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Ct and Mr Imaging of Neurological Illnesses in Pregnancy and Puerperium

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Abstract :
Aim*: The aim of the study is to know the incidence of CNS diseases in pregnancy and puerperium and to assess the role of computerised tomography (CT) and Magnetic resonance imaging (MRI) in determining the treatment modalities.*
Materials and Methods:*This is an observational study done in pregnant and puerperal patients with neurological symptoms admitted to obstetrics and neurology wards during a one year period from August 2013 to August 2014. About 120 pregnant and puerperal patients with various recent onset neurological symptoms like headache, seizures, altered sensorium, sensory motor deficit and lactation failure were included in the study. The techniques used were MRI in antenatal period and CT/ MRI in postnatal period.*
Results: *Total number of deliveries in the hospital during the study period was 7100. The cases included cerebral venous thrombosis(CVT),posterior reversible encephalopathy syndrome (PRES), postpartum cerebral angiopathy (PCA)and arterial infarction. Total number of patients in whom imaging was positive in the study period was 50, which was 41.6% of symptomatic patients. Incidence rate of patients with positive findings was 704/100000 deliveries. Total number of cerebral venous thrombosis cases that occurred in the study period was 35.Incidence rate of CVT cases was 492/1,00,000 deliveries. Total number of PRES was 12.Only 2 patients had arterial infarction. Total deaths during the study period among the 50 positive patients were 4. Mortality ratedue to neurological complications was 56/1,00,000 deliveries. In all the 4 cases, death was due to venous occlusion followed by hemorrhagic infarction.*
Conclusion: *This study emphasizes the significance of imaging in early diagnosis of neurological disorders in pregnancy and puerperium. The commonest neurological disorder is cerebral venous thrombosis.Hypertensive encephalopathy is the second most common neurological complication. CVT is the most common cause of maternal mortality among the neurological complications. Hence early imaging with prompt identification of pathologic conditions can help in early and appropriate management of serious neurological complications.*
Keywords*: CT and MR imaging, neurological disease,pregnancy and puerperium*

I. Introduction

Maternal health revolves around the provision of adequate care in the antenatal period and also after delivery. Technological advancements in medical imaging have revolutionized the diagnosis of maternal and fetal problems. While there is increasing awareness of anemia, sepsis, PIH etc, neurological symptoms in pregnancy have not been properly evaluated. The advent of CT and MRI has proved to be a boon in early and accurate diagnosis of pregnancy related neurologic complications.The study focuses on non-invasive evaluation of neurologic symptoms occurring in pregnancy and puerperium with CT / MRI. By knowing the prevalence and spectrum of neurologic complications in pregnancy, early appropriate treatment can be initiated, thus improving maternal outcomes.

II. Materials And Methods

This is an observational study done in pregnant and puerperal patients with neurological symptoms admitted to obstetrics and neurology wards in Coimbatore medical college fromAugust 2013 to August 2014. About 120 pregnant and puerperal patients with various recent onset neurological symptoms like headache, seizures, altered sensorium, sensory motor deficit, lactation failure or a combination of symptoms were analyzed. Known seizure disorder patient, known psychiatric patients and post traumatic patients were excluded.

The techniques used were MRI in antenatal period and CT/MRI in postnatal period. In 78 post-natal cases both CT and MRI were done. In 18 post-natal cases CT scan was done. In 24 antenatal cases MRI was done. Relevant clinical details were obtained based on neurologist's opinion. Non contrast CT imaging of the head was done with 4 slice Toshiba CT scanner machine. For contrast CT study, 2ml/kg of iohexol in 360mg/ml concentration was used. Images were acquired in parenchymal phase as routine. Slice thickness was 3mm, pitch factor was 1.2mm. Reconstruction interval in infratentorial compartment was 3-5mm and in supratentorial

compartment was 5-7mm. MR imaging was done with1.5 Tesla Siemens machine and routine brain imaging protocol was followed which included T1 sagittal, T2 axial, fluid attenuated inversion- coronal, gradient echo images – axial, diffusion weighted images with ADC maps – axial, intracranial MR angiogram and venogram (MRA and MRV).

