

A Vital Role of Magnetic Resonance Imaging in Pregnancy-Related Neurological Complications

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Abstract

Introduction: Any neurological problem occurring during pregnancy has serious complications for both mother and child. Headache remains the most common symptom of intracranial disease, encountered by most of the women during pregnancy and puerperium.

Aim: To evaluate and characterize the various neurological conditions of the central nervous system and pituitary gland that occurs during pregnancy and postpartum period with the help of 1.5 tesla magnetic resonance imaging (MRI).

Place and Duration of Study: The study was conducted in the Department of Radiology, Chettinad Hospital and Research Institute, Chennai from May 2014 to May 2016.

Materials and Methods: A retrospective analysis of all pregnant and postpartum patients presenting with neurological manifestations of the central nervous system and pituitary gland were included in this study. Patients imaged in GE signa 1.5Hdx MRI. The images obtained were subjected for radiological interpretation.

Results: The cases included cerebral venous thrombosis (CVT), posterior reversible encephalopathy syndrome (PRES), eclamptic encephalopathy, ischemic stroke, and less common entities like pituitary apoplexy.

Conclusion: MRI plays a very crucial role in early diagnosis of neurological and pituitary-associated complications in pregnancy and postpartum period. The most common neurological complications which cause increased maternal mortality are eclamptic encephalopathy and CVT. Hence, early imaging can help in early and appropriate management of serious pregnancy-related neurological complications.

Key words: Magnetic resonance imaging, Maternal health, Maternal mortality, Neurological disorder, Pregnancy disorder, Puerperium

INTRODUCTION

Adequate maternal care in the antenatal period and also after delivery can resolve many pregnancy related complications and fetal problems.¹ During this time, physiological and physical changes take place in the woman,

to prepare her body for delivery. These changes include coagulation, hemodynamic, and hormonal changes as well as changes in mechanical pressure due to an enlarged uterus. Usually, these changes are not pathologic, but sometimes it leads to various adverse effects. A series of neurological disorders may be encountered during pregnancy and puerperium.² Headache remains the most common symptom encountered due to intracranial disease during the course of pregnancy and the puerperium.³ Thus, the development of acute headache should be taken seriously. Epilepsy, migraine and stroke are the most common neurological diseases which complicate pregnancy. Other nonspecific but occur more often in pregnant women (e.g.: Cerebral infarction, dural venous

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thrombosis, and pituitary apoplexy). Series symptoms of cerebral venous thrombosis (CVT) usually appeared in the first 3 weeks after delivery, women who had home deliveries and poor prenatal care were more often affected.⁴ Even when imaging changes are nonspecific, knowledge of those entities associated with pregnancy and awareness of the increased likelihood of certain diseases in pregnancy will allow a more informed differential diagnosis. Magnetic resonance imaging (MRI) has proved to be a boon in the early and accurate diagnosis of pregnancy-related neurologic complications. By knowing the prevalence and spectrum of neurologic complications in pregnancy, appropriate treatment can be initiated in early, thus improving maternal and fetal outcomes.⁵

MATERIALS AND METHODS

The study was a hospital based cross-sectional study, conducted in the Department of Radiology, Chettinad Hospital and Research Institute, Chennai from May 2014 to May 2016.

Clinically suspected cases of neurological disorders of the central nervous system and pituitary gland associated with pregnancy, who were referred to the Department for Radiological evaluation and who had positive imaging findings were taken up for the study. Most common presenting symptoms were headache, vomiting, seizures, altered sensorium, neurological deficits, visual disturbances, and symptoms of pituitary hypofunction. MR sequences along with time of flight (TOF), magnetic resonance angiography (MRA), and magnetic resonance venography (MRV) were done.

Sample Selection

Inclusion criteria

- Neurological manifestations of the central nervous system and pituitary gland are precipitated because of the pregnancy and postpartum state were included.
- Patients of second, third trimester and postpartum were included because most of the disorders occur in this period.

Exclusion criteria

- Claustrophobic patients.
- Neurological disorders not directly related to pregnancy were excluded from the study.
- Patients presenting in the first trimester were not included.

Consent

All authors declare that “written informed consent was obtained from the patient (or other approved parties)” for publication of this case report and accompanying images.

