ORIGINAL ARTICLE

PATTERN OF MAGNETIC RESONANCE IMAGING AND MAGNETIC RESONANCE VENOGRAPHY CHANGES IN CEREBRAL VENOUS SINUS THROMBOSIS

Zafar A, Ali Z

Department of Neurology, Government Lady Reading Hospital Peshawar, Pakistan

Background: Cerebral venous sinus thrombosis is a common but highly under-recognised condition, which is missed not only by general practitioners but also by neurologists. Computerised tomography (CT) or magnetic resonance imaging (MRI) of brain alone is not sufficient to diagnose this condition. Objective of this study was to explore the pattern of magnetic resonance imaging (MRI) and magnetic resonance venography (MRV) changes in cerebral venous sinus thrombosis (CVST). **Methods:** This was a descriptive study in which 52 cases of cerebral venous sinus thrombosis with special emphasis on their MRI and MRV findings were included. The study was conducted in Neurology Unit, Lady Reading Hospital, Peshawar, Pakistan, from January 2010 to July 2011. All patients suffering from cerebral venous sinus thrombosis were included in the study. Multi-planar/multi-sequential, Tesla 1.5 MRI/MRV time of flight images were done in all cases where there was suspicion of cerebral venous sinus thrombosis. **Results:** Out of 52 patients with cerebral venous sinus thrombosis 41 (78.84%) were female and 11 (21.15%) were male. Mean age was 37±5 years. Definite risk factors were found in 38 (73.076%) patients with pregnancy, use of oral contraceptives or puerperium being the most frequently found risk factor in 20 (73.076%) patients. Most common complaint was headache found in 41 (78.84%) patients, followed by focal neurological deficits, and altered mental status and seizures. Papilloedema was seen in 20 (38.46%) patients. The cerebral venous sinuses most frequently involved were transverse and sigmoid sinuses in 17 patients (32.69%) while superior sagittal sinus alone in 10 (19.23%) patients. Overall CT brain was normal in 30% and MRI brain in 23.07% patients; however, MRV of these patients revealed CVST. **Conclusion:** Imaging plays a primary role in the diagnosis of cerebral venous sinus thrombosis because the clinical picture of CVST is non-specific and highly variable. Thrombosis of cerebral venous system is readily picked-up on MRV even if it is missed by CT scan or MRI.

Keywords: Cerebral venous sinus thrombosis, CVST, Magnetic Resonance Imaging, MRI, Magnetic Resonance Venography, MRV, Computed Tomography, CT

INTRODUCTION

Cerebral venous sinus thrombosis (CVST) results from thrombosis of cerebral venous, dural sinuses or cortical veins. The incidence of CVST in children and neonates has been reported to be as high as 7 per million, whereas in adults the incidence is 3–4 cases per million.[1] It can affect all age groups, however it has a predilection for younger individuals and still more for women of childbearing age.[2]

It is now realised that CVST is more prevalent in the Asian population than in the West.[3] About 10–20% of young strokes in India are due to CVST.[4] However, it is a less frequent cause of stroke than arterial pathologies.[5] With advancing knowledge and greater availability of non-invasive neuro-imaging techniques it is realised that CVST is far more common than previously assumed.[6] Cerebral venous system comprises basically of two drainage systems.[7]

A superficial system comprises of sagittal sinuses and cortical veins. It drains the superficial surfaces of both cerebral hemispheres. A deep system comprises of transverse sinus, straight sinus and sigmoid sinus, along with deeper cortical veins. Both these systems ultimately drain into internal jugular veins.[8] A multitude of conditions are known to cause CVST.[9,10]

Several factors can be involved at the same time thus multiplying the risk of developing CVST. The clinical picture of CVST is non-specific as well as highly variable,[11] ranging from mild headache to altered mental status, seizures and even death. Neurological manifestations are due to focal effects of venous obstruction, including oedema, infarction and local haemorrhage, as well as secondary to raised intracranial pressure.[12] Importantly, headache can be the sole presenting symptom in about 80% of the patients.[13] Thus CVST may be misdiagnosed as idiopathic intracranial hypertension (IIH) if suspicion of CVST is not kept in mind and MRI with MRV is not done promptly. If diagnosed early and managed properly it has an excellent prognosis, otherwise the mortality usually ranges from 6–15%, with trans-tentorial herniation being the major cause of death.[14,15]

