradient-echo T1-weighted images are not affected by the angle between vessels and imaging slab or flow velocity.

Three-dimensional surface algorithms can also be used with post contrast 3D MR imaging to display the brain surface and the superficial venous system.

Conclusion

CT venography should be strongly recommended when cerebral venous thrombosis is suspected, particularly in situations in which MR imaging has inconclusive results. In patients with unenhanced CT findings suggestive of venous thrombosis, CT venography can be performed without delay to confirm the diagnosis and to start appropriate therapy immediately there by decreasing morbidity and mortality.

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