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Stepwise approach and management of traumatic brain injury during pregnancy. A tertiary apex trauma centre experience

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ABSTRACT

Introduction. Trauma is the leading cause of non-obstetric maternal mortality and affects up to 8% of all pregnancies. Pregnant patients with traumatic brain injury (TBI) are a vulnerable population and management is complex with multiple special considerations. Recommendations proposed for the management of TBI patients are non-applicable to pregnant women as often have been excluded from these major trials. Evidence on TBI management in pregnant women is limited and mostly based on clinical experience.

Aim and objective. This study is to share our experiences in the management of TBI during pregnancy at a tertiary trauma centre in north India to formulate a stepwise approach consisting of different tiers of treatment.

Methods. Case records of thirty pregnant patients with traumatic brain injury admitted at the tertiary apex trauma centre of northern India during the period of January 2015 to June 2022 were retrospectively analyzed.

Results. Road traffic accidents (specifically two-wheelers) were the most common cause of TBI in pregnancy (80%). 60% suffered from moderate to severe TBI. Operative neurosurgical intervention was required in 30% of cases. During hospital stay, 27 patients (90%) had continuation of pregnancy. Nine patients (30%) who expired, belonged to moderate to severe TBI.

Conclusion. Moderate or severe TBI in pregnancy is associated with unfavourable maternal and fetal outcomes. The complex physiological modifications occurring in pregnancy have a crucial role in the management and require a stepwise approach. Fetal concerns and the paucity of high-quality evidence further complicate the issue and more studies including this group specifically are required.

Keywords
pregnancy,
traumatic brain injury,
Glasgow coma scale

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INTRODUCTION

Traumatic brain injury (TBI) resulting from Road traffic accidents (RTA) is a major cause of morbidity and mortality in the world especially in developing countries [1]. When coupled with pregnancy it imposes a significant physiological alteration that may confuse and complicate the clinical evaluation, resuscitation and definitive management of traumatic brain injury. According to the 2019 statistics provided by the Ministry of Road transport and Highways transport of India, there were 21794 RTA related female deaths in India, with 7632 deaths attributed to two wheelers related accidents [1]. Accurate prediction of pregnancy

and its outcome after traumatic brain injury is largely unknown [2]. In the treatment of TBI with pregnancy, it should always be remembered that there are two patients being treated, the mother and the foetus. Resuscitation of the mother is the main action which has profound secondary implications on the foetus, and is followed by intrauterine resuscitation. Decision-making regarding such patients is a multidisciplinary effort requiring cooperation between neurosurgeons, gynaecologists, neonatologists, and anaesthetists [3]. Recommendations proposed for the management of TBI patients are not applicable to pregnant women as often have been excluded from these major trials. Evidence on TBI management in pregnant women is limited and mostly based on clinical experience.

Aim and objective

This retrospective study is to share our experiences in the management of TBI during pregnancy at tertiary trauma centre in north India so that we can formulate a stepwise approach consisting of different tiers of treatment based on pathophysiological knowledge, common sense in the selection of the best combination of monitoring and medical-surgical intervention, according to the different status of pregnancy, risks and benefits for both mother and foetus.

Materials and methods

All the patients of pregnancy with TBI admitted and treated at tertiary apex trauma centre of northern India during the period of January 2015 to June 2022 were included in this retrospective study. This trauma centre serves the northern part of the country as a tertiary institute and referral centre.

The data was collected from the case records available in the record section of the Department of Neurosurgery. Epidemiological and clinic-radiological parameters were tabulated and the outcome was analysed on the basis of morbidity & mortality. Follow up records were updated till December, 2022.

As with non-pregnant patients, initial evaluation and management was done in the emergency room. Airway, breathing and circulation were secured. Patients with Glasgow Coma Scale (GCS) score of less than 8 or with aspiration were intubated and those with a GCS score of more than 8 kept on oxygen mask at 5 litre/min to keep the target Oxygen Saturation (SPO2) >95% [4]. Intravenous access was secured with 2 large bore (18 Gauze) lines. Once the patient was stabilized a secondary survey of history, clinical examination and relevant investigations was done.

The initial targets for resuscitation were (1) systolic blood pressure of 80–100 mmHg, (2) SpO2>95%, (3) haematocrit 25–36%, (4) platelet count >50,000/ cell mm3, (5) normal serum calcium, (6) temperature >35°C, (7) Prevention of metabolic acidosis and elevated serum lactate and (8) adequate analgesia [5].