Magnetic resonance imaging (MRI) in combination with magnetic resonance venography (MRV) has been used in the diagnosis of CVST for

approximately two decades and is the investigation of choice for diagnosing CVST.[16–18] the magnetic resonance appearance of the thrombus within the cerebral venous system varies and is largely dependent on the age of the thrombus.[19]

The objective of this study was to explore the pattern of magnetic resonance imaging (MRI) and magnetic resonance venography (MRV) changes in cerebral venous sinus thrombosis (CVST).

MATERIAL AND METHODS

This was a descriptive study in which 52 cases of cerebral venous sinus thrombosis with special emphasis on their magnetic resonance imaging and magnetic resonance venography findings were included. This study was conducted in Neurology Unit, Lady Reading Hospital, Peshawar, Pakistan, from January 2010 to July 2011. All patients of either gender with suspected CVST were included in the study after taking an informed written consent. Exclusion criteria were patients with normal MRV or patients with suspicion of CVST but who failed to do MRI/MRV either because of economic restraints or due to technical/medical reasons like metallic implants or claustrophobia.

Diagnosis of CVST was made on the basis of clinical and radiological assessments. The diagnosis was suspected clinically on the basis of headache, signs of raised intra-cranial pressure and focal neurological abnormalities, (e.g., abnormal vision, stroke-like symptoms such as weakness of the face and limbs on one side of the body and seizures).

Multiplanar/multisequential, Tesla 1.5 MRI/ MRV time of flight images was done in all cases where there was suspicion of cerebral venous sinus thrombosis. Computed Tomography (CT), magnetic resonance imaging (MRI), or Magnetic Resonance Venography (MRV) of brain were done to demonstrate obstruction of the venous sinuses by thrombus (absent flow, secondary venous infarcts in odd places which did not obey any particular arterial territory with or without foci of haemorrhage, enhancement of the dura surrounding the sinus thrombosis and the typical delta/'empty delta' sign). Contrast was advised in 14 cases with suspicion of cerebritis or malignancy. The data were analysed using SPSS-15.

RESULTS

Out of 52 patients with CVST, 41 (78.85%) were female and 11 (21.15%) were male with a female to male ratio of 3.7:1. Age ranged from 14–60 years and mean age was 37±5.2 years, and 45 (86.53%) patients were between 14–38 years of age.

Definite risk factors were found in 38 (73.07%) patients with pregnancy. Uuse of oral contraceptives or puerperium being the most frequently found risk factors in 20 (38.46%) patients, followed by para-nasal sinuses/mastoid infections in 7 patients (13.46%), or central nervous system infections (tuberculous meningitis) in 6 (11.53%) patients, dehydration, acquired and congenital hyper-coagulable states in 4 patients (7.69%), and Systemic Lupus Erythematosis (SLE) in 1 patient (1.92%) (Table-2).

Table-2: Risk factors in patients with cerebral venous sinus thrombosis (n=52)

Risk factors	No.	%
Pregnancy/OCP use	20	38.46
PNS/ mastoid infections	7	13.46
CNS infection	6	11.53
hyper-coagulable states	4	7.69
CLE	1	1.92
Unknown Cause	14	26.92

No cause could be identified in 14 cases. Most common complaint was headache in 41 (78.84%) patients, followed by focal neurological deficits in 37 (71.15%) patients, and altered mental status 36 (69.23%) patients, and seizures in 12 (23.07%) patients. Papilledema was seen in 20 (38.46%) patients.

Out of 52 patients with evidence of CVST, 30 (57.69%) underwent a preliminary CT brain before MRI/MRV, and CT brain of 9 (30%) did not reveal any pathology. In 4 of these 9 patients MRI was also normal (Figure-1a), while MRI of remaining 5 patients showed some degree of cerebral oedema with gyral enhancement. However MRV revealed evidence of chronic CVST in 2 of the former 4 patients, and acute changes of venous obstruction on MRV in rest of 7 patients (Figure-1b).

