Effect of pathology and gestational age on the management of neurosurgical emergencies in pregnant women
S Elwatidy

Citation

Abstract

BACKGROUND: The diagnosis of neurosurgical pathology in a pregnant lady is a stressful event to the patient, her family and attending physician and the management of these problems challenges the skills of obstetricians and neurosurgeons to secure both the baby and his mother. In this study, the author presents 10 pregnant women presented acutely to neurosurgery with different neurosurgical problems, the management of each patient was individualized according to the pathology and gestational age.

OBJECTIVE: To establish a protocol for management of acute neurosurgical lesions during pregnancy according to the pathology and gestational age.

PATIENTS AND METHODS: Retrospective review of all pregnant ladies who had surgery for acute neurosurgical problem during the period 1995 – 2007.

RESULTS: 10 patients, 9 multiparous and one primigravida (one in the first trimester and 9 in the 2nd or 3rd trimester). The patient age ranged from 24 -40 years, mean 30.2 years. Six patients had brain lesions (5 brain tumors and 1 tuberculosis), 2 had aneurysmal subarachnoid hemorrhage (SAH), and 2 had traumatic fracture of the spine. The brain tumors were 3 meningiomas, 1 malignant astrocytoma (grade III), and 1 colloid cyst. Five patients had the neurosurgical operation first and pregnancy was completed to full term. Two patients had emergency cesarean section (CS) followed by neurosurgical operation in the same session, 2 patients completed pregnancy to full term and had neurosurgical operation after delivery, and one patient had therapeutic abortion followed by the neurosurgical operation. No maternal or foetal complications were recorded in this series.

CONCLUSION: The management of pregnant patients with acute neurosurgical problem must be individualized according to intracranial pathology and gestational age. A multidisciplinary and cooperative approach, which involves neurosurgeon, anesthesiologist, obstetrician and neonatologist, is required to improve maternal and fetal outcome. For patients in the 2nd and early 3rd trimester, it is possible to perform neurosurgical operation first and complete pregnancy to full term. Patients at 34 weeks or more gestation, emergency CS followed by neurosurgical operation is recommended, and for patients in the 1st trimester, it is advisable to terminate pregnancy to allow safe management. In some patients who had benign tumor and responded to corticosteroids, it is possible to complete pregnancy and do surgery after delivery.

INTRODUCTION
Physiological changes that take place in pregnant women almost exclusively affect the whole body systems. The cardiovascular system expands to support the needs of the growing fetus. The circulating blood volume increases by 40% to 50% and resting heart rate increases by about 15 to 20 beats per minute by the third trimester, and there is reduction of resting blood pressure due to vasodilatation. Pregnancy hormones stimulates lengthening and laxity in the ligaments and other connective tissues which leaves joints more vulnerable to injury. All metabolic functions are increased during pregnancy to meet the demands of fetus, placenta and uterus as well as for the gravida's increased basal metabolic rate and oxygen consumption. Pregnancy is
also associated with a hypercoagulable state due to a combination of venous stasis and altered levels of circulating clotting factors during pregnancy and the puerperium (1)
.
These changes make the mother and her foetus vulnerable and requires utmost attention during the whole course of illness. The diagnosis of brain lesion might be delayed in pregnant women as the clinical picture (headache, vomiting, or seizure) can be confused with hyperemesis gravidarium early in pregnancy or with eclampsia late in pregnancy. However, the presence of an abnormal fundoscopic examination, visual impairment, focal seizures, and lateralizing neurological deficits should alert physicians to the possibility of an intracranial lesion and prompt further investigations with MRI to establish the diagnosis (1-3).

In this study, the author presents 10 pregnant women who presented acutely to neurosurgery service, the management of each case was tailored to each patient according to the pathology and duration of conception.

**OBJECTIVE**

Review the management of pregnant ladies who present acutely with CNS lesions and establish a protocol for their management according to the pathology and gestational age to improve maternal and fetal outcome.

**PATIENTS AND METHODS**

All pregnant patients who presented acutely to neurosurgery service and required surgical intervention at King Khalid University Hospital between 1995 and 2007 were retrospectively collected and analyzed. The medical records were reviewed and demographic, clinical, radiological and treatment data were collected including; patient's age, duration of illness, presenting symptoms, physical signs, maternal, and obstetric history. The radiological findings (CT, MRI, and ultrasound scans), obstetric management, operative intervention including surgical approach, the extent of tumor excision, postoperative complications, follow up notes, and maternal and fetal outcome were recorded.