Emergency Computerised Tomogram (CT) scan of head with protective abdominal lead shield and ultrasound of the abdomen were acquired in each case. Indications of CT scan were a GCS score of less than 15, a history of loss of consciousness for more than 30 minutes, a history of seizure, bradycardia, anisocoria and high velocity injuries. CT scan was obtained with shielding. Ultrasound abdomen with Doppler study was repeated in patients with a pregnancy of gestational age less than 28 weeks, patients who underwent a procedure or had deterioration in GCS score and in hemodynamically unstable patients. Magnetic Resonance Imaging (MRI) Brain was not done routinely due to technical feasibility. It was conducted in patients who were stable, conscious and oriented without neurological deficit but with persistent symptoms. Apart from radiological investigations blood investigations included Complete Blood Count, Coagulation profile, serum creatinine and urea, serum electrolytes, viral markers and Blood Grouping. Cross match was also sought in relevant patients.

Secondary survey physical examination of pregnant head injury patients was similar to non-pregnant ones and followed the same principles of full exposure with inspection and palpation followed by evaluation of patient by the neurosurgical team. A full obstetrician's examination was sought. Antiepileptic drug and osmotic cerebral dehydrants were used judiciously. The preferred antiepileptic drug was Levetiracetam. Indications of surgical intervention were similar to non-pregnant patients. Indications of emergency lower segment caesarean section were low GCS of mother having a pregnancy of Gestational Age (GA) >28wks).

Foetal wellbeing was ensured by evaluation and resuscitation of foetus performed simultaneously with maternal evaluation and resuscitation. We used

external foetal assessment and ultrasound to assess foetal wellbeing. If the foetus was pre-viable, interventions were limited and focused mainly on maternal resuscitation.

Results

30 patients of TBI in pregnancy were analysed during the study period, with ages ranging from 18 to 41 years with a median age of 25 years. Patients were admitted for 4 days on an average (with a range of 1-24 days) with different mode of injuries & 80% of injuries were a result of RTAs (specifically two-wheeler related) [Figure 1].

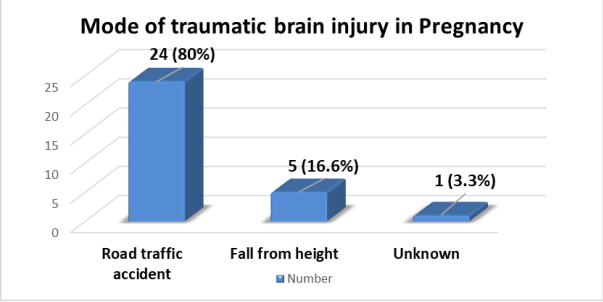

Figure 1. Mode of traumatic brain injury in pregnancy.

The time lag between injuries to admission for 29 of these patients ranged from 6 hours to 12 days, the data of time lag for 1 patient was not available as she was found in a field with no attendant to give history.

Six of our patients (28.6%) were primigravida, in 8 patients (38.1%) it was their second pregnancy, six patients were in their third pregnancy (28.6%) and one patient was pregnant for the 4th time. The month of gestation ranged from 2-9 with a median of 6 months. A majority of patients (36.67%) presented in the second trimester of pregnancy [Table 1].

Table 1. Incidence of traumatic brain injury in relation to trimester of pregnancy

Trimester of Presentation	Number of pregnant women	Percentage
First Trimester of pregnancy	10	33.33%
Second Trimester of pregnancy	11	36.67%
Third Trimester of pregnancy	9	30%

The GCS score at admission ranged from 4-15 with a median of 12 [Figure 2]. One patient had a mandibular fracture in addition to head injury. All 30 patients showed foetal cardiac activity at admission.

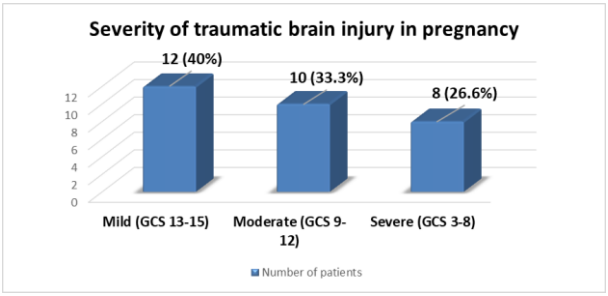

Figure 2. Severity of traumatic brain injury in pregnancy.

Ten of our patients had bilateral lesions (33.3%), and twenty (66.6%) had unilateral injuries (left sided in 12 and right sided in 8). The lesions were supratentorial in all 30 patients. Nine (30%) patients expired in hospital, out of which 4 patients were those who had undergone neurosurgical intervention, while 5 were those who had been managed conservatively. Out of the 9 (30%) patients who expired, 6 (20%) were those with a severe head injury, while 3 (10%) were those with moderate head injury. All patients with mild head injuries survived [Table 2].