CT brain of 21 patients revealed infarcts in odd places with or without hemorrhagic transformation which did not obey any particular arterial territory, thus raising the suspicion of CVST and the need for MRI/MRV. Brain changes on CT scan are shown in Table-2.

Table-2: Computerised Tomography (CT) Brain Changes in 30 Patients (n=30)

CT Brain changes	Patients	%
Normal CT brain	9	30
Venous infarcts alone	11	36.67
Venous infarcts with hemorrhagic transformation	6	20
Cerebral oedema (with or without gyral enhancement)	4	13.33

In 22 (42.30%) patients direct MRI/MRV was done due to strong suspicion of CVST either in relation to their history or clinical presentation. Hemorrhagic transformation of the infarct was seen in 7 of these patients. In one case infarct was found in right basal ganglia and right thalamus with CVST on left side while in another patient there was infarct in right occipital area with left sided CVST. Over all MRI brain was normal in 23.07% patients; however, MRV of these patients revealed CVST. Relative frequencies of cerebral venous sinuses involvement are shown in Table-3.

Table-3: Cerebral venous sinuses involvement (n=52)

Cerebral venous sinuses involved	Patients	%
Transverse and sigmoid sinus	17	32.69
Superior sagittal, tranverse and/or sigmoid sinus	8	15.38
Superior sagittal sinus	10	19.23
Transverse sinus (either unilateral or bilateral)	12	23.07
Deep cortical sinuses	5	09.62

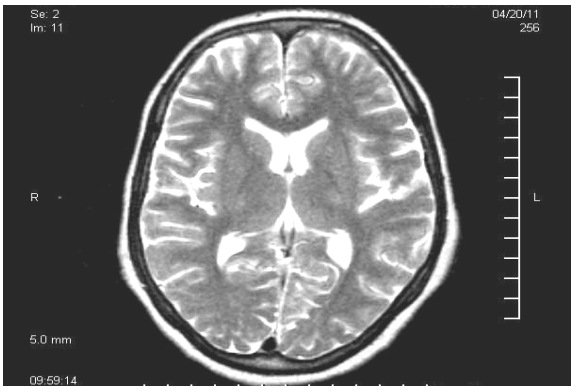

Figure-1a: Normal MRI Brain (T_2 WI)

Figure-1b: MRV of same patient as above showing Left transverse, sigmoid and internal jugular vein thrombosis

Figure-2: MRI brain showing pansinusitis

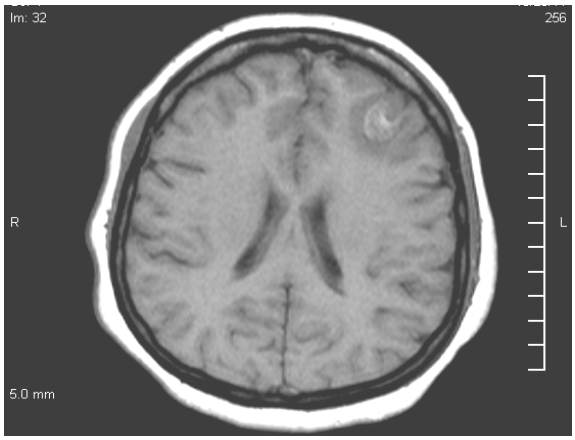

Figure-3a: MRI brain (T_1 WI) showing hemorrhagic focus in left anterior parietal region

Figure-3b: MRV of same patient as above showing partial thrombosis of both transverse sinuses

DISCUSSION

Cerebral venous sinus thrombosis is regarded as a continuing process of imbalance between prothrombotic and thrombolytic state resulting in the formation and then progression of the thrombus in cerebral venous system. The patho-physiology of venous infarction is related primarily to rise in venous and capillary pressure due to persistence of thrombosis.[20] This causes dilatation of veins and capillaries, development of interstitial/ vasogenic oedema, increase in cerebrospinal fluid (CSF) formation, reduction in CSF absorption and ultimately rupture of venous structures with haematoma formation.[21]

