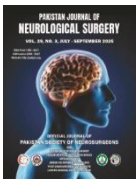

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

The Comparison of Outcome of Traumatic Brain Injury in Left and Right Hemispheres of The Brain

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ABSTRACT

Objective: One of the main causes of death and permanent disability worldwide is traumatic brain injury (TBI). Although several prognostic indicators have been studied, little is known about the part played by hemisphere involvement, particularly the distinctions between damage to the left and right hemispheres. Using the Glasgow Coma Scale (GCS) and Glasgow Outcome Scale (GOS), this study compares the clinical presentation, surgical requirements, and functional results of unilateral LH versus RH TBI.

Materials & Methods: Patients with unilateral LH or RH TBI were the subjects of a retrospective observational study. Individuals with bilateral, brainstem, or diffuse axonal injuries were not included. Initial GCS scores, imaging results, surgical procedures, and GOS scores at discharge were among the data gathered. To evaluate the variations in the clinical trajectory between the two groups, a comparison study was conducted.

Results: The findings showed that patients with RH injuries needed surgery more often than those with LH injuries and had substantially lower first GCS scores. Lower GOS scores at discharge were linked to RH injuries, even if the radiological findings were identical. On the other hand, LH injuries could be found more quickly and easily, which frequently resulted in better results and faster medical treatment. RH deficits' mild, frequently nonverbal character may cause a delay in diagnosis and treatment, which could worsen the prognosis.

Conclusion: Hemispheric laterality is important for TBI presentation and results. RH injuries are associated with worse healing, most likely because of delayed diagnosis and care. Understanding these hemisphere-specific variations better could facilitate early detection and direct more efficient, customized treatment plans.

Keywords: Traumatic Brain Injury, Right Hemispheric Injuries, Glasgow Coma Scale, Observational Study, And Left Hemispheric Injuries.

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Date of Submission: 05-03-2025
Date of Revision: 05-08-2025
Date of Acceptance: 08-08-2025
Date of Online Publishing: 01-9-2025
Date of Print: 30-9-2025

DOI: 10.36552/pjns.v29i3.1125

INTRODUCTION

One of the main causes of morbidity and death is traumatic brain injury (TBI). It causes significant socioeconomic distress and damage, and impacts more than 50 million people worldwide.[1] Sixty to seventy-five percent of cases of this illness are in males. The greatest risk group is young guys.[2] TBI encompasses a variety of injuries. These include diffuse and focal (localized) damage and can be moderate to severe. These include penetrating damage, diffuse axonal injury, haemorrhage, contusion, and concussion.[3] This disease is linked to multiple mechanisms. Direct harm to brain tissue is referred to as primary injury. This covers fractures, hematomas, and contusions. Hypoxia, hypotension, and elevated intracranial pressure can contribute to secondary damage.[4] Excitotoxicity, mitochondrial damage, oxidative stress, and mortality are among the reactions that are triggered by this.[5] Different patterns of neurological dysfunction might result from damage that is restricted to one hemisphere. While right hemisphere[rh] injuries lead to visuospatial disorientation and emotional processing deficiencies, left hemisphere[lh] lesions are linked to language and impaired analytical thinking.[6] Furthermore, diffuse cognitive, behavioural, and motor impairments may result from bilateral damage.[7] In contrast to their right-sided counterparts, left-sided injuries may result in quicker clinical identification and aggressive intervention due to hemisphere dominance, particularly the left hemisphere's link with language and analytical processing.[8] Injuries to the left hemisphere result in impaired orienting in comparison to the right.[9.] On the other hand, involvement of the right hemisphere is more frequent, which may be partly due to rh being more exposed to attacks, falls, and traffic accidents.[10] In the same vein, rh injuries are linked to lower arrival Glasgow Coma Scale [GCS] scores and worse functional outcomes.[11] The clinical importance of hemisphere laterality in TBI is assessed in this study, with particular attention paid to variations in presentation, initial Glasgow Coma Scale (GCS), management strategies, and neurological outcomes.

MATERIALS AND METHODS

Study Design

This cross-sectional study was carried out in the neurosurgery division of the tertiary care hospital Jinnah Postgraduate Medical Centre in Karachi. Between October 3, 2023, and October 9, 2023, information was gathered from 150 individuals who had been diagnosed with traumatic brain injury. Patients received follow-up care for a year.