RESULTS

A total number of deliveries in the hospital during the study period was 8400. A total number of antenatal and puerperal patients who presented with neurological symptoms during that period was 150. The cases included eclamptic encephalopathy, CVT, posterior reversible encephalopathy syndrome (PRES), ischemic stroke, subarachnoid hemorrhage (SAH), pituitary apoplexy, and pituitary adenoma (Table 1).

DISCUSSION

In both pregnancy and puerperium, number of pathologic manifestations involves the central nervous system and pituitary gland. The most common presenting complaint of patients in both pregnancy and peripartum phase is headache. History of seizures for the first time in peripartum period causes biggest diagnostic muss. Peripartum seizures contribute significant problems to both maternal morbidity and mortality including their unborn children.⁶ The incidence of eclampsia has been dramatically increasing in the worldwide and reported as 2 in 100 to 18 in 1700 pregnancies. Usually, eclampsia may result in PRES.

Some neurologic conditions are related to the physiologic modifications in pregnancy, such as:

- Eclampsia
- Reversible cerebral vasoconstriction syndrome
- Sheehan syndrome.

Some of the cerebrovascular diseases occur more frequently in pregnancy and postpartum women, particularly:

- Cerebral infarction
- Dural venous thrombosis
- Pituitary apoplexy.

Neoplastic Disorders

- Primary intracranial tumors
- Intracranial metastasis.

Few of these conditions may remain subtle and go unnoticed during the pregnancy and postpartum. MRI plays

Table 1: Pregnancy patients affected with Neurological complications

Diagnosis	Number of cases (%)
Eclamptic encephalopathy	21 (33.33)
Cerebral venous thrombosis	15 (23.80)
PRES	11 (17.45)
Ischemic stroke	8 (12.70)
Subarachnoid hemorrhage	4 (6.34)
Pituitary apoplexy	3 (4.79)
Pituitary adenoma	1 (1.59)

PRES: Posterior reversible encephalopathy syndrome

an important role in recognition and characterization of these lesions and helps in future management. Additional diagnostic merit of MRI can be performed with the help of MRV with contrast or without contrast using time of flight sequences.⁸ MRI is the preferred imaging option in pregnancy. There is no documentation of hazardous fetal effects in humans due to the magnetic field exposure.

Ischemic stroke

The most important leading cause of maternal mortality is a stroke. It usually mimic other complications such as eclampsia, so it should be taken into serious consideration whenever neurological deterioration is observed. In pregnant women, the incidence of ischemic stroke is gradually increased by 3 times when compared to non-pregnant women.¹ The risk of stroke in most of the patients is reported in 2 days before delivery and 1 day after delivery. The most commonly reported etiology is cardio embolism. Other risk factors include lupus, blood transfusion, and migraine. Major benefits of MRI are acquired through diffusion-weighted imaging (DWI), with the use of this sequence radiation exposure is eliminated. The risk of ischemic stroke increases with age, particularly after age 35 years. Black women are at a higher risk. The risk of both ischemic infarction, which accounts for 60% of all strokes. There are two types of infarcts:

- Thrombotic infarcts
- Embolic infarcts.

Thrombotic infarcts

Results from hypercoagulable states and thrombosis on top of existing atherosclerotic plaques. Factors leading to hypercoagulability of blood include low levels of inhibitors of the coagulant protein S; elevated levels of inhibitors of protein C; increased levels of fibrinogen, factor VII, factor VIII, and factor X; and an enhanced ability to neutralize heparin.² Infarctions typically occur in the major arterial distributions.

Emboli infarcts

Results from dissections due to prolonged difficult labor, cardiac valvular disease, and the rare dilated peripartum cardiomyopathy.⁵ Watershed infarcts can result from dissections and significant obstetric hemorrhage. Frontal and parietal regions were the most common site of infarcts (Figures 1 and 2).

Eclamptic encephalopathy

The most serious complication that occurs in pregnancies is eclampsia, and it accounts for about 10% of the deaths related to pregnancy.⁹ Clinically, eclampsia is defined as seizure or coma associated with pregnancy-induced hypertension, and more than 30% of cases are diagnosed postpartum. Antenatal women present with tonic-clonic