Extent of neuronal injury is related to several factors including dural sinus pressure, venous flow obstruction, development of cytotoxic and vasogenic oedema, collateralisation/recanalisation of venous channels and development of infarction and haemorrhage.[22]

There were more females (78.84%) in the present study while 86.53% patients were between 14–

38 years of age and this observation corresponds to that of international studies, making CVST a disease of the young.[1,3,8,23]

Definite risk factors were found in 73.076% patients with pregnancy, use of oral contraceptives or puerperium as being the most frequently found risk factor (38.46%). The peripartum state and pregnancy are predisposing factors and CVST accounts for about 6% of maternal deaths.[2,8,24]

MRI with MRV to date is the single most sensitive diagnostic technique.[17,25–28] Tsai FY *et al*[29] identified five stages of brain parenchymal changes on MR imaging in CVST, related to dural sinus pressure in acute setting. These stages are:

1. No parenchymal change
2. Brain swelling, no signal change
3. Parenchymal signal change
4. Severe oedema, with or without haemorrhage
5. Massive oedema and/or haemorrhage.

Signal changes on MRI/MRV due to thrombus within the dural sinus or cortical vein are variable depending on the age of the thrombus.[19] (Table-4)

Table-4: Signal changes of intra-luminal thrombus (depending on the duration) on MRI and MRV

Age of Thrombus	T1	T2	Reason
<5 days	Iso-intense	Hypo-intense	Deoxy-haemoglobin
5–15 days	Hyper-intense	Hyper-intense	Met-haemoglobin
>15 days	Hypo-intense	Hypo-intense	Re-canalization

We observed normal CT brain in 30% patients. Initial head CT was reported to be normal in 12% cases by Santos *et al*[23] and in 26% of cases of CVST by Anxionnat R, *et al*[30]. Normal CT brain in CVST can be explained by several mechanisms, including presence of collateral channels, recanalisation of the occluded veins since all venous occlusions do not necessarily end up in neuronal injury or venous infarction, and the speed of development of thrombus.[22]

The slower the rate of occlusion the lesser would be the chance of parenchymal damage, since more time is available under such circumstances for collateralisation and thus no change on CT brain. Similarly the more rapid the development of venous thrombus the more are the chances of hemorrhagic transformation of the infarct[21] as was seen in 5 of our patients.

Non-hemorrhagic infarcts, parenchymal oedema with venous infarction and haemorrhagic transformation can occur in 10–50% of the cases, mainly affecting the cortex and adjacent white matter. Not only this, haemorrhagic infarcts are considered as bad prognostic indicators of CVST by 'International Study on Cerebral Vein and Dural Sinus Thrombosis (ISCVT)'.[31] Venous infarcts alone on CT were seen in 11 patients raising the suspicion of CVST which was confirmed on MRV. CVST results in infarction only in 50% of cases.[29]

Also location of thrombus in cerebral venous system is of utmost importance.[23,24] Massive brain oedema can be the sole manifestation of superior sagittal sinus thrombosis.[20]

Two out of 52 patients' MRI showed infarct opposite to the side of venous occlusion shown by MRV. These were probably arterial infarcts with findings of venous occlusion picked up incidentally on doing MRV. We were however unable to do MRA brain in these two patients since the patients could not afford a third scan.

CONCLUSION

MRV is the investigation of choice for confirming CVST.

RECOMMENDATIONS

A normal CT scan/MRI of brain does not exclude the possibility of cerebral venous thrombosis. Likewise since the symptoms and signs of benign/idiopathic intra-cranial hypertension (BIH, IIH) are similar to CVST, therefore whenever there is slightest suspicion of CVST, MRV should be performed to rule out CVST.

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Address for Correspondence:

Dr. Ayesha Zafar, Department of Neurology, Lady Reading Hospital Peshawar, Pakistan. **Cell:** +92-315-9367585
Email: neurologistpsh@yahoo.com