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Original Research Article

COMPARISON OF LEFT AND RIGHT HEMISPHERE INVOLVEMENT IN TRAUMATIC BRAIN INJURY

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ABSTRACT

Background: Traumatic brain injury (TBI) is a major cause of morbidity and mortality worldwide. The clinical manifestations and outcomes of TBI may vary depending on the hemisphere involved. Left hemispheric injuries are commonly associated with language impairment, whereas right hemispheric injuries are more frequently associated with visuospatial dysfunction. The objective is to compare the clinical characteristics, management, and outcomes of traumatic brain injury involving the left and right cerebral hemispheres. Study Design: Cross-sectional study. Duration and Place of Study: This study was conducted at Bilawal Medical College Hospital BMC @ LUMHS Jamshoro from December 2025 to June 2026.

Materials and Methods: A total of 120 patients with traumatic brain injury admitted to the Department of Neurosurgery were included in this study. Patients of all age groups and both genders were enrolled. Data regarding demographic characteristics, affected cerebral hemisphere, mechanism of injury, Glasgow Coma Scale (GCS) score at admission, management, and clinical outcomes were collected and analyzed using SPSS version 25.0.

Results: Of the 120 patients, 74 (61.7%) had right hemispheric injuries, while 46 (38.3%) had left hemispheric injuries. Males constituted 64 (53.3%) of the study population. The mean age was 36 years among males and 39 years among females. Patients with right hemispheric TBI had lower GCS scores at admission, whereas those with left hemispheric TBI underwent surgical intervention more frequently and demonstrated greater improvement in GCS scores during treatment.

Conclusion: Hemispheric laterality appears to influence the clinical presentation, management, and outcomes of traumatic brain injury. Patients with left hemispheric injuries showed better neurological recovery and more favorable clinical outcomes than those with right hemispheric injuries.

Keywords: Traumatic brain injury, cerebral hemisphere, left hemisphere, right hemisphere, Glasgow Coma Scale, neurological outcome.

INTRODUCTION

Traumatic brain injury (TBI) is a major cause of morbidity and mortality worldwide, affecting more than 50 million individuals annually.[1,2] In addition to its significant health burden, TBI imposes considerable socioeconomic costs on patients, families, and healthcare systems.[3] Approximately 60–75% of TBI cases occur in males, with young adults representing the most commonly affected age group.[4]

Traumatic brain injury is broadly classified into focal and diffuse injuries, including cerebral contusions, diffuse axonal injury, intracranial hemorrhage, concussion, and penetrating brain injuries.[5] The pathophysiology of TBI involves both primary and secondary brain injury. Primary injury results from the initial mechanical force

applied to the brain, whereas secondary injury develops through a cascade of pathological processes, including hypoxia, hypotension, excitotoxicity, oxidative stress, increased intracranial pressure, mitochondrial dysfunction, neuroinflammation, and neuronal cell death.[6,7]

The clinical manifestations of TBI depend largely on the location and extent of brain injury. Left hemisphere (LH) injuries are commonly associated with impairments in language, speech, and analytical functions, whereas right hemisphere (RH) injuries are more frequently associated with deficits in visuospatial processing, attention, and emotional regulation.[8] These functional differences may contribute to variations in clinical presentation, injury severity, management, and neurological outcomes between patients with left- and right-sided brain injuries.[9] The functional specialization of the cerebral hemispheres, with the left hemisphere predominantly responsible for language and the right hemisphere for visuospatial and emotional functions, provides the biological basis for these differences.[10]

Despite the recognized functional asymmetry of the cerebral hemispheres, limited evidence is available regarding the influence of hemispheric involvement on the clinical characteristics and outcomes of traumatic brain injury. Therefore, the present study was conducted to compare the clinical presentation, management, and outcomes of traumatic brain injury involving the left and right cerebral hemispheres.

MATERIALS AND METHODS

A cross-sectional study was conducted among patients diagnosed with traumatic brain injury (TBI) who were admitted to the Department of Neurosurgery at a tertiary care hospital. The study included a total of 120 patients who were recruited using a random sampling technique. All enrolled patients were followed for a period of one year to assess their clinical course and outcomes. The study population comprised patients of all age groups and both genders who sustained traumatic brain injury due to road traffic accidents, falls, gunshot injuries, assaults, or other traumatic mechanisms.

Inclusion Criteria

Patients of all age groups and both genders with a confirmed diagnosis of traumatic brain injury based on clinical evaluation and radiological findings were eligible for inclusion. Patients presenting with traumatic brain injury resulting from any mechanism of trauma and admitted to the Department of Neurosurgery during the study period were enrolled.