**RESULTS**

Ten patients, 9 multiparous and one primigravida, were treated at our institute; one patient was in the first trimester and 9 patients were in the 2nd or 3rd trimester. There were 6 brain lesions (5 brain tumors and 1 brain tuberculosis), 2 subarachnoid hemorrhage (SAH) due to ruptured cerebral aneurysm, and 2 patients had fracture spine (L1, and C5-6).

The patient age ranged from 24 -40 years , mean 30.2 years. The brain tumors were 3 meningiomas, 1 malignant astrocytoma (grade III), and 1 colloid cyst. The clinical presentation of brain lesions was rather acute in the form of seizures in 3 patients, deterioration of consciousness with motor weakness in 2 patients, and deterioration of vision in one patient. Patients with SAH presented with sudden headach, meningism and loss of consciousness (both were grade II according to Hunt and Hess grade). Patients with fracture spine were involved in road traffic accidents, one had burst fracture of L1 vertebra and was paraplegic, and the second one had C4-5 fracture subluxation with locked facet joint and significant weakness of the right upper limb (3/5 at elbow and wrist). The management of pregnant patients included; completion of pregnancy to full term and neurosurgical procedure was performed after delivery in 4 patients (2 had spontaneous vaginal delivery- SVD- and 2 had CS). Five patients (2 nd and early 3 rd trimester) had neurosurgical procedure at first and completed their pregnancy to full term (4 had SVD, and 1 paraplegic patient had CS). Two patients had emergency CS followed immediately by craniotomy, and one patient (1 st trimester) had therapeutic abortion followed by cranial surgery. No maternal or fetal mortality in this series. Table 1 shows clinical details of all patients.

**SUMMARY OF PATIENTS**

Case 1. A 40 year-old lady, 30 weeks pregnant (G6P5), was admitted through emergency with repeated seizures, and loss of consciousness. CT and MRI scan revealed huge frontoparietal meningioma with marked mass effect (Fig1).
Figure 1
Figure 1: CT brain after contrast injection showing a large fronto-parietal meningioma.

Figure 2
Figure 2: MRI scan, T1 after gadolinium injection showing olfactory groove meningioma

Urgent craniotomy and total resection of the tumor (meningoma) was performed and she continued her pregnancy till full term. Her postoperative course was smooth and at full term she had uneventful SVD of a normal baby.

Case 2. A 28 year-old lady, 23 weeks gestation (G3P2), presented with generalized seizures and drowsiness. MRI scan showed a large olfactory groove meningioma with severe brain edema (Fig 2).

She responded well to corticosteroids and phenytoin so she was scheduled for elective craniotomy after labour. At the end of her 36th week, the patient went into status epilepticus, she had emergency CS and delivered normal baby (Apgar score 10 at 5 minutes). Six weeks later she had craniotomy and excision of the tumor.

Case 3. A 30 year-old lady, 22 weeks gestation (G5P4) presented with progressive headache and loss of vision, MRI scan showed suprasellar meningioma (Fig 3).
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Case 4. A 36 year-old lady, 26 weeks pregnant (G4P3), presented with severe headache and bilateral papilledema. MRI scan showed colloid cyst filling the 3rd ventricle causing acute obstructive hydrocephalus (Fig 4).

Her symptoms improved after corticosteroids (Dexamethasone 4 mg 8 hourly), she was discharged on a tapering dose of corticosteroids and scheduled for craniotomy after labor. She had full term SVD of normal baby, and tumor removal was carried out 3 months later.

Case 5. A 33 year-old lady, 34 weeks pregnant (G6P5), presented with recurrent generalized seizures, progressive right side weakness and disturbed sensorium (GCS 13/15). MRI scan showed large left frontal tumor with marked mass effect and bilateral papilloedema (Fig 5).

She had craniotomy and transcallosal excision of colloid cyst and continued her pregnancy smoothly and at full term she had SVD of normal baby.
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Figure 5
Figure 5: MRI scan, FLAIR image, showing a large Rt. Frontal glioma causing mass effect

She had emergency C/S followed by craniotomy and tumor excision (anaplastic astrocytoma, grade III). Both mother and baby did well postoperatively with no complications.