III. Results

Total number of deliveries in the hospital during the study period was 7100.Total number of antenatal and puerperal patients who presented with neurological symptoms during that period was 120. In 78 post-natal cases both CT and MRI were done. In 18 post-natal cases CT scan was done. In 24 antenatal cases MRI was done. Total number of patients in whom imaging was positive in the study period was 50 which were 41.6% of symptomatic patients. The cases included cerebral venous thrombosis, posterior reversible encephalopathy syndrome, postpartum cerebral angiopathyand arterial infarction. Incidence rate of neurological complication was 704/100000 deliveries. Total number of cerebral venous thrombosis cases that occurred in our study period was 35.Incidence rate of CVT cases was 492/1,00,000 deliveries. Total number of PRES was 12.Only 2 patients had arterial infarction. Total deaths during the study period among the 50 with positive imaging findings were 4. Mortality rate was 56/1,00,000 deliveries. In all the 4 cases, death was due to venous occlusion followed by haemorrhagic infarct. Most common symptom associated with positive imaging findings is acute headache. Symptoms predicting poor prognosis are altered sensorium and motor weakness. Most commonly involved venous sinuses in CVT are superior sagittal and sigmoid sinuses.

Sl. No.	Sinuses vs Cortical veins	No. of cases
1	Venous sinus	26
2	Superficial cortical vein	9
	Total	35

Table 2- Frequency of involvement of individual venous sinuses

Sl. No	Sinus involved	No. of cases
1	Superior sagittal sinus	16
2	Sigmoid sinus	16
3	Transverse sinus	9
4	Straight sinus	4

Table 3- Incidence of haemorrhagic infarct in CVT	
Venous thrombosis with haemorrhagic infarct	16 cases
Venous thrombosis without haemorrhagic infarct	19 cases
Total	35 cases

IV. Discussion

A spectrum of pathologic disorders involve the central nervous system and pituitary gland in both pregnancy and puerperium. Few neurologic conditions are related to the physiologic modifications in pregnancy (for instance eclampsia, reversible cerebral vasoconstriction syndrome, Sheehan syndrome). Some of the cerebrovascular diseases occur more frequently in pregnancy and post-partum women, particularly cerebral infarction, dural venous thrombosis and pituitary apoplexy. Most often, these conditions may have subtle presentations and go unnoticed. Neurological complications are classified into four major categories of ischemic stroke, hemorrhage (subarachnoid hemorrhage, eclamptic encephalopathy, cerebral venous thrombosis), pituitary gland related disorders (pituitary apoplexy, pituitary adenoma, Sheehans syndrome, lymphocytic adenohypophysitis) and other neoplastic disorders (primary intracranial tumors and intracranial metastasis).

MRI is the preferred imaging option in pregnancy. Though there is a hypothetical risk to the fetus due to exposure to powerful magnetic fields, minimal increases in body temperature and loud tapping noises of the coils, there is no documentation of hazardous fetal effects in humans due to the magnetic field exposure. In puerperium, CT and MRI can be used as the condition warrants.

4.1.Eclamptic Encephalopathy

Eclampsia is a critical condition seen in 5% of pregnancies and is responsible for 10% of the obstetric deaths. Eclampsia clinically presents with tonic-clonic seizures or coma in antenatal women who have developed pregnancy-induced hypertension. Eclampsia is one of the causes of posterior reversible encephalopathy syndrome(PRES). This impairment in cerebral auto-regulation predisposes to disruption of the blood-brain barrier in the posterior circulation. The predilection of posterior circulation in watershed areas is believed to be due to sparse sympathetic innervations (16,17).Eclampsia and hypertensive encephalopathy are seen to have analogous imaging findings(18 , 19). CT demonstrates posterior areas of patchy low attenuation which are transitory. MR imaging has proven to be better than CT in patients with eclamptic encephalopathy.

Lesions are characterized by low signal intensity on T1-weighted images and high signal intensity on T2-weighted images in the posterior cortex and subcortical white matter. However the anterior cerebral hemispheres can also be involved in PRES. There are usually four types of radiological presentation of PRES - Holohemispheric watershed pattern, superior frontal sulcus involvement pattern, predominant parieto occipital involvement, asymmetric presentation of primary pattern. Lesion typically shows no diffusion restriction. Diffusion-weighted imaging helps to differentiate between reversible vasogenic edema from cytotoxic edema of complete infarction(20).Sometimes there is involvement of the basal ganglia and brainstem(21). Catheter angiography classically shows vasospasm in the medium and large cerebral arteries, notably the basilar artery(22).

Complications of PRES include cerebral ischemia (reported to occur in 10 to 25%), cerebral herniation(5-15%) and cerebral haemorrhage (5-15%). Though PRES resolves clinically after 3 to 8 days, MRI findings take a longer time to resolve. The ideal time for repeat MRI is 7 to 10 days (20).Treatment of eclampsia is supportive with priorities set out for controlling seizures and hypertension as well as maintaining a stable hemodynamic state. Magnesium is the treatment of choice to prevent recurrent convulsions and eclampsia (23).

