Original Article

Comparative Outcomes of Traumatic Brain Injury in Pregnant and Non-Pregnant Women: A Clinical Observational Study

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Abstract

Background: Trauma is the leading non-obstetric cause of death in women of reproductive age, and traumatic brain injury (TBI) poses significant risks to both mother and fetus. However, comparative data on outcomes of TBI in pregnant versus non-pregnant women remain limited. This study aimed to evaluate clinical, functional, and obstetric outcomes in both groups. **Material and Methods:** This prospective observational study was conducted at a tertiary neurosurgical center from August 2023 to April 2025. Forty female patients aged 18–50 years with TBI were enrolled, including 20 pregnant and 20 non-pregnant women. Patients with polytrauma or dead-on arrival were excluded. Baseline severity was assessed using Glasgow Coma Scale (GCS) and Rotterdam CT scores. Outcomes were measured using Glasgow Outcome Score (GOS) at discharge and 3 months. **Results:** Baseline GCS and CT scores were similar between groups. Among pregnant women, 20% were in the first trimester, 30% in the second, and 50% in the third. Favorable recovery (GOS ≥ 4) at discharge was achieved in 35% of pregnant versus 60% of non-pregnant women. At 3 months, favorable outcomes improved to 55% and 65%, respectively ($p < 0.05$). Maternal mortality was higher in pregnant women (10% vs. 5%). Fetal demise occurred in 30% of pregnancies, predominantly in severe TBI or maternal death. Third-trimester patients had the poorest outcomes. **Conclusion:** Pregnancy is associated with poorer neurological recovery, higher maternal mortality, and significant fetal loss after TBI despite comparable injury severity. Multidisciplinary, trimester-based management is essential.

Keywords: Traumatic brain injury; Pregnancy; Maternal outcome; Fetal demise; Glasgow Outcome Score; Neurosurgical trauma; Trimester; Maternal mortality; Rotterdam CT score; Neurological recovery.

Received: 12 September 2025 **Revised: 10 October 2025** **Accepted: 05 November 2025** **Published: 04 December 2025**

Introduction

Trauma is the leading non-obstetric cause of death in women of reproductive age, accounting for 6–7% of pregnancies,[1,2] and up to 0.4% requiring hospitalization.[3] Although abdominal trauma is more frequent, traumatic brain injury (TBI) carries greater risk of morbidity and mortality.[4,5] Motor vehicle accidents, falls, and violent assaults are the most common causes.[3] Even minor trauma can result in fetal loss or preterm labor, and the severity of maternal injury does not always correlate with fetal outcome.[6,7] Di Filippo et al,[8] in their "10 steps to management of moderate and severe TBI during pregnancy," emphasized the importance of understanding the altered maternal physiology in order to distinguish between physiological changes that mimic disease and true pathological conditions requiring medical intervention. Maternal stabilization remains the priority, followed by neurological and obstetric assessment, emphasizing the need for a multidisciplinary approach involving neurosurgeons, anesthesiologists, and obstetricians.

Despite these concerns, data comparing outcomes of TBI in pregnant and non-pregnant women remain scarce and conflicting. Understanding whether pregnancy influences maternal recovery and fetal prognosis is crucial for guiding management. This study aims to evaluate and compare clinical outcomes of traumatic brain injury in pregnant versus non-pregnant women.

Materials and Methods

This prospective observational study was conducted in the Department of Neurosurgery at a tertiary care facility between August 2023 and April 2025. The recruitment period extended from August 2023 to January 2025, while follow-up assessments continued until April 2025. A total of 40 patients were included, comprising 20 pregnant women with head injury and 20 non-pregnant women of reproductive age (18–50 years) admitted with head injury during the same period. Patients with polytrauma, those declared dead on arrival to the emergency department, and those lost to follow-up before the 3-month assessment were excluded. All participants provided informed consent, and the

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DOI:
10.21276/amit.2025.v12.i3.220

How to cite this article: Mayank R, Narayan, Prakash A, Kumari S, Sinha N. Comparative Outcomes of Traumatic Brain Injury in Pregnant and Non-Pregnant Women: A Clinical Observational Study. Acta Med Int. 2025;12(3):1019-1023.

study was conducted in accordance with institutional ethical standards.