Inclusion Criteria

Patients with a traumatic brain injury diagnosis, regardless of age or gender, are eligible to participate. Falls, assaults, gunshot wounds, traffic accidents, and any other cause of traumatic brain damage were considered. Included were patients who willingly consented after being told that the study would anonymize their data and conceal their identifiers.

Exclusion Criteria

Patients who have not given consent, and those who don’t fit the criteria for TBI.

Sampling Method

A random sampling method was used to select participants from the department of neurosurgery, Jinnah Post-Graduate Medical Centre, Karachi.

Data Collection Methods

Following institutional review board approval, data were gathered at the neurosurgical department. Management was done, and history was gathered. Each patient's age, gender, and the cause of their TBI were gathered from their medical records.

Data Analysis

Descriptive statistics were used to summarize the characteristics of the patients, and SPSS 25.0 was used for data analysis. This study examined factors such as hemisphere involvement, GCS during arrival and after management, management style, and result.

RESULTS

Demographic Involvement

Out of 150 participants, 92 had engagement in the right hemisphere and 58 in the left. Of the participants, 50 (33%) were female, with around 30 in the right hemisphere group and 20 in the left, while 81 (54%) were male, with roughly 49 in the right hemisphere group and 32 in the left. Of the 19 people (13%), 19 were children, with about 12 exhibiting involvement of the right hemisphere and 8 of the left. Male participants' average age was about 36 years, while female participants' average age was slightly higher at about 39 years. **(Table 1)**.

Table 1: *Demographic information of included participants.*

Characteristic	Right Hemisphere (n=92)	Left Hemisphere (n=58)	Total (n=150)
Male	49	32	81 (54%)
Female	30	20	50 (33%)
Children	12	8	19 (13%)

Hemispheric Involvement

To comprehend the distribution and possible ramifications of hemisphere involvement, the study assessed 150 patients with traumatic brain injury (TBI). Of these patients, 92 (61%) had TBI in the right hemisphere, and the remaining 58 (39%) had TBI in the left hemisphere. This significant distributional disparity suggests that right-sided brain injuries are more common in the research population. To ascertain a correlation or causality, this variance in hemisphere engagement was not statistically examined. To make it easier to compare the two groups further, the side of hemisphere participation was instead considered a crucial stratifying feature.

Arrival Glasgow Coma Scale (GCS)

Based on their initial Glasgow Coma Scale (GCS) scores, the study's patients were divided into four groups: 3–6, 6–8, 8–10, and 10–15. The distribution of patients with traumatic brain injuries (TBI) in the right hemisphere was as follows: There were 25 patients in the 3–6 group, 21 in the 6–8 group, 21 in the 8–10 group, and 25 in the 10–15 group. The distribution was somewhat different for left hemisphere injuries, with 6 patients falling into the 3–6 group, 10 into the 6–8 group, 15 into the 8–10 group, and 27 into the 10–15 group. A statistically significant difference in the severity of injury at presentation is suggested by this data (p-value = 0.0244), with a higher proportion of left hemisphere TBI patients falling into the 10–15 GCS category, indicating comparatively improved neurological function at admission. According to these results, patients with TBI in the left

Table 2: *GCS on admission.*

GCS Range	% Patients	Approx. Count
3 – 6	10%	6
6 – 8	18%	10
8 – 10	26%	15
10 – 12	24%	14
12 – 15	22%	13

Right Hemisphere Left Hemisphere

GCS Range	% Patients	Approx. Count
3 – 6	27%	25
6 – 8	23%	21
8 – 10	23%	21
10 – 12	18%	17
13	8%	7
14	1%	1

hemisphere tended to have higher initial GCS scores than those with injuries in the right hemisphere. This could be because the two groups' initial levels of neurological impairment differed **(Table 2 and Graph 1).**