Table 2. Radiological findings & mortality in traumatic brain injury during pregnancy.

CT head radiological findings	Left	Right	Bilateral	Total =30	Surgery done in	Expired
Acute SDH	3	2	0	5	4	2 (surgical)
EDH	1	2	0	3	2	1 (surgical)
Intra Cerebral Hematoma	6	4	6	16	1	3 (conservative)
Depressed fracture	1	0	0	1	1	-
Pneumocephalus	-	-	1	1	-	-
IVH	-	-	1	1	-	1(Conservative)
DAI			2	2	-	1 (conservative)

Hemispheric Infarct	1	0	0	1	1	1 (surgical)
	12	8	10 (33%)	30	9	9(30%)

Among the survivors, 19 out of 21 patients had a continuation of pregnancy, while 2 patients required medical termination of pregnancy. After discharge, all 21 patients were given antiepileptic drug in the form of Levetiracetam.

Out of 21 patients discharged, 17 were discharged in full GCS with a live foetus in utero, while the remaining 4 were discharged with a GCS of 14, 13, 10 and 9 respectively. All the 21 patients were alive at follow up, and their foetuses survived to term and were alive and well at follow up except for one who expired on day 10 after birth due to pneumonia.

Discussion

Consideration of physiological changes caused by pregnancy

Physiological changes during pregnancy must be in our minds while managing the TBI as there are some specific risks related to these changes. We have tried to elaborate these risks based on our experience in [Table 3].

Table 3. Consideration of Physiological Changes Caused by Pregnancy

Physiological change	Cause	Effect	Risk
Decreased systemic vascular resistance	To optimize uteroplacental blood flow	Capillary engorgement & tissue edema (Upper airway) Low blood pressure in first trimester	Risk of failed intubation Hemodynamic instability
Increased circulatory blood volume	Due sodium retention via R-A-A system activation	Relative anemia state	Delay in hemorrhagic shock recognition
Concentration of clotting factor raised	To prevent acute blood loss after delivery	Prothrombotic state	Risk of DVT & DIC
Diaphragm upward displacement	Due to uterine enlargement	Increased metabolic rate and oxygen consumption	Rapid episode of desaturation during intubation

Priorities in initial resuscitation

As per ATLS protocol initial resuscitation is done by ABCDE approach in trauma patients, but there is specific need of this population (TBI in Pregnancy) during trauma which must be tackled simultaneously for successful initial resuscitation [Table 4].

Table 4. Priorities in Initial Resuscitation during trauma with pregnancy

ABCDE approach	Specific need of this population	Management
A	augmented risk of failed intubation and acidic gastric contents aspiration compared to the non-pregnant population	Early placement of an endotracheal and a nasogastric tube is recommended to secure the airway
B	Risk of maternal and fetal hypoxia	Oxygen supplementation is mandatory to maintain a saturation > 95%
C	Risk of supine hypotension & decreased venous return Avoid high dose norepinephrine (risk of decrease placental perfusion)	Left tilt or manual uterine displacement Use of Phenylephrine is safe Use of O negative blood
D	Quick but accurate neurological assessment (GCS limitation) Distress of fetus evaluation	Obstetric evaluation of the fetus and USG
E	Entire exposure and examination	special regard to thorax, abdomen, pelvic and perineal regions to rule out fetal injuries. Avoiding extreme hypothermia

The main outcome of neurosurgical management in pregnant patients with traumatic brain injury is to maintain maternal and foetal survival [6,7]. The timing of surgery is a big challenge for neurosurgeons. In the first trimester, there is highest risk of spontaneous abortion caused by general anaesthesia (risk ratio = 1.58) [8]. In addition, a study has reported the incidence of spontaneous abortion of 15%–20% and a risk of congenital abnormalities of 3%–5% when the surgery is performed in the first trimester before 13 weeks of gestation [5]. Gestational age ranging from 13 to 23 weeks is usually a safe period for surgery for trauma cases in pregnancy [9,10]. Once the foetus becomes viable (>24 weeks), three risks of complications have to be faced, namely (1) supine hypotension, (2) neurodevelopmental delay in offspring and (3) premature delivery [5]. If trauma occurs with a viable foetus (>32 weeks of gestation), the usual clinical decision is to terminate the pregnancy by delivering the foetus especially in cases of acute neurological worsening. The preferred method is a caesarean section under general anaesthesia followed by neurosurgery [11,12,13]. Categorisation of mother & foetus risk: benefit, based on trimester of pregnancy and clinical status is formulated by us for management strategy [Table 5].