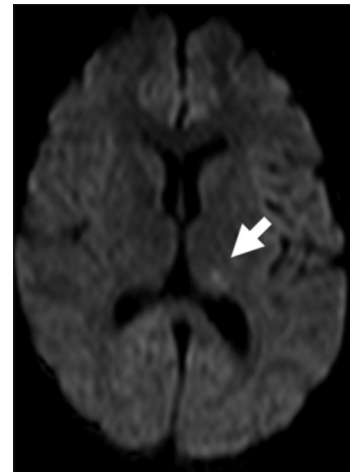


Figure 1: Magnetic resonance imaging scan of a woman presenting motor weakness in the right arm and leg at 26 gestational weeks on diffusion-weighted images shows a left thalamic infarction (arrow)

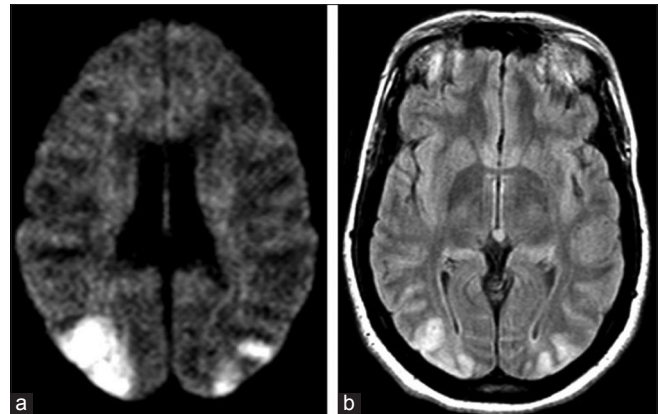


Figure 2: Complete (irreversible) cerebral infarctions in a 24-year-old woman who developed cortical blindness after difficult labor. (a) Axial diffusion-weighted magnetic resonance imaging (MRI) shows restricted diffusion in both occipital lobes, primarily in the arterial watershed zones. (b) Axial fluid-attenuated inversion recovery MRI shows corresponding edema and mass effect

seizures or coma who have developed pregnancy-induced hypertension. The exact diagnosis is made by the presence of hypertension, proteinuria, and edema along with seizures occurring after 20 weeks of pregnancy.⁹ About 70% of patients were diagnosed in antepartum, and more than 90% made after 27 weeks of gestational age. More than 50-75% of patients presents with occipital or frontal headaches that usually precede the attack of seizures, and 20-30% have visual blurring or cortical blindness.¹⁰ The most commonly involved brain regions in eclamptic encephalopathy are parieto-occipital, frontal, temporal, and sometimes even cerebellar hemispheres. In atypical cases even basal ganglia, thalamus and brainstem are involved. The exact mechanism remains unknown. It is likely to be multifactorial, and it causes cytotoxic effects on the vascular endothelium

leading to increased permeability and vasogenic edema. Cerebral auto regulation impairment eventually leads to disruption of the blood-brain barrier in the posterior circulation. The predilection for the posterior circulation and watershed zones is believed to be related to its sparse vasomotor sympathetic innervation. The most important complication associated with eclampsia is PRES.¹¹ Lesions typically show no diffusion restriction. DWI is particularly useful in distinguishing the reversible vasogenic edema from the cytotoxic edema of complete infarction. Catheter angiography typically shows vasospasm in the medium and large cerebral arteries, particularly of the basilar artery. Treatment of eclampsia is supportive, with controlling of seizures and hypertension, as well as maintaining a stable hemodynamic state. Magnesium sulfate is the drug of choice to prevent recurrent convulsions in eclampsia.

PRES

Eclampsia is one of the most important causes of PRES.¹¹ This condition is likely induced by endothelial dysfunction leading to increased permeability. Clinical features are headache, altered consciousness, visual abnormalities, and seizures in conjunction with the neuroimaging findings of vasogenic edema, typically involving the posterior circulation. Four major types of radiological presentation of PRES are holohemispheric watershed pattern, superior frontal sulcus involvement pattern, predominant parieto-occipital involvement, and asymmetric presentation of primary pattern.¹¹

A typical MRI finding on T2-weighted image and fluid-attenuated inversion recovery (FLAIR) associated with PRES is hyperintensity of the parieto-occipital cortices and subcortical white matter, usually indicating vasogenic edema. Usually, the regions of calcarine and paramedian occipital lobe structures are spared. It should be differentiated from infarction in the bilateral posterior cerebral artery territory, where the calcarine, thalamic, and midbrain regions are usually affected. The most important complications of PRES are cerebral ischemia, cerebral herniation, and cerebral hemorrhage. Clinically, PRES resolves after 3-8 days. The most ideal time to repeat MRI in PRES patients is 7-10 days. In follow-up MRI, more frequent complete resolutions of edema were observed (Figure 3).

