Neurocritical Care Perspective of Traumatic Brain Injury During Pregnancy

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INTRODUCTION

Trauma including traumatic brain injury (TBI) is a leading cause of morbidity, mortality, and disability that can potentially affect women of childbearing age. TBIs not only can lead to impairment of physical, cognitive, and/or emotional well-being of the mother, but also compromise the well-being of the foetus and can impair the healthy outcome of pregnancy. There are only few studies which have reported the impact of TBI in this vulnerable population which include mother and foetus. These studies have emphasized that emergency stabilization set the priorities so the risk of further injuries to mother and foetus can be avoided or minimized. Additional challenges in the management of TBI in this group of population include understanding and addressing the altered maternal physiology, choosing optimal pharmacologic therapies thus to avoid potential teratogenicity, selection of imaging modality and addressing the issues of ionizing radiation and monitoring needs of mother as well as foetus. In the background of multidisciplinary challenges, in this article we take an overview of the challenges in the management of TBI in pregnant women and review the relevant literature.

OVERVIEW

During pregnancy the major causes of trauma include motor vehicle accidents, physical assault including intimate partner violence,
penetrating injury, and fall from height \(^{14,15}\). Although majority of the injuries lead to abdominal and categorized as minor, however these injuries can impact foetal outcomes significantly \(^{16,17}\). Traumatic brain injury (TBI) has also been recognised as one of the important factor that can influence non-obstetric mortality in child bearing age group particularly in developing countries \(^{18,19}\).

**CLINICAL PRESENTATION**

Clinical presentation of the patients will depend on the underlying severity of injury of TBI and presence of any concomitant systemic injuries. The clinical presentation may vary severity and duration of loss of consciousness, headache, vomiting, seizures or other signs of injuries including scalp laceration, black eye, ear or nasal bleed or signs of skull fractures. Trauma during pregnancy can cause delayed onset premature labour \(^{20,21}\). In addition to the injuries to mother, the foetus also can sustain injuries including skull fractures, spine injuries, injury to pubic symphysis, fracture involving the pelvis or other long bones \(^{22,23}\), diffuse axonal injury (due to strong accelerations/decelerations forces) can injure the premature brain \(^{24}\). The impact of these injuries can be compounded by presence of maternal hypovolemic shock, disseminated intravascular coagulation, and compromised placental blood flow and a hypercoagulable state \(^{25,26}\). Although oestrogen and progesterone have been suggestive as neuroprotective steroid hormones, however; the role of increased levels of oestrogen and progesterone during pregnancy as neuroprotective agents is controversial \(^{27}\).

**MANAGEMENT**

Standard investigation may be carried out as per the need of individual patient including complete blood count, kidney and liver function tests, coagulation profile, serum electrolytes and any other test which may be indicated. Due precautions need to be practiced while submitting the patients to imaging modalities where there is radiation exposure and potential radiation risk to the foetus including x-rays and CT scans \(^{28}\). In such cases the foetus can be protected with shields and the use of unsafe anaesthetic and contrast agents needs to be avoided or to be weighed against the benefits \(^{29-33}\). After stabilizing the patient and depending on the semestery of the pregnancy and the viability status of the foetus (pregnancy of \(>23\) weeks), monitoring of foetal heart rate and other foetal parameters can be initiated (in obstetrical consultation) \(^{29}\). Blood pressure needs to controlled to maintain it in the normal range for the age and a hypotension needs to be avoided \(^{34}\).

In the management priority effective maternal resuscitation always takes the precedence as this will resuscitate the foetus as well \(^{35}\). As an exception, in third-trimester pregnancy and if the injury is severe and anticipated maternal survival is poor, caesarean section may take the precedence \(^{36}\). In a special circumstance where the severe traumatic brain injury leads to either persistent vegetative state of if the patients becomes brain dead and foetus is alive, special care needs to be taken to prolong the pregnancy till the safe delivery of viable foetus is possible \(^{37,38,39,40,41}\). In reference to the perimortem caesarean section, the literature suggests that chances of foetal survival are best it is performed within 5 min of maternal arrest \(^{42}\) and as the delay occurs chances of foetal survival decreases (67% if the section is performed before 15 minutes of cardiopulmonary compromise versus 40% at 16-25 minutes) \(^{33,34}\).