Case 6. A 27 year-old lady 10 weeks gestation (G2P1), presented with recurrent focal seizures, persistent headache, and visual disturbances. MRI scan revealed a small right occipital lesion surrounded with marked brain edema suggestive of malignant tumor or tuberculoma (Fig 6).

Figure 6
Figure 6: MRI scan, T2 and FLAIR images, showing a small Rt. Occipital lesion surrounded with marked brain edema

She had therapeutic abortion followed by image guided biopsy from the lesion, it was proven to be tuberculoma, she received combination of 4 anti-TB drugs for 9 months together with phenytoin, she recovered without deficits.

Case 7. A 26 year-old lady, 36 weeks gestation (G3P2) presented with sudden onset of severe headache and meningism (Hunt and Hess grade-II). CT scan showed subarachnoid hemorrhage in the suprasellar cistern, CT angiography showed large left internal carotid artery bifurcation aneurysm (Fig 7).

Figure 7
Figure 7: CT angiography showing a large left internal carotid artery bifurcation aneurysm (arrow)

She had emergency CS followed by craniotomy and aneurysm clipping in the same session. Both mother and baby had no complications.

Case 8. A 24 year-old lady, 22 weeks gestation (G2P1), presented with severe headache followed by transient loss of consciousness and neck stiffness (Hunt and Hess grade-II). CT and cerebral angiography showed right middle cerebral artery aneurysm (Fig 8).
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Figure 8
Figure 8: Rt. Carotid angiography showing a middle cerebral artery aneurysm

She had uneventful endovascular coiling of the aneurysm, her pregnancy afterwards was uncomplicated and at full term she had uncomplicated SVD, both baby and his mother had good outcome.

Case 9. A 30 year-old lady, 24 weeks gestation (G4P3) admitted following road traffic accident, she sustained fracture dislocation of L1-2 (Fig 9- A, B) with complete paraplegia.

Figure 9
Figure 9a: CT reconstructed images of the lumbar spine showing fracture dislocation of L 1-2 vertebrae

Figure 10
Figure 9b: Intra-operative x-ray showing reduction and fixation of the spine

Obstetric assessment confirmed 24 week-old viable foetus. The condition was complicated with deep vein thrombosis (DVT) of lower limbs. Full anticoagulation (heparin) was started and inferior vena cava filter was inserted before surgery. Spinal fixation was done with the patient in prone position (with adequate abdominal support and shielding), she tolerated surgery well and postoperative abdominal US confirmed viability of foetus. At full term she had CS and delivered healthy baby.

Case 10. A 28 year-old lady, pregnant 20 weeks (G4P3) was involved in road traffic accident, she sustained fracture dislocation of cervical spine with locked C5-6 facet joint on the left side (Fig 10).
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**Figure 11**
Figure 10: Plain x-ray showing fracture dislocation of C5-6 vertebrae with locked fact (arrow)

Clinically she was fully conscious, had severe neck pain, torticollis, and weakness of left upper limb (mainly the wrist - power 3/5). Skull traction was applied and after reduction of cervical dislocation, the patient had anterior cervical (C5-6) fixation using plate and screws. Postoperatively, arm weakness improved and foetus was viable. At full term she had uneventful SVD of normal baby.

**DISCUSSION**

During the course of pregnancy and delivery many physiological and anatomical alterations develop in virtually all body systems. Early changes are due, in part, to the metabolic demands brought on by the fetus, placenta and uterus and, in part, to the increasing levels of pregnancy hormones, particularly those of progesterone and oestrogen. Later changes, starting in mid-pregnancy, are anatomical in nature and are caused by mechanical pressure from the expanding uterus.

The signs and symptoms of a meningioma may initially appear during the second or third trimester of pregnancy and subside in the postpartum period. It is believed that the presence of hormone receptors, mainly progesterone receptors are responsible for the worsening symptoms of meningioma.

Several studies reported presence of progesterone binding sites in meningiomas, they suggested that the growth, recurrence, and behaviour of meningiomas may be regulated by hormones. The fluctuations in the hormonal milieu of pregnancy as a result of increase in the blood volume, redistribution of body water between intracellular and extracellular fluid compartments and the influence of steroid hormones may increase the tumour size and peritumour edema.