Clinical and radiological data were collected at the time of admission, during treatment and at follow up at 3 months. Vital parameters at admission were recorded, along with the Glasgow Coma Scale (GCS) score, ranging from 3 to 15, with lower scores reflecting more severe head injury. The Rotterdam computed tomography (CT) severity score, ranging from 1 to 6, was used to assess radiological severity, with higher scores indicating greater injury severity and higher mortality risk. Outcomes were assessed using the Glasgow Outcome Score (GOS) at discharge and at 3 months ranging from 1 to 5, with lower scores indicating poorer functional outcomes. According to ACOG,[9] fetal exposure up to 5 rad (50 mGy) is not linked to increased risk of anomalies or pregnancy loss, and essential imaging should not be delayed in critically injured pregnant women. Most diagnostic imaging delivers far lower doses (e.g., chest X-ray <0.005 rad, head CT ≈0.05 rad). Abdominal shielding was routinely used during head CT scans in pregnant women to minimize fetal radiation exposure.

I follow this Algorithm management of severe traumatic brain injury in pregnancy, including surgical and nonsurgical intervention,[10] [Figure 1]. In the first and second trimesters, prophylactic antiepileptic therapy was given to prevent seizures due to raised intracranial pressure, and postoperative fetal management decisions depend on obstetric factors. In the third trimester, intracranial pressure control measures such as head elevation, low tidal volumes, and antiemetic precautions was given, while mannitol was used cautiously due to risks of fetal hyperosmolality and altered physiology. For viable pregnancies (>24 weeks), neurosurgical planning was done by coordinating with obstetric teams—either caesarean delivery before or simultaneous with surgery if the uterus interferes or fetal distress occurs, or neurosurgery preceding delivery in cases of maternal collapse. Postoperatively, intensive care was given to maintain maternal and fetal stability. All patients underwent scheduled follow-up visits at three months. Neurological and functional outcomes were assessed using the GOS. In addition, pregnant women were evaluated for obstetric and fetal outcomes, including maternal complications, mode of delivery, and neonatal status. The immediate and long-term outcomes of TBI in pregnant women were then compared with those of non-pregnant women in the same age group.

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) and compared between groups using the independent t-test or Mann–Whitney U test, depending on data distribution. Categorical variables were expressed as frequencies and percentages and compared using the Chi-square test or Fisher's exact test as appropriate. A p-value < 0.05 was considered statistically significant.

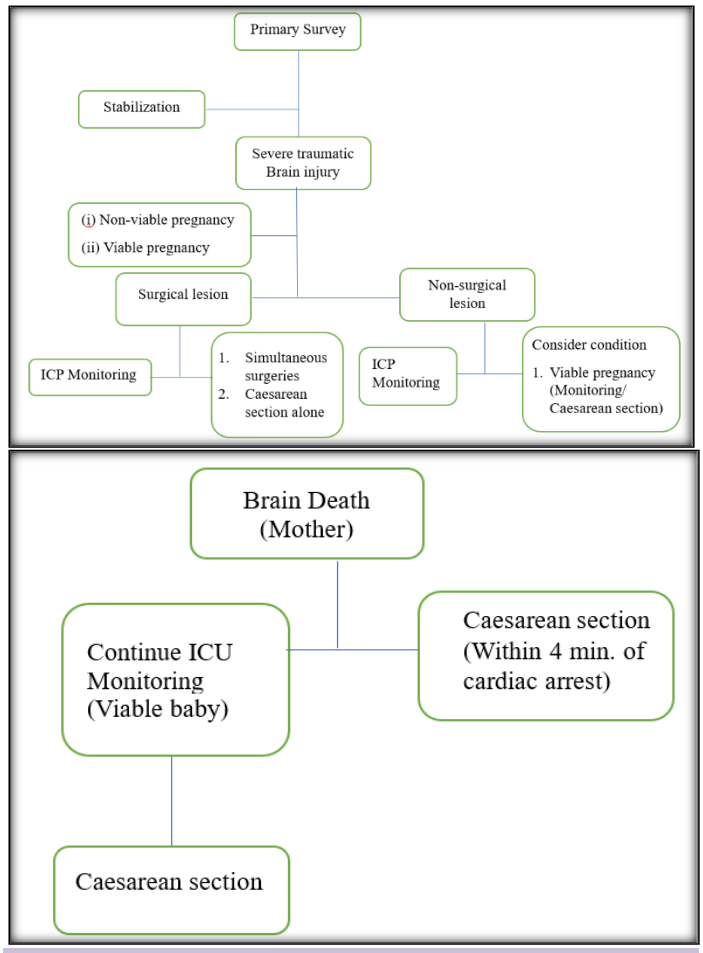

Figure 1: Clinical Decision-Making Framework for Severe Traumatic Brain Injury in Pregnancy

Results

A total of 40 female patients with traumatic brain injury (TBI) were included in this observational study, comprising 20 pregnant women and 20 non-pregnant women. Most of the patients in our study were between 18 and 33 years of age [Table 1]. The mean age of participants was comparable between the two groups, mean for pregnant group is 28.70 ± 7.26 and for non-pregnant group is 29.65 ± 6.88.