Table 5. Categorizing the mother and the Fetus Risks and Benefits during traumatic brain injury

Trimester & Clinical status	Monitoring & assessment	Protocol and purpose	Treatment option
During first & second trimester: Fetus is considered non-viable (<23 week)	Maternal assessment & stabilization In case of neurosurgical intervention	ATLS protocol Brain trauma foundation guideline	Optimizes fetal status Postoperative & ICU care
Third trimester: fetus is considered viable (>23 week)			
if mother clinical status is stable	Monitor the viability of fetus and documentation	To establish the appropriate time and method delivery	(Caesarean section alone or with neurosurgery)
if maternal condition is critical or cerebral damage leads to maternal brain death			Urgent caesarean delivery

Computed tomography scan is the neuroimaging of choice to evaluate TBI

CT scan head is frequently delayed due to fear of expose the developing fetus to harmful ionizing radiations. Ionizing radiations have a dose-dependent teratogenic and carcinogenic potential. NCCT Head, expose the fetus to a radiation amount below the threshold of 5,000 m-rad, considered safe for fetal damage [Table 6].

Table 6. Estimated fetal radiation adsorbed doses during some common radio-diagnostic procedures

Radiological procedure	m-rad
CT Head	0
CT Chest	16
CT Abdomen	3000

Determine fetal viability though fetal monitoring is fundamental

Serial echo-graphic approaches, electronic fetal heart rate monitoring (EFM), obstetric anamnesis and physical examination are various tools to determine the foetal viability. Abnormal heart rate pattern is early warning signal of maternal hemodynamic compromise and uteroplacental hypoperfusion, it allows to rapidly assess and prevent reversible causes such as hypoxia and acidosis

Avoid secondary insults of systemic origin

An injury whose effects do not occur at the time of the trauma but becomes evident in the following hours or days leads to secondary insults. GHOST-CAP mnemonic (Glycemia, Hb, Oxygen, Sodium, Temperature, Comfort, Arterial pressure & PaCo2)

highlights eight pivotal elements which should be regularly assessed during patient's ICU stay to prevent secondary insults of systemic origin.

When to induce labor? Natural or caesarean section?

Preterm delivery is considered best, when delivery improve mother's prognosis. If definitive treatment can be safely delayed, and the gestational age is appropriate, to guarantee in-utero fetal development, additional stay in the ICU is recommended. No further prolongation of pregnancy is necessary after 32 weeks of gestation. Cesarean section should be reserved to cases when maternal injuries result in severe complications. In case of maternal stability, induced vaginal delivery should be considered in view of a non-viable fetus. Previous case reports and their management approach of TBI in pregnancy has been summarized in Table 7.

Table 7. Previous case reports of traumatic brain injury in pregnancy [7,9,14,15,16,17]

Reference	GCS	Gestational Age (in weeks)	Timing of Surgery	Outcome
Cirak et al.[7]	NA NA	38 39	CS Per vagina	Both Alive Both Alive
Satapathy et al.[9]	11 14 7	24 16 28	Craniotomy Both Conservative	Both Alive Both Alive
Dawar et al.[14]	11	36	CS->Craniotomy	Both Alive
Whitney et al.[15]	3	20	ICP monitor	Foetal Complication (Germinal Matrix haemorrhage)
Goldschlager et al[16]	9	34	CS-> craniotomy	Both Alive
Darlan et al.[17]	6 6	18 20	Craniotomy ICP monitor	NA NA

In our study, the main corroborative factor that appeared to affect the outcome was the admitting GCS score of the patient, as maximum morbidity as well as mortality was in those patients who had suffered a severe head injury, followed by patients with moderate head injury.

Conclusions

Moderate or severe TBI in pregnancy is associated with unfavorable maternal and fetal outcomes. The complex physiological modifications occurring in pregnancy have a crucial role in the management. Fetal concerns, and paucity of high-quality evidence further complicate the issue and more studies including this group specifically are required.

Abbreviations

RTA-Road Traffic accidents;
MTP- Medical Termination of Pregnancy;
LSCS- Lower segment caesarean section;
GCS- Glasgow Coma Scale;
TBI- Traumatic Brain Injury;
SPO2- Oxygen Saturation;
CT- Computerised Tomogram;
MRI-Magnetic Resonance Imaging;
GA- Gestational Age;
CS-Caesarean section;
ICP-Intracranial pressure;
NA-Not available.