Exclusion Criteria

Patients who declined to provide informed consent, those who did not fulfill the diagnostic criteria for traumatic brain injury, and patients with incomplete clinical records were excluded from the study.

Ethical approval for the study was obtained from the Institutional Review Board of the hospital before the commencement of data collection. Written informed consent was obtained from all participants or, where applicable, from their legally authorized representatives. Confidentiality of patient information was maintained throughout the study, and all collected data were used exclusively for research purposes.

Demographic and clinical information was collected using a structured data collection form. The recorded variables included age, gender, mechanism of injury, affected cerebral hemisphere (left or right), Glasgow Coma Scale (GCS) score at admission, radiological findings, treatment modality (conservative or surgical management), duration of hospital stay, and clinical outcome at follow-up. The affected hemisphere was determined based on clinical assessment and neuroimaging findings, including computed tomography (CT) scans or magnetic resonance imaging (MRI), where available.

Patients received treatment according to standard neurosurgical protocols and were managed either conservatively or surgically, depending on the nature and severity of the injury. Clinical outcomes were evaluated during the follow-up period using improvement in Glasgow Coma Scale scores and overall neurological recovery as documented in the medical records.

Data were entered, cleaned, and analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0. Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages. Comparisons between patients with left- and right-hemispheric traumatic brain injuries were performed using appropriate statistical tests. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 120 patients with traumatic brain injury (TBI) were included in this study. Of these, 74 (61.7%) patients had injuries involving the right cerebral hemisphere, while 46 (38.3%) had injuries involving the left cerebral hemisphere. Adult males constituted the largest proportion of the study population (n=64, 53.3%). The mean age of male patients was 36 years, whereas the mean age of female patients was 39 years.

Table 1: Demographic characteristics of the study population

Demographic Characteristics	Right Hemisphere (n = 74)	%	Left Hemisphere (n = 46)	%
Adult Male	39	52.7	25	54.3
Adult Female	24	32.4	16	34.7
Children	11	14.9	5	11.0
Total	74	100.0	46	100.0

The distribution of patients according to admission Glasgow Coma Scale (GCS) scores is presented in Table 2. Patients with right hemisphere injuries generally presented with lower GCS scores at admission than those with left hemisphere injuries, indicating relatively more severe neurological impairment at presentation.

Table 2: Distribution of patients according to admission Glasgow Coma Scale (GCS)

Admission GCS Score	Right Hemisphere (n = 74)	%	Left Hemisphere (n = 46)	%
3–6	20	27.0	5	11.0
6–8	17	22.9	8	17.3
8–10	17	22.9	12	26.1
10–12	14	18.9	11	23.9
12–15	6	8.2	10	21.7
Total	74	100.0	46	100.0

The treatment approaches used for patients with traumatic brain injury are summarized in Table 3. Conservative management was more frequently employed among patients with right hemisphere injuries (71.6%), whereas surgical intervention was more common among patients with left hemisphere injuries (52.2%).

Table 3: Management Approach

Management Approach	Right Hemisphere (n = 74)	%	Left Hemisphere (n = 46)	%
Conservative Management	53	71.6	22	47.8
Surgical Management	21	28.4	24	52.2
Total	74	100.0	46	100.0

Improvement in neurological status following treatment was assessed by changes in Glasgow Coma Scale scores. Patients with left hemisphere injuries demonstrated greater neurological improvement than those with right hemisphere injuries. The highest recovery rates were observed among patients with higher baseline GCS scores.

Table 4: Post-treatment Improvement in Glasgow Coma Scale (GCS)

Outcome Measure	Right Hemisphere	Left Hemisphere
Overall improvement in GCS	29.7% (≤2-point increase)	Greater overall improvement (>2-point increase)
Patients with baseline GCS 11–15 who improved	81.1%	100.0%
Patients with baseline GCS 7–10 who improved	22.9%	26.1%
Patients with baseline GCS 3–6 who improved	5.4%	17.4%

The final clinical outcomes of the patients are shown in Table 5. Mortality was higher among patients with right hemisphere injuries (52.7%) than among those with left hemisphere injuries (45.6%). Recovery was observed more frequently in the left hemisphere group (34.7%) compared with the right hemisphere group (25.6%). The frequency of complications was comparable between the two groups.

