Original Research

Traumatic Brain Injury during Pregnancy: Maternal-Fetal Outcomes and Management

Shirin Gul Suhail[1], Omair Afzal[2], Zahra Safdar[1], Madeeha Rasheed[1], Uzma Zia[1] , Sumera Zeb[3]

[1]*Department of Obstetrics & Gynecology, Avicenna Hospital, Lahore*
[2]*Department of Neurosurgery, Punjab Institute of Neurosciences, Lahore*
[3]*Department of Obstetrics & Gynecology, Lahore General Hospital, Lahore – Pakistan*

ABSTRACT

Objective: To provide local evidence for the development of a maternal-fetal unit of management to control adverse outcomes in pregnant patients with traumatic brain injury (TBI).

Material and Methods: This study was executed at the Punjab Institute of Neurosciences (PINS) and the Department of Obstetrics and Gynecology, General Hospital, Lahore (LGH). The study recruited a sample of 30 patients who reported with TBI. In the first phase of the study, initial assessment and treatment for the patients were provided; later, maternal-fetal outcomes of these patients were observed. After the description of data, the Chi-square test of association and Analysis of variance were used to draw inferences.

Results: The average maternal age was 30 ± 4.7 years, and most of the patients got this injury during the second and third trimester. Road accidents were the leading cause of TBI in these patients, and a significant number underwent neurosurgical interventions, with three mortalities. More than half of the patients needed critical care in the intensive care unit. A substantial proportion of fetal distress, neonatal deaths, cesarean deliveries, preterm births, and maternal mortality had been recorded in patients who had severe TBI as per the Glasgow Coma Scale.

Conclusion: This study concludes that both maternal and fetal status are at risk in this study group; however, a well-defined maternal-fetal management unit, which is a combination of obstetricians, neurosurgeons, and critical care professionals, can reduce the potential negative outcomes.

Keywords: Maternal-fetal management, TBI during pregnancy, Maternal mortality, Fetal complications, Severity of TBI.

Corresponding Author: *Shirin Gul Suhail*
Assistant Professor of Obstetrics and Gynecology, Avicenna Medical College, Lahore
Email: *shirin.suhail@gmail.com*

INTRODUCTION

Traumatic brain injury (TBI) is a complex medical

and a surgical emergency that can severely influence the two interconnected lives of mother and fetus. Even TBI is witnessing an upsurge in the global incidence; however, the literature is limited in addressing this medical challenge.[1] Developing countries have been facing this issue more commonly, and one in 12 pregnancies has to face some type of trauma, which can cause maternal deaths, and their complication rate ranges from 6-7%.[2] This is a very specific type of injury that requires specialized simultaneous management frameworks and guidelines due to various associated complications like maternal physiological changes, teratogenic risks of treatment, and equally important monitoring of the fetus.[3] The common causes of TBI in pregnant women are sudden injuries like falls, road accidents, obstetric trauma, and domestic violence.[1] TBI in pregnancy can worsen the conditions of the mother by sudden changes in intracranial pressure and blood volume, and most importantly, metabolic changes that subsequently affect the diagnosis and treatment-related decision-making.[4] Therefore, this situation needs a comprehensive solution to manage such cases.

Generally, practitioners focus on stabilizing the maternal condition, especially in opening the airways and circulation. In parallel, computed tomography (CT) and magnetic resonance imaging (MRI) are suggested after detailed assessment, considering the least exposure to radiation of the fetus.[5] After diagnosis, strong neuroprotective management plans are executed to maintain the cerebral pressure, controlling teratogenic modifications and hypoxia. These maternal conditions need to be controlled; otherwise, hypoxia, low blood pressure, and increased intracranial pressure of the mother can damage the fetus's well-being and even cause fetal mortality.[6] Therefore, simultaneity in managing both lives is the main goal for doctors and provides a foundation for collaborative efforts of various specialties and the maternal-fetal unit.[7,2]

In developing countries like Pakistan, traumatic injuries are increasing[8] but trauma during pregnancy is often not reported; therefore, the availability of TBI data is scarce. This non-availability creates the contextual gap that needs to be filled through the provision of local evidence that further helps in designing customized management guidelines and protocols for such cases. There are two recent studies; however, these studies just emphasized the TBI in the general population, not in pregnant women.[9,10] In low-resource settings, multiple issues can delay the process of treatment, maternal and fetal management due to low awareness, and the lack of obstetric-neurosurgical units can worsen the conditions of patients. Therefore, this study aims to explore the existing management strategies and TBI-related maternal-fetal outcomes in Pakistani hospitals, so that unified strategies can be developed to manage such cases in the future.