4.2.Ischemic Stroke

Ischemic infarction of pregnancy and puerperium accounts for 60% of all strokes. Pregnancy and the puerperium bring about an alteration in the levels of inhibitors of coagulant proteins(1,2). Probabilities of obstetric stroke to be of venous origin is higher in comparison to stroke due to other factors. Procoagulant states are more marked around term and worsens in the immediate postpartum period(4,11), presumably related to the expulsion of the placenta and release of thromboplastic substances following placental separation. Blood coagulation and fibrinolysis switch over to those of the non-pregnant state by around 3 weeksafter delivery(3,4). Caesarean delivery has been shown to be associated with a 3–12 times heightened risk of stroke in peripartum and postpartum period(6,7).Early diagnosis and intervention by administration of thrombolytic agents such as human tissue plasminogen activator (Rt-PA) is a lifesaving procedure and has favorable maternal outcome(8).

4.3Cerebral Venous Thrombosis

Cerebral venous thrombosis(CVT) has been identified to be the cause of 6% of maternal deaths. There seems to be heightened risk during the first 2 weeks of puerperium(11) particularly in young mothers and after caesarean section. Hypercoaguability has a provocative role in the evolution of CVT during pregnancy and puerperium. Some of the prime events that further render a hypercoagulable state are dehydration due to antepartum as well as post-partum hemorrhage, poor obstetric practices, trauma during instrumental delivery and inadequate intake of fluids despite added demands of breastfeeding(6). Based on the pattern of onset(acute vs subacute) and the extent of thrombus in the sinuses, CVT has a pleomorphic clinical presentation namely headache, somnolence, coma, generalized seizures and neuropsychiatric symptoms. Focal neurologic deficits are also manifested(9). Nonseptic CVT commonly occurs in the superior sagittal sinus, whereas septic CVT involves cavernous and lateral sinus(9).

Plain CT imaging studies depict enhanced attenuation of the cerebral venous sinuses in which thrombosis has occurred. Contrast-enhanced CT shows 'empty delta sign' which is a characteristic filling defect. Nevertheless it might take 7–10 days for the empty delta sign to appear on CT following the commencement of symptoms. In comparison to CT, MR imaging proves to be of better accuracy and sensitivity(10, 12). A credible sign of CVT is simultaneous high signal intensity of the venous sinuses with all routine sequences(13) (T1-weighted, T2-weighted, and FLAIR). High signal intensity on T1-weighted images with a corresponding filling defect after gadolinium enhancement may develop within the first week after clinical onset. Early detection can be done with MRI within7 days of clinical onset whereas CT imaging may take 7-10 days to show significant changes(10, 13). MR venography in addition to routine MR imaging, helps us to understand involvement of the tributaries of the major cerebral veins and dural venous sinuses and anatomic variants (12, 13). Catheter angiography has more significance in the treatment of CVT rather than diagnostic purpose(15). Anticoagulation is the recommended treatment. Early thrombolysis has better response even in the presence of hemorrhagic infarctions(14,15). Also symptomatic treatment of seizures, reduction of raised ICT and treatment of primary cause if any are important for better prognosis.

4.4.Intracranial Hemorrhage

Chronic hypertension, pregnancy-induced hypertension, preeclampsia, or eclampsia frequently contribute to ICH during pregnancy and the puerperium(18).Pathology shows fibrinoid necrosis of small penetrating vessels, as in typical hypertensive hemorrhage. Arteriovenous malformations (AVMs) and aneurysms are more likely to rupture during pregnancy and the puerperium. Aneurysms usually bleed in the latter half of pregnancy, and are more likely to rupture in a hypertensive patient.The signal intensities of the hematoma depends on age of the hematoma.GRE sequences are more sensitive to hemorrhage (Luxia Liang et

al).FLAIR sequence is highly sensitive for subarachnoid hemorrhage (RohitBaskhi et al). FLAIR is basically T2 image with suppression of free water protons. So the CSF is suppressed and rendered dark. This results in increased visibilityof blood in subarachnoid space.

4.5.Subarachnoid Hemorrhage

Subarachnoid hemorrhage is a rare event in pregnancy. Intracranial aneurysmal rupture is the most common cause of SAH even in pregnancy and puerperium. Management protocol of ruptured aneurysms remains the same as in patients who are not pregnant.