**Medical management**

The standard protocol regarding management of TBI must be followed with appropriate modifications with regards to particular duration of pregnancy. Commonly targeted measures include intravenous fluids, antioedema measure, anticonvulsants and correction of underlying coagulopathy.

1. Intravenous Fluids: Intravenous fluids with glucose content should be avoided in prevent further damage to the injured brain. Hypovolemia may lead to hypoperfusion to the foetus and hence crystalloid rich fluid should be administered to maintain euvolemia \(^{43}\).

2. Correction of Coagulopathy: Coagulation disorders after head injury is common and this condition is aggravated when it is associated with pregnancy. All measures should be taken to correct the underlying coagulation disorder for wellbeing of mother and foetus \(^{44}\).

3. Mannitol: Mannitol (20%) an osmotic diuretic is commonly used to mitigate raised ICP. The commonly available osmolality of mannitol have shown gradual accumulation in foetal circulation. This hyperosmolality in foetal blood leads to decreased foetal lung fluid production, reduced urinary blood flow and foetal hypernatremia \(^{37,38}\). A better safety profile was noticed with low dose of mannitol (0.25–0.5 mg/kg).

4. Anticonvulsants: After moderate to severe head injury 5% to 15% population suffers with Posttraumatic epilepsy which gets more complicated during pregnancy. Appropriate anticonvulsant becomes very important to avoid secondary brain damage and to eliminate the chances of drug induced developmental foetal anomalies. Levetiracetam and Carbamazepine are commonly used anticonvulsants during gestational period. Phenytoin sodium and Valproic acid are generally avoided due to high risk of teratogenicity \(^{45}\).

5. Hyperventilation: According to brain train foundation guidelines, hyperventilation is advocated for a brief period with target PaCO2 of around 35 mm Hg. Hyperventilation in the critical care
setting provides a safe window period for the initiation of other treatment measures to control the elevated ICP\textsuperscript{49}.  

**Surgical management**  
Neurosurgical intervention following head injury during pregnancy needs to be balanced against the risk to the developing foetus. A multidisciplinary team and patient-individualized approach is crucial for better outcome. Cranial surgery under general anaesthesia during first trimester carries the highest risk of spontaneous abortion. There are 3% to 5% risk of congenital malformations when surgeries are performed up to 13 weeks of gestation\textsuperscript{41,42}. General anaesthesia is considered relatively safe during the gestational age of 13 to 23 weeks\textsuperscript{43}. Beyond 24 weeks of gestation, the foetus is considered viable. After administration of general anaesthesia, hypotension following supine position, premature labour and neurodevelopmental delay in foetus are common complications noticed in the third trimester of pregnancy\textsuperscript{44}.  

**COMPLICATIONS**  
In comparison to non-pregnant females, the occurrence of TBI in a pregnancy increases the risk of complications both to mother and foetus including increase rate of instrumental vaginal deliveries, unplanned caesarean sections, preterm birth, increased need of analgesia during labour and there will be an increased health impairment risk to neonate\textsuperscript{12,33,45}. In addition pharmacologic therapies and diagnostic studies where the ionizing radiation is used will increase the risk teratogenicity, placental abruption, and risk of preterm labour\textsuperscript{3}. In patients with severe TBI and patients with brain death due to immobility and motor weakness there is increased risk of deep venous thrombosis and this may require prophylactic anticoagulation\textsuperscript{14,46-48}. TBI related endocrine dysfunctions shall need appropriate investigations and replacement hormone therapy as per the needs of the patients\textsuperscript{49}, however if the glucocorticoids needs to be used for a prolonged time a careful monitoring of the foetus shall be required to prevent complications\textsuperscript{50,50}.  

**CONCLUSION**  
TBI sustained during pregnancy needs specific considerations to look after the well-being of mother as well of foetus. These patients need careful evaluation of injuries and investigations to determine the health of both mother and foetus. While selecting the imaging and anaesthetic modalities, care needs to take to minimize the radiation exposure and teratogenic effect of drugs. The comprehensive management of these patients needs a multidisciplinary approach comprising of obstetrician, paediatrician, neurosurgeon, anaesthetists, intensivist, radiologist and a team of nurses and rehabilitation experts.  

**NOTES**  
Conflict of interest  
There is no conflict of interest to disclose.  

**REFERENCES**  
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