In clinical practice, it is feasible in most cases of meningioma and other benign, slowly progressive tumors to continue pregnancy to full-term without endangering the mother or fetus. Urgent intervention is reserved for patients with a (a) malignancy, (b) active hydrocephalus requiring shunting, or (c) a benign brain tumor such as a meningioma associated with signs of impending herniation, progressive neurological deficit, or both.

In the present study one patient with meningioma had craniotomy and tumor excision done on emergency basis because the patient showed evidence of progressive increase in ICP with rapidly escalating deterioration and MRI scan showed massive shift of midline structures caused by the tumor. On the contrary, the other two meningioma patients responded well to medical treatment and their symptoms improved so pregnancy was continued to full term and tumor excision was performed sometime after delivery. One of them delivered by CS because she went into status epilepticus and fetal distress was documented, and the other one had SVD.

Advances in noninvasive fetal monitoring, neuroanesthesia, and microsurgical techniques permit safe neurosurgical management of brain lesions during pregnancy. Corticosteroids is very effective in the treatment of severe brain edema perioperatively and in the peripartum period. They may accelerate fetal maturity by stimulating the lecithin-sphingomyelin index which is a marker for lung maturation, however, Long term use of corticosteroids, particularly during the third trimester, may result in fetal adrenal suppression and neonatal hypoadrenalism; the usual regimen is a divided dose of 2–4 mg dexamethasone every 6 hours, tapered slowly over few weeks.

Controversy exists for the intraoperative management of ICP in a pregnant patient. Hyperventilation may adversely affect the fetus by reducing cardiac output due to reduced venous return, thus decreasing uterine blood flow by two different mechanisms, first; hypocapnia produces uterine/umbilical artery vasoconstriction, and second; by producing alkalosis which causes shift of the oxygen-hemoglobin dissociation curve to the left which reduces oxygen delivery to the fetus. Hemodynamic stability is important for maintaining...
In certain situations, where pregnancy is precious or parents refuse termination of pregnancy, the developing foetus. In certain situations, where pregnancy investigations and safe treatment without geopardization of with the patient her husband, to allow adequate radiologic trimister had therapeutic abortion, After detailed discussion the method of delivery (SVD or CS). One patient (1 st trimester) had therapeutic abortion, After detailed discussion with the patient her husband, to allow adequate radiologic investigations and safe treatment without jeopardization of the developing foetus. In certain situations, where pregnancy is precious or parents refuse termination of pregnancy, pregnancy can be completed despite high risk of teratogenicity.

Our management strategy for brain tumors during pregnancy was individualized according to neurologic status of patient and duration of pregnancy. Similarly, decisions about whether to continue the pregnancy and selection of the best means of delivery are critically influenced by the nature of prognosis of the mother's intracranial lesion. In this series, patients near full term ( 34 weeks or more) with rapidly escalating neurologic deficit caused by raised ICP had emergency CS followed by the neurosurgical operation in the same session. Patients in the 2 nd and early 3 rd trimester had the neurosurgical procedure done first (with careful attention to hydration and oxygenation of the mother) and pregnancy was completed. At full term, obstetrician decided the method of delivery (SVD or CS). One patient (1 st trimester) had therapeutic abortion, After detailed discussion with the patient her husband, to allow adequate radiologic investigations and safe treatment without jeopardization of the developing foetus. In certain situations, where pregnancy is precious or parents refuse termination of pregnancy, pregnancy can be completed despite high risk of teratogenicity.

Antiepileptic drugs should be prescribed (preferably monotherapy) to all gravid patients with brain lesions and their levels should be monitored closely during pregnancy and puerperium and the dose is adjusted accordingly (8). Studies have shown that monotherapy with the most commonly used antiepileptic drugs is associated with an increase in risk of major congenital anomalies by two to three times, and that the magnitude of risk increases in offspring exposed to polytherapy (9). However, the benefits of avoiding seizures during pregnancy (avoiding maternal foetal hypoxia and acidosis) outweighs their delirious effects. Patients with seizures should be maintained on folic acid from early pregnancy and should receive supplemental vitamin–K1 three weeks before and during confinement to minimize the risk of drug–induced neural tube defects or blood dyscrasias (9,8).