PATIENTS AND METHODS

Study Design & Settings

This descriptive, observational follow-up study was a single-center study and was conducted at Lahore General Hospital (LGH), Lahore, during the period of 02/06/2024 to 30/08/2025. This hospital is famous for its services to traumatic injuries in Pakistan and has a huge unit for neurological treatment.

Inclusion Criteria

This study used clear but rigorous criteria for the selection of study subjects. There are three main conditions behind the selection of patients for this study (a) Pregnant women aged 18-45 years having mild, moderate, and severe TBI assessment (b) the cause of TBI is common; falls, road accidents, domestic violence, and mechanical trauma (c) only those patients were selected who clear indication of brain injury diagnosed through a CT scan or MRI.

Exclusion Criteria

Those patients were excluded from the study who had the following conditions (a) any existing comorbidity that modifies the level of brain injuries. These existing conditions could be neurological and psychiatric disorders (b) who had no diagnostic data, like CT scan, MRI images, etc. (c) pregnant women who had non-traumatic injuries like rupture of the fetal sac or stroke, etc., and lastly (d) not available for their child delivery at LGH, Lahore.

Ethical Approval

This study was executed after approval from the Ethical Review Committee of LGH, Lahore, with approval # 2025-05-79. Further, written informed consent from the study participants or from their attendants was also obtained.

Data Collection

This study targeted such women who were pregnant (in any trimester) and registered at the emergency department with TBI. This population did not put any compulsion on particular socio-economic and demographic groups. However, only those patients were chosen who had arrived at the defined study settings of LGH, Lahore. After a diagnostic through CT scan or MRI, these patients were identified. This study consisted of two phases: in the first phase of the study, initial assessment and emergency or detailed treatment for the patients were provided; later, maternal-fetal outcomes of these patients were observed at the time of delivery.

Sampling Technique and Sample Size

In this study, purposive sampling (non-probability sampling) was used to choose the sampling units from the emergency department of LGH, Lahore. This study targeted a rare but complex research domain and already stated that there was no published data about the prevalence and incidence of TBI in pregnant women. However, to make a more rationalized approach in choosing a representative sample size, an appropriate statistical method was used to estimate the sample size. From the previous one-year record of LGH Hospital, it was found that around 2-3 persons per 1000 trauma cases were pregnant TBI cases. Therefore, considering this aspect, a statistical formula is used to estimate a representative sample. Using 5% margin of error, a 95% confidence interval, and a 1 design effect, a sample of 31 patients was selected through the software OpenEpi version 3.0 [11]. However, the sample size was inflated considering the non-response (20%) in this study, and the final sample size was 38 patients. However, out of these selected patients, 30 had completed the study. Eight patients did not appear in the second phase of the study and delivered their babies in other settings. Therefore, the data of these 30 patients had been processed for analysis. This sample size was not very large considering the timeframe of the study, because TBI is not common in pregnant women, as supported by LGH data as well.

Data Collection Instrument

Investigators of this study developed a well-structured questionnaire to collect the data. Three neutral experts (neurosurgery, obstetrics, and critical care) were also consulted for the validation of the questionnaire. There were five components of this questionnaire: (a) demographic profile of the patients that collects information about age, gestational age, parity, etc. (b) Injury-related information in which the Glasgow Coma Scale (GCS) score[12] was computed for each patient, and asked about the mechanism of injury. CT scan or MRI findings were also recorded in this section (c). Patient management data that includes initial hospital care, any interventions and therapies (d). Maternal-fetal unit collaboration was assessed through obstetric and neonatal involvement, fetal monitoring and any decision related to delivery (e)

Maternal and fetal outcomes that recorded information about mortality, morbidity, ICU stay, complications etc. Further APGAR (Appearance, Pulse, Grimace, Activity, Respiration) score was also computed for the newborn with a standard threshold of 7 or less, which indicates the newborn needs proper medical support.[13] This data was collected and recorded by trained nurses under the supervision of the investigators of the study. However, after initial treatment, patients were discharged from the hospital and asked to visit LGH, Lahore, for follow-up and their delivery. In this phase, their fetal outcomes were observed.