References

1. https://morth.nic.in/sites/default/files/RA_Uploading.pdf
2. El-Kady D, Gilbert WM, Anderson J, Danielsen B, Towner D, Smith LH. Trauma during pregnancy: an analysis of maternal and fetal outcomes in a large population. Am J Obstet Gynecol. 2004 Jun;190(6):1661-8. doi: 10.1016/j.ajog.2004.02.051. PMID: 15284764.
3. Macarthur A. Craniotomy for suprasellar meningioma during pregnancy: role of fetal monitoring. Can J Anaesth. 2004 Jun-Jul;51(6):535-8. English, French. doi: 10.1007/BF03018393. PMID: 15197113.
4. Jain V, Chari R, Maslovitz S, Farine D; Maternal Fetal Medicine Committee, Bujold E, Gagnon R, Basso M, Bos H, Brown R, Cooper S, Gouin K, McLeod NL, Menticoglou S, Mundle W, Pylypjuk C, Roggensack A, Sanderson F. Guidelines for the Management of a Pregnant Trauma Patient. J Obstet Gynaecol Can. 2015 Jun;37(6):553-74. English, French. doi: 10.1016/s1701-2163(15)30232-2. PMID: 26334607.
5. Reddy SV, Shaik NA, Gunakala K. Trauma during pregnancy. J Obstet Anaesth Crit Care 2012;2:3-9
6. ACOG Committee on Obstetric Practice. ACOG committee opinion. Nonobstetric surgery in pregnancy. Number 284, August 2003. Int J Gynaecol Obstet. 2003

Oct;83(1):135. doi: 10.1016/s0020-7292(03)00391-6. PMID: 14635614.

7. Cirak, Bayram et al. Neurosurgical procedures in pregnancy. Acta Cirúrgica Brasileira [online]. 2003, v. 18, n. 1. Epub 19 Feb 2003. ISSN 1678-2674. https://doi.org/10.1590/S0102-86502003000100002.
8. Duncan PG, Pope WD, Cohen MM, Greer N. Fetal risk of anesthesia and surgery during pregnancy. Anesthesiology. 1986 Jun;64(6):790-4. doi: 10.1097/00000542-198606000-00019. PMID: 3717642.
9. Satapathy MC, Mishra SS, Das S, Dhir MK. Emergency management strategy for pregnant head trauma victims–Case reports and review of literatures. Indian Journal of Neurotrauma. 2014 Jun;11(01):45-8.
10. Liu PL, Warren TM, Ostheimer GW, Weiss JB, Liu LM. Foetal monitoring in parturients undergoing surgery unrelated to pregnancy. Can Anaesth Soc J. 1985 Sep;32(5):525-32. doi: 10.1007/BF03010803. PMID: 4041953.
11. Qaiser R, Black P. Neurosurgery in pregnancy. Semin Neurol. 2007 Nov;27(5):476-81. doi: 10.1055/s-2007-991129. PMID: 17940927.
12. Ng J, Kitchen N. Neurosurgery and pregnancy. J Neurol Neurosurg Psychiatry. 2008 Jul;79(7):745-52. doi: 10.1136/jnnp.2007.117002. PMID: 18559459.
13. Wang LP, Paech MJ. Neuroanesthesia for the pregnant woman. Anesth Analg. 2008 Jul;107(1):193-200. doi: 10.1213/ane.0b013e31816c8888. PMID: 18635488.
14. Dawar P, Kalra A, Agrawal D, Sharma BS. Decompressive craniectomy in term pregnancy with combined cesarean section for traumatic brain injury. Neurol India. 2013 Jul-Aug;61(4):423-5. doi: 10.4103/0028-3886.117588. PMID: 24005739.
15. Whitney N, Raslan AM, Ragel BT. Decompressive craniectomy in a neurologically devastated pregnant woman to maintain fetal viability. J Neurosurg. 2012 Mar;116(3):487-90. doi: 10.3171/2011.11.JNS11707. Epub 2011 Dec 23. PMID: 22196099.
16. Goldschlager T, Steyn M, Loh V, Selvanathan S, Vonau M, Campbell S. Simultaneous craniotomy and caesarean section for trauma. J Trauma. 2009 Apr;66(4):E50-1. doi: 10.1097/TA.0b013e318031cc98. PMID: 19088560.
17. Darlan D, Prasetya GB, Ismail A, Pradana A, Fauza J, Dariansyah AD, Wardana GA, Apriawan T, Bajamal AH. Algorithm of Traumatic Brain Injury in Pregnancy (Perspective on Neurosurgery). Asian J Neurosurg. 2021 May 28;16(2):249-257. doi: 10.4103/ajns.AJNS_243_20. PMID: 34268147; PMCID: PMC8244712.
18. Sharma R, Grover VL, Chaturvedi S. Health-risk behaviors related to road safety among adolescent students. Indian J Med Sci. 2007 Dec;61(12):656-62. PMID: 18174635.