4.6.Postpartum Cerebral Angiopathy

Postpartum Cerebral Angiopathy is a rare but important diagnostic consideration in the postpartum period(27).These normotensive postpartum women present with severe headache, seizures, and focal neurologic deficits within 1–4 weeks of delivery(24, 25). Symptoms are sudden onset headache with vomiting. Definitive diagnosis for this condition is by cerebral angiography which will show multiple areas of focal and segmental narrowing, mainly in large size and medium size vessels. CT angio or MR angio are 80 % sensitive. T2/Flair hyper intensity is seen in watershed areas. Angiogram will be normal in early stages of disease that is within 4 – 5 days. A second angiogram done a few days later may become diagnostic. Angiogram shows reversible multifocal stenoses and post stenotic dilatations in the medium and small sized cerebral arteries in the anterior circulation(24,25). Treatment of PCA with corticosteroids such as intravenous methylprednisolone(24), calcium channel blockers such as nimodipine and hyperosmolar hypervolemic infusions have been suggested.

Pituitary apoplexy, sheehan's syndrome, lymphocytic adenohypophysitis, primary and metastatic intracranial tumours, wernickes encephalopathy and migraine are other rare conditions that occur in pregnant and puerperal patients.

Reports from western countries have shown that infarctions in pregnancy and puerperium were due to arterial occlusions (28,29,32) whereas Indian studies prove that venous strokes are more common than arterial strokes. This could be due to associated anaemia, sepsis and the custom of restricting fluids in the puerperal period(31). In our study the deaths during the study period were four and all were due to haemorrhagic venous infarct . Srinivasan et al reported that most cases of CVT were clustered in the second week of puerperium but could be delayed upto 3-4 weeks (5). However in our study most cases occurred in the first week of puerperium. Only two patients were identified with CVT in the antepartum period. In a study by James et al (30)and Radhabai et al the overall mortality rate for pregnancy related stroke were 4.1% and 19% respectively. In our study, the stroke related mortality rate was 10.8%. All the 5 cases of maternal deaths due to neurological complications were due to haemorrhagic stroke from venous occlusion. No case of maternal mortality was noted in arterial infarct. The deaths in patients with venous occlusion were due to haemorrhage and raised intracranial pressure. But once the venous occlusion patients survived there was steady neurological recovery. All patients who survived cerebral venous thrombosis had swift recovery without significant neurologic sequelae.

Fig 1:29year old post LSCS patient in immediate postnatal period who presented with altered sensorium. CT showed bilateral frontal haemorrhagic infarcts and midline shift to right side. MRI showed superior sagittal sinus thrombosis.

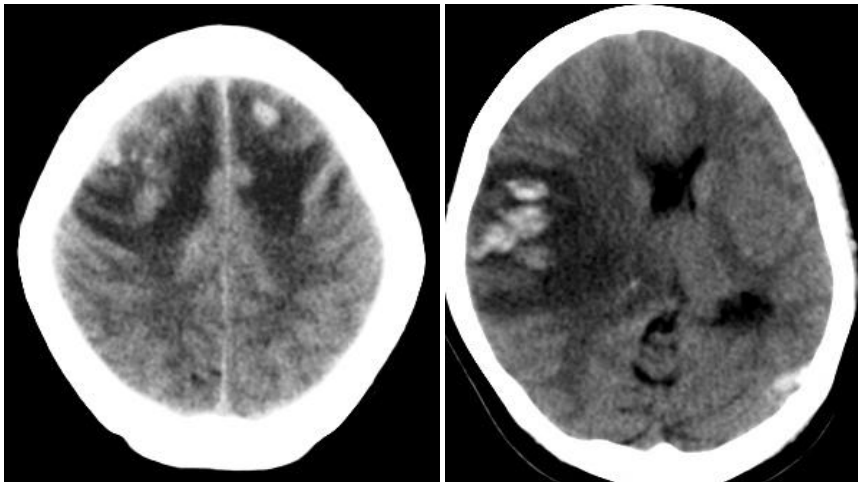


Fig 2:23 yearold postpartum patient with headache and seizures.T1 sagittal, T2 axial and MRV show superior sagittal sinus, right transverse and sigmoid sinus thrombosis.