Table 1: Age distribution of pregnant and non-pregnant patients

Age	Pregnant	Non-pregnant
18-25	8	7
25-33	6	7
34-41	3	4
42-50	2	2

Among the pregnant group (n = 20), 4 patients (20%) were in the first trimester, 6 patients (30%) in the second trimester, and 10 patients (50%) in the third trimester. The majority of patients presented with moderate head injury, with admission

GCS scores ranging from 6 to 13. The Rotterdam CT severity scores ranged between 2 and 5, indicating variable radiological severity. At admission, the mean GCS score was 9.65 in the pregnant group and 9.75 in the non-pregnant group, while the mean Rotterdam CT score was 3.55 and 3.68, respectively. In the non-pregnant group (n = 20), admission GCS and Rotterdam CT scores were comparable to those of the pregnant cohort, ensuring similarity in baseline injury severity between the two groups.

In the pregnant group (n = 20), GOS scores at discharge ranged from 1 to 4, with the majority (65%) showing unfavourable outcomes (GOS ≤ 3). Only 35% achieved favourable recovery (GOS ≥ 4). At 3-month follow-up, improvement was noted, with 55% achieving favourable outcomes and 45% remaining in the unfavourable category [Table 2]. This reflects gradual neurological recovery over time, though a subset of patients continued to experience persistent disability [Figure 2].

In contrast, the non-pregnant group (n = 20) demonstrated better outcomes at both time points. At discharge, 60% achieved favourable outcomes compared to 35% in the pregnant group, and by 3 months, 65% attained GOS ≥ 4, with no patients remaining in the vegetative or severely disabled range.

Table 2: Favourable Vs Unfavourable outcomes

Outcome Category	At Discharge		At 3 months	
	Pregnant (n=20)	Non-Pregnant (n=20)	Pregnant (n=20)	Non-Pregnant (n=20)
Favourable (GOS 4-5)	7 (35%)	12 (60%)	11 (55%)	13 (65%)
Unfavourable (GOS 1-3)	13 (65%)	8 (40%)	9 (45%)	7 (35%)

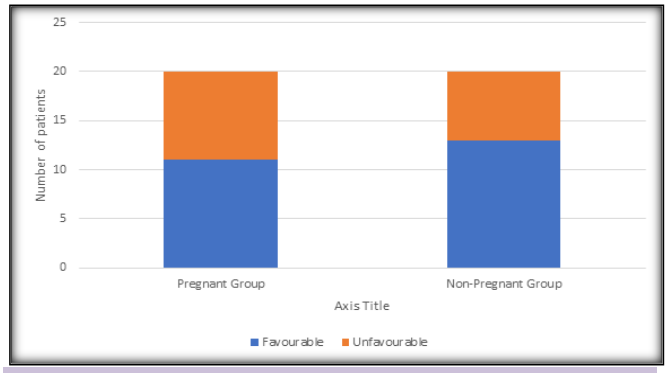

Figure 2: GOS outcome Distribution at 3 months follow up

At discharge, pregnant patients had a lower mean GOS score of 3.00 compared to 3.55 in the non-pregnant group. By three months, both groups showed improvement; however, recovery was greater in non-pregnant women, with a mean GOS score of 4.30 compared to 3.70 among pregnant patients [Table 3].

While both cohorts showed significant functional gains over time ($p < 0.05$), non-pregnant patients consistently exhibited higher mean GOS scores at both discharge and 3 months ($p < 0.05$). These findings suggest that pregnancy may modestly attenuate early neurological recovery following TBI, potentially due to pregnancy-related physiological and hemodynamic alterations influencing post-injury recovery.

Table 3: Mean GOS at discharge and at 3 months

	At discharge	At 3 months
Pregnant	3.00 ± 0.92	3.70 ± 1.22
Non-pregnant	3.55 ± 0.83	4.30 ± 0.92

Maternal mortality was observed in 2 out of 20 pregnant women (20%), compared to only 1 out of 20 non-pregnant women (5%). The difference, though limited by small sample size, suggests higher vulnerability in pregnant patients with TBI. Among the pregnant group, 6 cases of fetal demise were reported, four in patients with severe TBI and two due to maternal death. This highlights the dual burden of morbidity and mortality in pregnant women sustaining head injuries. While neurological outcomes in non-pregnant women were generally favorable, pregnant women not only demonstrated poorer recovery but also experienced significant fetal losses, particularly in the second and third trimesters.