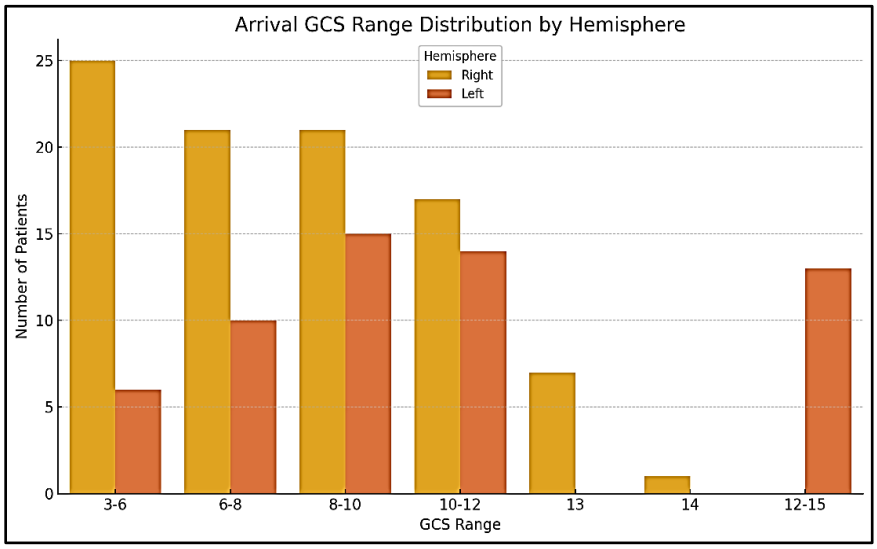

Figure 1: *GCS on admission.*

Management Type (Conservative vs. Surgical)

Significant variations in treatment approaches were found when the management procedures for traumatic brain injuries (TBI) in the left and right hemispheres were compared. 28% of the patients (26 patients) in the right hemisphere group needed surgery, whereas 72% of the patients (66 patients) were treated conservatively. While a larger percentage, 52% of the affected (30 patients), received surgical therapy, the left hemisphere group displayed a contrasting pattern, with only 48% of the affected (28 patients) receiving conservative management. A p-value of 0.0065 was obtained from this difference, showing that patients with TBI in the left hemisphere had a considerably higher chance of undergoing surgery than those with injuries in the right hemisphere. Consequently, left hemisphere injuries tended to be treated more aggressively with surgery, whereas right hemisphere injuries were more frequently managed with conservative approaches. [**Table no.3**].

Table 3: *Management Approach.*

Hemisphere	Conservative (%)	Surgical (%)
Right (n=92)	72% (66)	28% (26)
Left (n=58)	48% (28)	52% (30)

Post-Intervention GCS Improvements

Despite being descriptive, the post-intervention Glasgow Coma Scale (GCS) improvement data show significant disparities between individuals with traumatic brain injury (TBI) in the left and right hemispheres. Thirty percent of patients in the right TBI group improved to some extent, however, the increases were just two points. After the intervention, 81% of these people had a GCS in the 10–15 range, 24% in the 7–10 range, and only 5% in the 3–6 range. Patients with left hemisphere TBI, on the other hand, showed more significant gains, frequently surpassing 2 points. Interestingly, after therapy, every patient in the left TBI group who had a pre-intervention GCS of 11–15 improved. Furthermore, improvements were seen by 18% of individuals with pre-intervention scores between 3 and 6 and 27% of those with scores between 7 and 10. Despite the lack of precise numerical counts, this descriptive data indicates that, in comparison to their right hemisphere counterparts, left hemisphere TBI patients tended to exhibit more robust neurological recovery following intervention. (**Table 4**).

End Outcome (Death, Recovery, and Complications)

Both the left and right hemisphere traumatic brain injury (TBI) groups' final clinical results were

Table 4: *Post management GCS.*

Category	Right Hemispheric TBI	Left Hemispheric TBI
Overall Improvement	30% of patients improved (≤ 2-point increase)	Greater proportion improved (> 2-point increase)
- GCS 10–15	81% of those who improved	All with pre-intervention GCS 11–15 improved
- GCS 7–10	24% of those who improved	27% with pre-intervention GCS 7–10 improved
- GCS 3–6	5% of those who improved	18% with pre-intervention GCS 3–6 improved

examined. About 49 patients, or 53% of the right hemisphere TBI group, died, 23 patients, or 25%, recovered, and 20 patients, or 22%, developed problems. The death rate was somewhat lower for the left hemisphere TBI group, with 45% (26 patients) dying from their injuries, 35% (20 patients) recovering, and 20% (12 patients) experiencing sequelae. The observed variations in outcomes between the two groups were not statistically significant, according to the p-value of 0.440 that was obtained. Although there was a tendency for patients with left-hemisphere injuries to heal more quickly and for patients with right-sided injuries to die more frequently, these differences were not statistically significant **(Table 5)**.