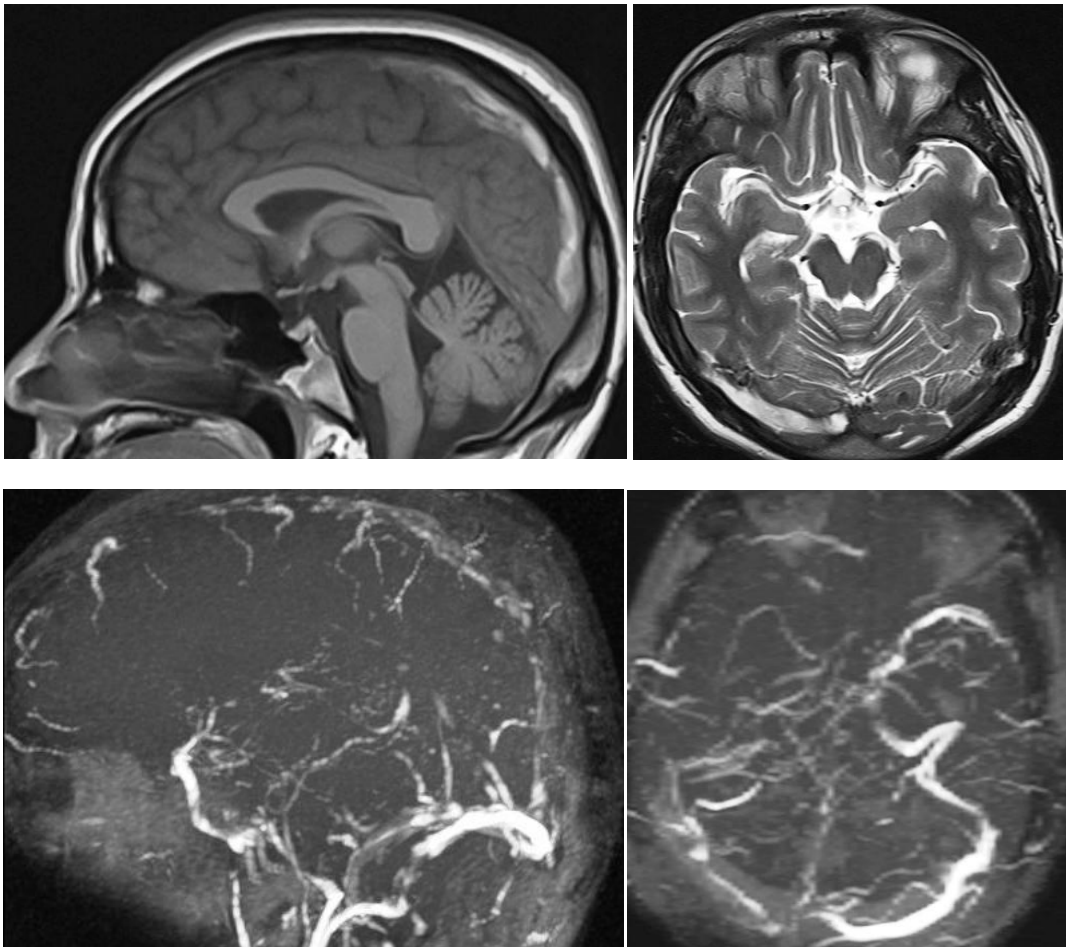


Fig 3:20 year old primi, post LSCS with motor weakness and seizure. CT and MRI showed sigmoid, transverse, superior sinus thrombosis with bilateral thalamic and right frontoparietalhaemorrhagic infarcts.