Intracranial hemorrhage (ICH) from aneurysm or arteriovenous malformation (AVM) is a rare but grave complication of pregnancy and is responsible for 5-12% of all maternal deaths during pregnancy and 17% fetal mortality (10,11,12,13,14). The management of aneurysmal SAH is basically the same for both pregnant and non pregnant women, if the patient is near full term (34 weeks or more gestation) emergency CS followed by aneurysm isolation (clipping or coiling). If pregnancy is still in earlier stages, aneurysm management is considered first and pregnancy is continued afterwards to full term. The method of delivery is left to the obstetrician but there is no contraindication to SVD when the aneurysm is secured. Dias M and Sekhar L (5) analysed 154 cases of intracranial hemorrhage (ICH) during pregnancy reported in the literature, they found that 77% of ICH were due to aneurysm rupture and 23% due to AVM. 92% of ICH occurred in the antepartum and 8% in the postpartum period. In 34% of cases there was difficulty in differentiating ICH due to vascular lesion from that due to eclampsia because of associated hypertension and/or proteinuria. They also found that maternal and fetal outcome with surgery for aneurysm was better than AVM, and concluded that decision for neurosurgical intervention should be based on neurosurgical condition and the method of delivery is based on obstetric considerations.

The management of unstable spine fracture is the same for both pregnant and non pregnant women. However, some key-points have to be taken into consideration; patients near full term should have CS followed spine fixation, while at early stages of pregnancy spine fixation is performed initially and pregnancy is completed. At full term, patients with paraplegia should have CS because their abdominal muscles are weak and voluntary contractions are lost.

The cautious use of CT with shielding of the uterus has been superseded by MRI because of its high–sensitivity diagnostic index and no radiation effect. The use of plain x-ray is mandatory for patients with fracture spine, before surgery to check reduction of dislocated vertebra and intraoperatively to check position of screws and spine alignment, however, its use should be restricted to minimal with adequate shielding of the uterus.

One patient in this series (had fracture L1 vertebra with paraplegia) developed DVT before spine fixation, she was treated with heparin and IVC filter was inserted before surgery. Thromboembolic disease is a major cause of maternal morbidity and mortality, pregnant condition is in
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**CONCLUSION**

The management of pregnant patients with acute neurosurgical problem must be individualized according to intracranial pathology and gestational age. A multidisciplinary and cooperative approach, which involves neurosurgeon, anesthesiologist, obstetrician and neonatologist, is required to improve maternal and fetal outcome. For patients in the 2nd and early 3rd trimester, it is possible to perform neurosurgical operation first and complete pregnancy to full term. Patients at 34 weeks or more gestation, emergency CS followed by neurosurgical operation is recommended, and for patients in the 1st trimester, it is advisable to terminate pregnancy to allow safe management. In some patients who had benign tumor and respond to corticosteroids, it is possible to complete pregnancy and do surgery after delivery.

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**Figure 12**

Table 1: Summary of all patients

<table>
<thead>
<tr>
<th>Case no</th>
<th>Age (yr)</th>
<th>Gestational age</th>
<th>Pathology</th>
<th>Management</th>
<th>Delivery</th>
<th>Maximum &amp; fetal outcome</th>
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<td>1</td>
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<td>2nd</td>
<td>Contusional hemorrhage</td>
<td>Craniotomy &amp; cord pregnancy</td>
<td>CS</td>
<td>Good</td>
</tr>
<tr>
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<td>36</td>
<td>2nd</td>
<td>Idiopathic hemorrhage</td>
<td>Craniotomy &amp; cord pregnancy</td>
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<td>Good</td>
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<td>Craniotomy &amp; cord pregnancy</td>
<td>CS</td>
<td>Good</td>
</tr>
</tbody>
</table>

*FSVD* Full term spontaneous vaginal delivery

**C/S** Cesarean section

**REFERENCES**

7. Brandis A, Mirzai Š, Tatagiba M, Walter G F, Samii M,
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Author Information
Sherif Elwatidy, FRCS (SN), MD
Division of neurosurgery, King Khalid University Hospital, College of Medicine, King Saud University