Data Analysis

After the collection, the data were analyzed through Statistical Package for Social Sciences (SPSS) version 26.0. Initially, frequency and percentage were used to display categorical variables; however, mean ± standard deviation was used to represent the quantitative variables. Later, a comparison between maternal and fetal related quantitative variables was performed for various levels of severity of TBI. Analysis of variance (ANOVA) and the Kruskal-Wallis H-test were used for this comparison. The choice of a suitable test was based on the assumption of normality. If the data were normally distributed, then the ANOVA test was used. Categorical variables were associated through the Chi-square test of association. All analyses were performed at 5% level of significance.

Table 1: *Demographic and Background Characteristics of Pregnant TBI patients (n =30).*

Characteristics	Frequency (n)	Percentage (%)	Mean ± SD
Women Age (years)	—	—	30.1 ± 4.7
Gestational age (weeks)	—	—	26.2 ± 5.9
Parity			
Primigravida	14	46.0	—
Multigravida	16	54.0	—
Mechanism of Injury			
Road Traffic Accident	21	70.0	—
Domestic Violence	03	10.0	—
Falls	04	13.3	—
Other (assault/industrial)	02	6.7	—
Levels of Severity of TBI			
Mild	13	43.3	—
Moderate	10	33.3	—
Severe	07	23.4	—
Trimester at Injury			
First	06	20.0	—
Second	14	46.7	—
Third	10	33.3	—
Prehospital Delay (hours)	—	—	3.8 ± 2.4
ICU Admission	17	56.0	—
Neurosurgical Intervention	07	23.3	—
Total Number of Deaths	03	10.0	

Table 2: Maternal and Fetal Outcomes by Severity of TBI (n = 30)

Outcome Variable	Mild (n = 13)	Moderate n = 10	Severe (n = 07)	p-value
Maternal Mortality	0 (0%)	1 (10.0%)	2 (28.5%)	0.08
ICU Stay (days)	2.2 ± 1.4	4.1 ± 2.2	8.1 ± 3.9	<0.001*
Cesarean Delivery	4 (30.7%)	4 (44.4%)	3 (60.0%)	0.501
Preterm Birth (<37 weeks)	2 (15.4%)	3 (33.3%)	3 (60.0%)	0.170
Fetal Distress	1 (7.6%)	2 (22.2%)	2 (40.0%)	0.265
Stillbirth/Neonatal Death	0 (0%)	1 (11.1%)	2 (40.0%)	0.054
APGAR Score < 7	1 (7.7%)	2 (25.0%)	1 (33.3%)	0.416

*Significant at 5% level of significance

RESULTS

Descriptive Findings

There were 30 patients who completed this study. Table 1 contains their demographic and other important information. Results have shown that the average maternal age was 30 with a standard

deviation of 4.7 years. It indicates that young and reproductive women are at a higher risk of TBI. Further, the majority of the women were in their second and third trimesters; therefore, there were more chances of having complications with the mother and fetus. Road traffic accidents were the most common (70%) cause of these traumas, followed by falls from height or unstable places. The severity of TBI was assessed through GCS, and it was found that almost 43% patients had a mild level of injury. However, the remaining 57% patients got moderate and severe injury. 56% patients were admitted to the ICU and received critical care from experts. Almost 1/4th of the patients got neurosurgical intervention. The overall mortality rate was 10%.

Impact of Severity of TBI on Maternal and Fetal Outcomes

Table 2 is very important and contains information about other important aspects of TBI patients: maternal and fetal outcomes. Except for ICU stay, all other variables were categorical; therefore, these were used in assessing the potential association with the severity of TBI. Chi-square test of association showed that all results were statistically insignificant at 5% level of significance. However, this was possibly due to small sample sizes in three groups of TBI. Otherwise, it can easily be observed that patients with severe TBI had high maternal mortality, higher chances of cesarean delivery, preterm births, fetal distress, stillbirth, and abnormal APGAR scores. Further, patients with severe TBI had significantly higher ICU stay as compared to the other two groups; an average of 8.1 days, which was higher than 4.1 and 2.2 days in the other two groups.