Table 5: *End outcome.*

End Outcome	Right Hemisphere	Left Hemisphere
Death	53% (49)	45% (26)
Recovery	25% (23)	35% (20)
Complications	22% (20)	20% (12)

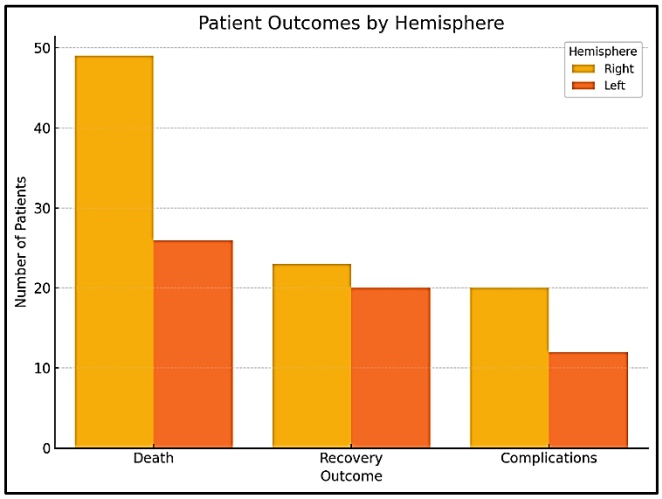

Figure 2: *End outcome.*

Chi-Square Test

The statistical analysis showed that the TBI groups in the right and left hemispheres differed significantly in terms of arrival GCS scores and management style. With a chi-square value of χ^2 = 7.40 (df = 1, p = 0.0065) for management type, left-sided injuries were substantially more likely to require surgical intervention. With χ^2 = 9.40 (df = 3, p = 0.0244), the arrival GCS scores also varied considerably, indicating that patients from the left hemisphere often had higher neurological status when they first arrived. Nevertheless, a chi-square value of χ^2 = 1.64 (df = 2, p = 0.440) was obtained from the comparison of outcomes (death, recovery, and complications), suggesting that there was no statistically significant difference in overall clinical outcomes between the two groups. (**Table 6**).

DISCUSSION

The purpose of this study was to investigate the relationship between hemisphere participation and traumatic brain damage. Hemisphere participation, GCs upon arrival, management approach, GCs after management, and results were the parameters utilized to investigate how the various hemispheres respond to brain damage.

Given the part these hemispheres play in brain function, hemispheric involvement in TBI varies widely. Because of their involvement in language and executive functioning, left hemisphere lesions can result in a wide range of symptoms, while right

hemisphere injuries might generate symptoms including neglect and visuospatial disorientation.[12] According to our research, injuries to the right hemisphere were more common than those to the left.

Table 6: *Chi-square test.*

Outcome	Chi-square (χ^2)	df	p-value	Significance
Management Type	7.40	1	0.0065	Significant
Arrival GCS	9.40	3	0.0244	Significant
End Outcome	1.64	2	0.440	Not significant

These results were consistent with another study that found a higher frequency of rh injuries.[13] Nonetheless, one investigation showed equal hemisphere activation, indicating the participation of several damage processes in this situation.[14] According to our research, patients with LH injuries presented with a higher GCS. Other investigations, such as those by Rosen et al, and Li et al, also support these findings, demonstrating that even in the face of aphasia, individuals with LH damage maintain higher levels of consciousness.[15–16] The disparity in GCS, however, can potentially be the result of observer bias, as left-sided injury-related linguistic impairment could be mistaken for confusion or agitation, which would artificially lower GCS.[17] On the other hand, individuals with injuries to the right side can exhibit more attentional and arousal impairment, which could impact the first GCS without obvious structural severity [1].