Despite similar admission GCS and CT severity profiles, the non-pregnant group demonstrated superior neurological recovery and functional outcomes compared to pregnant women. Third-trimester patients were particularly vulnerable to unfavorable outcomes, whereas early-trimester patients showed slightly better recovery profiles.

Discussion

This prospective observational study compared outcomes of traumatic brain injury (TBI) in pregnant and non-pregnant women of reproductive age. Our findings demonstrate that, despite having similar injury severity at admission pregnant women had poorer functional outcomes and higher mortality rates compared to their non-pregnant counterparts. Furthermore, fetal demise was a significant complication in the pregnant cohort, particularly among those with severe TBI and maternal death.

In our series, maternal mortality occurred in 10% of pregnant women compared to 5% of non-pregnant women. Additionally, pregnant women exhibited a higher proportion of unfavorable neurological outcomes (GOS ≤ 3) at 3 months. These results indicate that pregnancy may negatively influence recovery after TBI, despite similar baseline injury characteristics as in study done by Himanshu Bansod et al.[10] Cherisse Berry et al,[11] who found no significant difference in mortality between pregnant and non-pregnant women, although some studies suggest hormonal and hemodynamic changes of pregnancy may offer limited neuroprotection. Our data, however, suggest that physiological alterations in pregnancy—such as increased risk of hypoxia and hypotension—may instead predispose to poorer

outcomes.

A key finding of this study was the high incidence of fetal demise (30%) among pregnant patients with TBI. Most fetal losses occurred in the second and third trimesters, and in many cases were associated with maternal mortality or severe head injury (low GCS, high CT severity score). This aligns with earlier literature indicating that maternal injury severity does not always correlate with fetal prognosis; even minor trauma can precipitate adverse outcomes such as placental abruption, preterm labor, or fetal death. Studies by Adam RS et al,[12] similarly documented increased rates of stillbirth, abruption, and neonatal complications in women with head injuries or prior TBI history.

In our cohort, 10 of the 20 pregnant women were in the third trimester, a group that experienced the highest frequency of both maternal and fetal complications. Trauma, particularly severe head injury, occurs more frequently in the third trimester, as reported in previous studies,[13] and this trend was also observed in our series. This increased incidence, combined with the physiological changes of advanced gestation—such as greater cardiovascular and hemodynamic stress, reduced pulmonary reserve, and heightened risk of placental injury—likely contributes to the higher complication and mortality rates seen in late pregnancy. In contrast, women in the first trimester generally had better neurological and obstetric outcomes, reflecting the lower physiological burden and reduced severity of trauma during early gestation.

Our results differ from some earlier reports,[14] which suggested comparable or even improved maternal outcomes in pregnant women with TBI, possibly due to the neuroprotective role of estrogen and progesterone. However, consistent with larger registry-based studies, we found worse outcomes in pregnancy, particularly regarding fetal prognosis. This highlights the heterogeneity of published data and the influence of study size, design, and patient selection.

These findings underscore the dual challenge of managing TBI in pregnancy, where both maternal and fetal survival are at risk. Multidisciplinary care involving neurosurgeons, anesthesiologists, and obstetricians is essential. Rapid maternal stabilization remains the primary priority, followed by careful obstetric monitoring. Radiation concerns during imaging should not delay essential diagnostic CT scans, particularly with abdominal shielding. Early recognition of placental injury and timely obstetric intervention may help mitigate fetal loss.

The study is limited by its small sample size and single-center design, which restricts the generalizability of the findings. Long-term neurodevelopmental outcomes of surviving neonates were not assessed. Nevertheless, the prospective design, trimester-based subgroup analysis, and direct comparison with non-pregnant controls add strength to the results.

Conclusion

This study showed that pregnant women with traumatic brain injury have poorer neurological recovery, lower GOS scores, and higher maternal mortality compared to non-pregnant women, despite similar injury severity at admission. Pregnancy-related physiological changes may delay recovery and increase complications, particularly in late gestation. Therefore, early maternal stabilization, appropriate imaging, and a multidisciplinary approach involving neurosurgeons, obstetricians, and critical care specialists are essential to improve outcomes. Future large-scale studies are needed to define the optimal approach to the evaluation and treatment of pregnant women who suffer trauma.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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