Table 5: Clinical Outcomes

Clinical Outcome	Right Hemisphere (n = 74)	%	Left Hemisphere (n = 46)	%
Death	39	52.7	21	45.6
Recovery	19	25.6	16	34.7
Complications	16	21.7	9	19.7
Total	74	100.0	46	100.0

DISCUSSION

Traumatic brain injury (TBI) remains one of the leading causes of mortality and long-term disability worldwide. Despite advances in neurosurgical care and critical care management, TBI continues to impose a substantial clinical and socioeconomic burden because of its high incidence and associated neurological sequelae.[11] Clinical presentation and prognosis vary considerably according to the severity, location, and mechanism of injury. The present study compared the clinical characteristics, management strategies, and outcomes of patients with left- and right-hemispheric traumatic brain injuries.

In the present study, right hemispheric injuries were more common than left hemispheric injuries, accounting for 61.7% and 38.3% of cases, respectively. In addition, males constituted the majority of the study population, consistent with the well-established epidemiological pattern of traumatic brain injury. Young adult males are at greater risk of sustaining TBI because of increased involvement in road traffic accidents, occupational hazards, interpersonal violence, and high-risk physical activities.[12,13] These findings are in agreement with previous studies that have consistently reported a higher incidence of TBI among males than females.

Assessment of neurological status using the Glasgow Coma Scale (GCS) demonstrated differences between the two study groups. Patients with right hemispheric injuries were more likely to present with lower GCS scores, whereas patients with left hemispheric injuries more frequently presented with moderate or mild neurological impairment. These findings suggest that right-sided injuries may be associated with greater impairment of consciousness at presentation. Similar observations have been reported by Rosen et al. and Li et al., who demonstrated that the location of cerebral injury influences neurological presentation and early clinical severity following traumatic brain injury.[14,15] Dysfunction of the right cerebral hemisphere may impair arousal, attention, and awareness, contributing to lower GCS scores, whereas language deficits associated with left hemispheric injuries may facilitate earlier recognition and clinical diagnosis.

The management approach also differed between the two groups. Conservative treatment was more commonly employed in patients with right hemispheric injuries, while surgical intervention was performed more frequently in patients with left hemispheric injuries. Although right hemispheric injuries were more prevalent in the study population, a greater proportion of patients with left hemispheric injuries underwent surgical management. This observation differs from the findings of Honeybul et al. and Cooper et al., who reported a more cautious surgical approach for left-sided decompressive procedures because of concerns regarding injury to the dominant language hemisphere.[16,17] The variation observed in our study may reflect differences in institutional treatment protocols, patient selection, injury characteristics, or neurosurgical decision-making.

Post-treatment neurological recovery also differed according to the hemisphere involved. Patients with left hemispheric injuries demonstrated greater improvement in Glasgow Coma Scale scores following treatment than those with right hemispheric injuries. The greatest improvement was observed among patients presenting with higher baseline GCS scores, whereas patients with severe neurological impairment showed comparatively limited recovery. These findings suggest that hemispheric involvement may influence early neurological recovery following traumatic brain injury, although larger prospective studies are required to confirm this association.

Clinical outcomes were comparatively more favorable among patients with left hemispheric injuries. The recovery rate was higher, while mortality and complication rates were lower than those observed among patients with right hemispheric injuries. These findings are consistent with previous reports suggesting that hemispheric laterality may influence neurological recovery and functional outcomes following traumatic brain injury.[18] Likewise, Salmond et al. and Stocchetti et al. reported that right hemispheric injuries are frequently associated with persistent deficits in attention, visuospatial function, emotional regulation, and self-awareness, which may adversely affect rehabilitation and long-term functional recovery.[19,20]

The findings of the present study should be interpreted in light of several limitations. First, the relatively small sample size and the single-center design limit the generalizability of the results. Second, although patients were followed for one year, detailed neurocognitive, functional, and quality-of-life assessments were not performed during follow-up. Third, potentially important factors such as radiological characteristics of the injury, associated extracranial injuries, timing of surgical intervention, rehabilitation protocols, and pre-existing comorbidities were not evaluated. Future multicenter studies with larger sample sizes and longer follow-up periods are needed to further clarify the influence of hemispheric laterality on the clinical course and long-term outcomes of traumatic brain injury.

CONCLUSION

Right hemispheric traumatic brain injuries were more common in the present study and were associated with lower Glasgow Coma Scale (GCS) scores at presentation. In contrast, patients with left hemispheric injuries demonstrated greater neurological improvement, higher recovery rates, and underwent surgical intervention more frequently. These findings suggest that hemispheric laterality may influence the clinical presentation, management, and short-term outcomes of traumatic brain injury. Further multicenter studies with larger sample sizes are recommended to validate these findings and determine their long-term clinical significance.

Ethical Approval

Ethical approval was obtained from the Institutional Review Board/Ethics Committee of the participating institution before the commencement of the study. All study procedures were conducted in accordance with institutional ethical standards.

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