Our research revealed that, statistically significantly (p = 0.0065), LH injuries had a higher likelihood of undergoing surgical treatment than RH injuries. This finding differs significantly from that of Honeybul et al, and Cooper et al, who noted a cautious approach to left-sided decompression because of worries about language cortex damage and the aphasia that could follow.[18–19] However, rh injuries are frequently not adequately treated therapeutically, and they are linked to substantial swelling and a displacement in the midline, necessitating surgery.[14,20] Our study found that patients with left hemisphere injuries, particularly those with initially severe injuries (GCS 3–6 and 7–10), showed better post-intervention recovery. Compared to patients with right hemisphere injuries, individuals with left hemisphere TBI showed noticeably greater rates of functional independence (modified Rankin Score 0–3) at the six-month follow-up. These results build on those of Whyte et al, who showed that language-based therapy is frequently easier to access and more regimented, which may favour left TBI recovery. Because of these outcomes, LH injuries require less surgical intervention and are identified earlier because of their clinical symptoms. Similarly, RH injuries are often underrecognized due to subtle deficits, leading to delayed care and worse outcomes.[20] Our study showed a trend toward better recovery and lower mortality in left hemispheric TBI; these differences were not statistically significant (p = 0.440). This aligns with the findings of Poca et al, who also reported no significant difference in outcomes based on hemispheric involvement. However, it contrasts with Salmond et al, and Stocchetti et al, who emphasized poorer psychosocial outcomes in right hemisphere injuries due to emotional dysregulation and impaired self-awareness.[22]

Limitations

This study has several limitations, even if it provides insightful information about the effects of left versus right hemisphere involvement in traumatic brain injury (TBI). First, it is challenging to extrapolate the results to the larger TBI community due to the comparatively small sample size, which restricts the findings' statistical power and generalizability. Second, the capacity to evaluate functional results and sustained recovery is limited by the absence of long-term follow-up data, especially in domains such as cognitive and motor rehabilitation. Third, the study design seems to be retrospective, which restricts the ability to control for variables that could affect results and

creates selection bias. Lastly, confounding variables such as patient age, sex, concomitant diseases, and the specific mechanism and extent of injury are not given enough thought. These uncontrollable factors might have had a big impact on the outcomes, especially in terms of Glasgow Outcome Scale scores and surgical intervention rates. Future prospective multicenter studies should address these limitations to improve the clinical relevance and trustworthiness.

CONCLUSION

The clinical presentation, surgical requirements, and recovery results of traumatic brain injuries in the left and right hemispheres differ significantly, according to this study. Compared to patients with left-sided injuries, those with right-sided injuries had worse post-recovery GCS, more surgical intervention needs, and lower entry GCS scores. These results could be explained by the widespread character of right-sided brain injury symptoms, the delayed identification of right hemisphere impairments, and possibly more severe radiological characteristics. On the other hand, left-sided injuries, which are frequently linked to overt language impairments, are typically identified earlier, resulting in prompt intervention and improved results. Our findings show hemispheric diversity in TBI outcomes, which is consistent with other studies. However, the lack of long-term follow-up, sample size, and study design constraints highlights the need for more extensive, prospective research. Comprehending these hemisphere variations can enhance clinical evaluation and direct more customized treatment approaches for TBI.

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Additional Information

Disclosures: The Authors report no conflict of interest.
Ethics approval: This research was approved by the institutional review board at Jinnah Postgraduate Medical Centre on 24 April 2024, and the reference number was NO.F.2-81/2024-GENL.
Human Subjects: Consent was obtained from all patients/participants in this study.
Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work**.**
Other Relationships: All authors declare that they have no other relationships or activities that could be perceived as influencing the submitted work.
Data Availability Statement: For data sharing, interested researchers can contact the corresponding authors
Funding: None**.**

AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Bushra Maqsood	1. Study design and methodology.
2.	Shafin bin Amin	2. Paper writing.
3.	Iram Bokhari	3. Data collection and calculations.
4.	Rabbia Aqeel and Haris Ahmed	4. Analysis of data and interpretation of results.
5.	Hammad Sheikh and Sana Maqsood	5. Literature review and referencing.
6.	Rabail Qazi and Shafin bin Amin	6. Editing and quality insurer.