CVT

CVT may occur anytime during the course of pregnancy and the puerperium, but the risk of developing of CVT is increased twice during the first 2 weeks of the puerperium.¹²

There is a high risk of developing CVT in young mothers and after cesarean section. About 6% of maternal deaths is due to CVT. Hypercoagulable state provokes CVT during

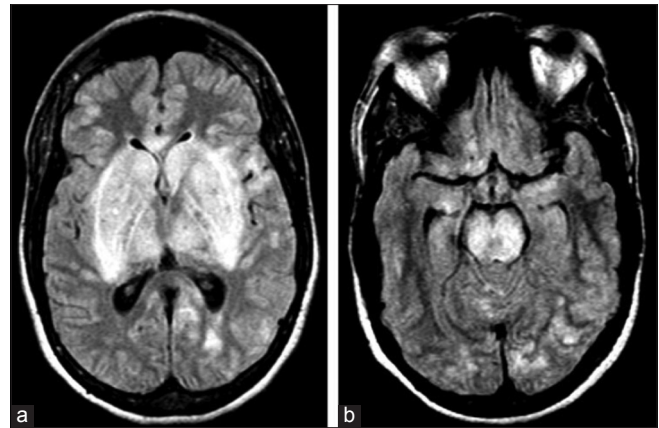


Figure 3: A 36-week pregnant woman presented with a history of eclampsia. (a) Axial fluid-attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI) shows symmetric edema in the thalami and basal ganglia. (b) Axial FLAIR MRI shows diffuse edema in the pons. Follow-up MRI obtained 2 months later was normal posterior reversible encephalopathy syndrome

pregnancy and puerperium. The condition that provokes hypercoagulable states are clotting factors, factors II, VII, and X are increased during the pregnancy, the level of protein S is decreased, but the level of protein C remains unchanged.¹² The hypercoagulable state, along with dehydration during labor and puerperium, is responsible for thrombotic complications such as CVT in pregnancy. The most common symptom of CVT that occurs in 95% of patients is headache. Other manifestations are focal seizures, paresis, papilledema, altered consciousness, and isolated intracranial hypertension. The associated risk factors with pregnancy-related cerebral venous sinus thrombosis are increased maternal age, hyperemesis, delivery by cesarean section, maternal infection, and maternal hypertension. The most commonly involved sinus in nonseptic patients is superior sagittal sinus, and in sepsis patients most commonly involved sinus is cavernous and lateral sinus thrombosis. On MRI, usually, it shows the high signal intensity of the venous sinuses with all routine sequences (usually on T1-weighted, T2-weighted, and FLAIR). On contrast enhanced T1W, it usually shows high signal intensity with a corresponding filling defect after gadolinium enhancement may develop within the first week after clinical onset. Early detection can be done with MRI within 7 days of clinical onset. Other parenchymal signs of CVT include diffuse mass effect, localized sulcal effacement, and venous infarcts. Venous infarcts are often associated with hemorrhage at the gray-white matter interface. MRV helps us to understand involvement of the major cerebral veins tributaries, dural venous sinuses, and anatomic variants¹² catheter angiography has more significance in the treatment of CVT rather than diagnostic purpose (Figures 4 and 5).¹⁵

SAH

The occurrence of SAH during pregnancy is dramatically increased, 85% of SAHs occur in the second or third trimester. The risk of developing SAH is 5 times higher than in non-pregnant women.¹ Most commonly occurs in young primigravidas during the third trimester. Straining during the time of delivery usually increases the bleeding during the puerperal period.¹² The most common cause of SAH during pregnancy is rupture of an intracranial aneurysm. Other causes include pregnancy-induced hypertension, failure of cerebral autoregulation with propagation of the increased arterial pressure waves to the relatively thin-walled pial veins, ruptured berry aneurysm, arteriovenous malformation, anticoagulant toxicity, bleeding disorders, and cocaine use. Treatment of ruptured aneurysms is same as in the case of non-pregnant women. Unruptured aneurysms should be left as such, they should be treated only if they are symptomatic or enlarging. Patients undergoing endovascular treatment for ruptured aneurysms in the first trimester should be advised to terminate the pregnancy because of high risk to fetus.