DISCUSSION

This study focused on a very important but less explored population: pregnant women with TBI. The management of TBI in such a specialized group is very challenging for practitioners and needs simultaneous monitoring by involving various specialties. This small empirical study has tried to fill the gap and provided local evidence that partially reflects there is a need for a maternal-fetal unit management model to control the adverse events in this group. This study found that the severity of TBI can be the main reason behind various adverse events like maternal mortality, prolonged ICU stay, fetal distress, still births, and low AGPAR scores.

This study found that the average age of the patients was 30 years, which is close to the existing literature,[14]; however, a previous study focused on spinal cord injury in pregnant women. In our study, it was found that road accidents are the leading cause of TBI and other related injuries, and it was consistent with previous studies.[15] There were more than half of the patients were admitted to the ICU and received critical care. Some studies have reported that TBI cases are at risk of getting secondary brain injury; therefore, they often need specialized care in the ICU.[16,17] Our study also found that there were almost 1/4th cases that got severe TBI, and it is also consistent with the literature,[18] where this proportion was around 30%.

At the start of the study, it was discussed that TBI can cause various physiological changes in the maternal body that subsequently affect the fetal status. It means this interdependence can affect two lives, and our study also augmented this hypothesis. In 5 cases, there was fetal distress, which is almost 20% of the total cases, and this distress is the outcome of maternal hypotension and hypoxia.[5] Kamble and Sawant[2] reported in their study that this distress can vary between 30-40%. This fact indicates that a collaborative approach in the management of such cases is essential; otherwise, there are very high chances of adverse events. Early management through continuous monitoring by obstetricians and critical care providers can reduce the chance of further complications. The meta-analytic findings of Heller, Kraft[1] showed that there were around 40%

preterm births in such pregnancies, and we also found that overall, more than 30% pregnancies ended with preterm births. Further, our study found that there is very high mortality in severe TBI cases, and this finding also aligned with the literature[1,18] that also supports our assumption that unity of the maternal-fetal unit is extremely needed.

The severity of TBI in such patients can easily prolong the stay at hospitals, especially in the ICU. The average ICU stay was around 8 days in severe cases and in those patients who underwent neurosurgical interventions, which aligned with the literature, where this stay was also 5-8 days.[5] This Pakistani Dataset also indicated that Cesarean section was very common in all types of TBI patients, mild to severe. However, in severe cases, it was around 60%, which was significantly higher than existing literature, where it was around 40%.[19] This was quite possible in Pakistani settings, where the Cesarean section is significantly higher even in the general population.[20] Based on these findings, it can be argued that there is a long list of complications that can be categorized into three types: maternal, fetal, and neonatal. Maternal complications can be prolonged ICU stay, their deaths, higher Cesarean and preterm birth rates, and neurosurgical interventions. On the other side, fetal distress that can lead to fetal death and neonatal abnormalities has also been recorded. All these complications indicate that pregnant patients with TBI can only be managed through an integrative approach of various specialties.

This study has two main limitations that should be considered to understand the findings of this study. This study used a relatively small sample size due to the low incidence rate of this problem in the study settings. A large sample size can yield significant findings for TBI severity and other categorical variables and may strengthen the findings. This study was a single-center study, and future researchers can replicate this study using a multi-center approach.

CONCLUSION

Although the majority of findings are statistically insignificant, this study provides preliminary insights into the low-resource settings that need further investigation. This study concludes that TBI during pregnancy is a complex scenario for the emergency department. After neuroimaging, timely involvement of neurosurgeons, obstetricians, critical care specialists, and therapists can work in a sequential as well as parallel model to save the future child and mother.

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Additional Information

AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Shirin Gul Suhail & Zahra Safdar	1. Study design, methodology, and Literature review and referencing.
2.	Omair Afzal	2. Paper write-up, editing, and quality insurer.
3.	Sumera Zeb, and Madeeha Rasheed	3. Data collection, calculations and analysis of data & interpretation of
4.	Uzma Zia	4. Editing and referencing.