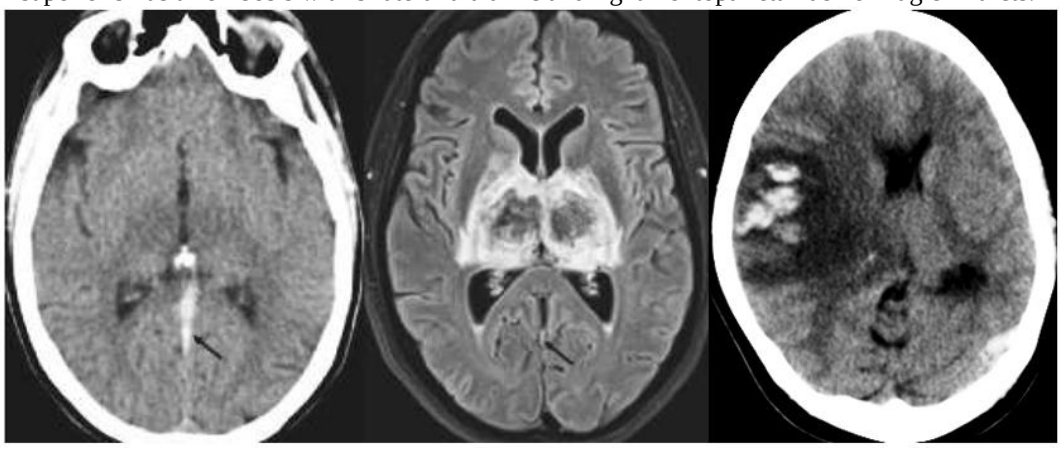
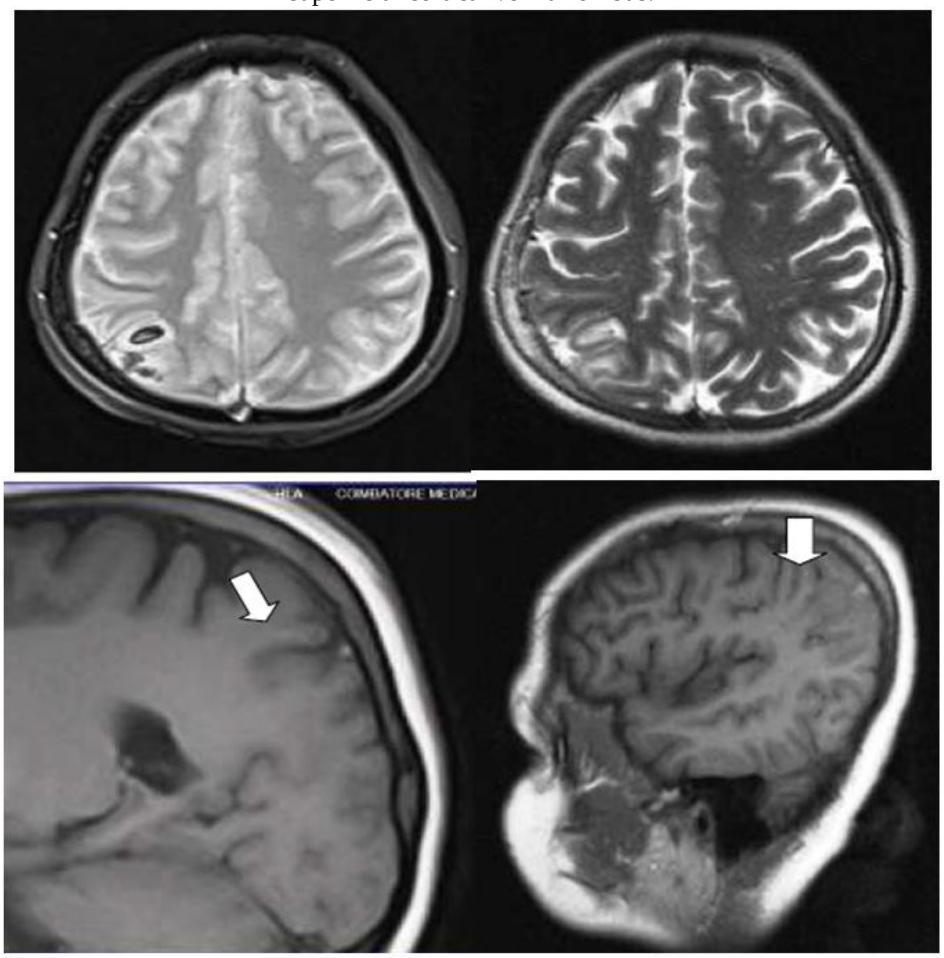


Fig 4:19 year old AN patient, T2W and GRE images showed haemorrhagic infarcts.T1W images showed superficial cortical vein thrombus.



V. Conclusion

Neurological symptoms are not uncommon during pregnancy and puerperium. In some patients they may indicate serious underlying problem. Headache is the commonest symptom associated with positive neuroimaging findings. Commonest complication to occur is CVT, the incidence rate of which is 492/1,00,000 deliveries. The neurological complication that is most associated with maternal mortality is CVT. Mortality rate due to CVT was 56/1,00,000 deliveries in the study. Superior sagittal and sigmoid sinuses are more frequently involved in CVT. Second commonestcomplication is PRES with incidence rate of 169/1,00,000 deliveries. The most common pattern of PRES is parieto-occipital. No mortality is related to PRES cases. Use of prompt and appropriate imaging modality potentially helps to diagnose serious neurological illnesses early thus helping the obstetrician to institute appropriate treatment strategies. Our study supports the liberal use of neuro- imaging in pregnant and puerperal women with neurological symptoms which can help in early identification andprompt management of serious neurologic complications.

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