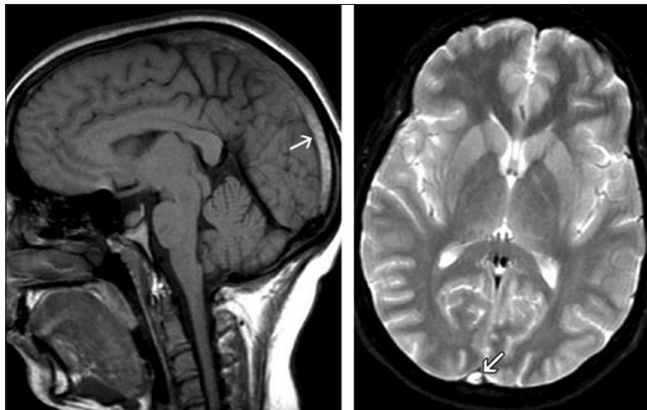


Figure 4: Thrombosis of the superior sagittal sinus and venous infarction in a 25-year-old woman who was 34 weeks pregnant and developed headaches and blurring of vision. Sagittal T1-weighted, axial T2-weighted magnetic resonance images show high signal intensity in the superior sagittal sinus (arrow)

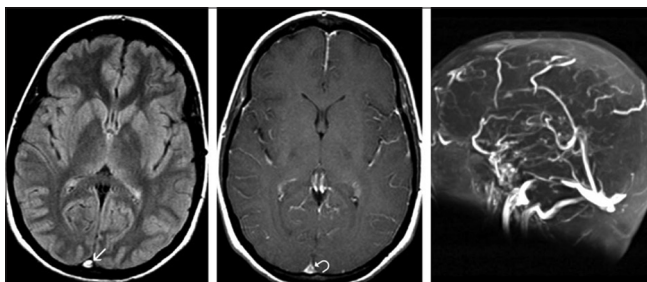


Figure 5: Axial fluid-attenuated inversion recover magnetic resonance imaging (MRI) show high signal intensity in the superior sagittal sinus (arrow). Axial gadolinium-enhanced T1-weighted MRI shows a filling defect (empty delta sign) (arrow) in the superior sagittal sinus. On a three-dimensional time of flight MR venogram, the superior sagittal sinus is not visualized because of extensive thrombosis

During second and third trimester successful endovascular coil treatment of ruptured aneurysms has been reported. An early and precise diagnosis is critical, and it is highly recommended to perform MRI on these patients. In few cases, FLAIR is useful in the detection of SAH. MRA plays a very crucial role in identifying the causes of hemorrhage, e.g., aneurysm, moyamoya disease, or arteriovenous malformation, without the use of contrast material.

Pituitary disorders

The rising levels of estrogen during pregnancy results in enlargement of the adenohypophysis. This is compensated by the rising levels of prolactin in the circulation. Prolactin levels may reach 35 ng/mL during the first trimester, 175 ng/mL during the second trimester, and up to 210 ng/mL during the third trimester.¹³ There is a chance of pituitary hemorrhage, infarction, and accelerated prolactinoma growth during the course of pregnancy and the puerperium.

Pituitary apoplexy

Pituitary apoplexy is an acute syndrome. It is usually characterized by acute hemorrhagic infarction in an existing pituitary adenoma or physiologically enlarging pituitary gland. The patients may present with a severe headache, vomiting, and visual disturbances including visual field defects and restricted eye movements. Incidence of pituitary apoplexy increases during pregnancy, and postpartum period, due to increased pituitary stimulation from placental estrogens, the enlargement of the adenohypophysis, rapid growth of tumors, and may also result from ischemia. On MRI, the pituitary gland is enlarged with variable T1 and T2 signal intensities, depending on the age of the hemorrhage. On DWI, an apoplexy secondary to infarction may also be detected earlier. All patients with apoplexy do not show intrasellar hemorrhage. Treatment of pituitary apoplexy is supportive, usually hormonal replacement is done. Transsphenoidal surgery although safe is rarely needed (Figure 6).

Neoplastic disorders

During pregnancy, there will be a change in the hormonal level which usually enhances the rate of growth of prolactinomas. Usually, symptoms of these tumors are masked by other existing pathologic processes such as migraine or pre-eclampsia. During pregnancy, there is gradual increase in the size of the tumor. The most common symptoms of primary brain tumors are headache, vomiting, visual symptoms, focal neurologic deficits, and seizures. MRI plays a very crucial role in diagnosis. Usually, MRI is preferred because of proper tissue resolution and the use of magnetic field is safe and does not affect the fetus.¹⁴ The contrast material used for MRI in pregnancy is gadolinium, and it is safe in pregnancy.

Pituitary adenoma

Prolactinomas are the most common pituitary tumors occurring during pregnancy. The elevated level of prolactin is recognized during pregnancy. During pregnancy evaluation of a pituitary mass poses an interesting challenge, because of continuously rising level of prolactin. In the presence of a prolactinoma, prolactin levels may vary. Hence, periodic measurements of prolactin give us a little clue in diagnosis. Evaluation of pituitary tumor is further hindered by administration of gadolinium during pregnancy. The optic chiasm and optic nerves symptomatically compressed by pituitary macroadenoma.¹² Clinically pituitary adenoma is defined as the height of the pituitary gland exceeds by 12 mm. If imaging becomes necessary, high-resolution MRI sequences without contrast material can be performed. Medications such as bromocriptine a dopamine agonist are considered the treatment of choice for prolactin-secreting microadenoma and adenomas confined to the sella and it can decrease the size of the tumor by up to 50% in pregnancy. Transsphenoidal resection is considered in pregnant patients in whom the tumor continues to grow, causing worsening visual symptoms. Adrenocorticotrophic hormone secreting adenomas should always be surgically removed. In growth hormone secreting adenomas and nonfunctioning adenomas surgery and medication are not indicated. In thyroid-stimulating hormone secreting tumors should receive only antithyroid medications to control hyperthyroidism (Figure 7).¹³

CONCLUSION

Pregnancy is a natural phenomenon, various central nervous system, and pituitary disorders can occur during the course of pregnancy and postpartum period. Good prenatal care, safety of drugs, and use of proper diagnostic modalities during pregnancy can prevent many of these neurologic complications.¹³ Accurate diagnosis is crucial, in acute neurologic disorders and pituitary disorders during pregnancy and postpartum period because appropriate and timely treatment can reverse the disease process and it plays a crucial role in reducing the risk of acute complications and long-term sequelae. These disorders when failure to diagnose at the earliest can lead to life-threatening complications, such as ischemia, massive infarction, and death. Common complications to occur in this period are eclamptic encephalopathy, followed by CVT, PRES, and ischemic stroke. Superior sagittal and sigmoid sinuses are more frequently involved in CVT. The most common pattern of PRES is parieto-occipital. Use of appropriate imaging modality potentially helps to diagnose serious neurological illnesses early thus helping the obstetrician to institute appropriate treatment strategies. MRI plays a very important role in depicting these disorders and



Figure 6: Magnetic resonance imaging scan of pituitary hemorrhagic apoplexy in a woman presenting prolactinoma at 34 gestational weeks. The patient also presented symptoms of headache and vomiting. An enlarged pituitary gland was observed with focal hemorrhage, high signal intensity on sagittal T1-weighted image (a: Arrow), and low signal intensity on sagittal T2-weighted image (b: Arrow)

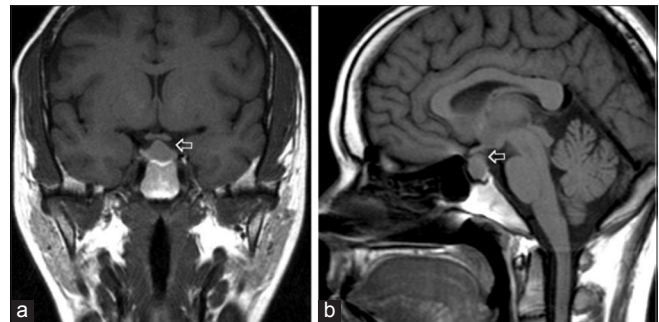


Figure 7: Prolactinoma in a 27-year-old woman who was 32 weeks pregnant and presented with headaches, visual disturbances, and a prolactin level of 290 ng/mL. Unenhanced coronal (a) and sagittal (b) T1-weighted magnetic resonance imaging show a large sellar and suprasellar tumor that causes mild compression of the optic chiasm (arrow)

complications arise due to these disorders at earliest.¹⁴ The radiologist may be the first person to propose the correct diagnosis on the basis of the imaging findings. Therefore, it is important that radiologists working in the emergency department setting be familiar with these entities to minimize the time to diagnosis.

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