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Significance of Best Motor Response in Evaluating the Outcome of Severe Traumatic Brain Injury Patients

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Author`s Contribution

[1,6]Substantial contributions to the conception or design of the work; or the acquisition, [2]Final approval of the article to be published, [3,4]Active participation in active methodology, [53]analysis, or interpretation of data for the work, [5]Drafting the work or revising it critically for important intellectual content

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ABSTRACT

Objective: To determine the significance of best motor response (BMR) in evaluation the outcome of severe traumatic brain injury patients at a tertiary care Hospital.

Methodology: A prospective observational study was done at Department Neurosurgery, Pakistan Institute of Medical Sciences (PIMS) Islamabad, from June 2023 to May 2024. Patients aged 18 to 60 years old, both gender presented with diagnosis of sever Severe traumatic brain injuries; evaluated by Glasgow Coma Scale "GCS" score of 3 to 8 at the time of admissions were included. All the patients underwent treatment involved comprehensive approaches include surgical interventions, monitoring of the intracranial pressure (ICP), and the conservative (medical treatment). BMR score was categorized into six domains. Final recovery was assessed by employing the GOS, which was further categorized in five classes.

Results: Overall mean age of the patients was 27.55 years and Mean Glasgow Coma Scale (GCS) score at admission was 9.38. Based on BMR 3.8% cases showed no response, 11.5% had Decerebrate posture, 7.7% had decorticated posture, 19.2% exhibited flexion to pain, 42.3% localized pain, and 15.4% obeyed all commands. There was a significant between BMR scores and overall recovery (GOS score) (p - 0.001). Cases with high BMR scores (42.3% with localizing pain and 15.4% with obeying commands) showed better recovery (GOS score V), while those with lower BMR scores (e.g., 3.8% with no response and 11.5% with decerebrate posture) had poorer outcomes (GOS scores I and II). These results show that higher BMR scores are linked to better recovery, while lower scores are associated with worse outcomes.

Conclusion: BMR observed to be a reliable and early indicator of prognosis among patients with STBI, which may guide clinical decision-making and management. Higher BMR scores, especially for pain localization and obeying commands, were linked to better recovery outcomes, while lower scores were associated with poor outcomes.

Keywords: Severe traumatic brain injury, Glasgow Coma Scale, Best Motor Response, Survival, Disability, Mortality.

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Introduction

Severe traumatic brain injury (TBI) is the significant concern of the health throughout the world, resulting the significant morbidity and the mortality.[1] It is considered as leading cause of disabilities the mortality globally, specifically among young population, and its socioeconomic impact on the families and the healthcare systems is thoughtful. Approximately 5.48 million people are impacted each year, with an incidence rate of 73 per 100,000 individuals.[2] As per WHO projections, over 90% of fatalities caused by injuries occur in low- and middle-income countries, which are home to 85% of the world's population.[2] TBI might vary in severity, ranging from minor, acute neurological damage or malfunction to severe, permanent disability that leaves patients completely incapacitated.[3] Preventing secondary brain injury is one of the objectives of early treatment, while treatment recommendations vary depending on the extent of the injury.[3] According to a study from Pakistan (Punjab), around 93.2% of TBIs occurred due to road traffic accidents, and of these, 78.7% were sustained by

motorbike riders who were not wearing helmets at the time of the incident.[4] Evaluations, therapeutic interventions, as well as its prognosis of traumatized patients are made extremely difficult by the heterogeneity of TBI complicated pathogenesis. Additionally, prognosis can be determined using a standardized scale to assess the level of consciousness and there are various approaches for evaluating impaired consciousness in cases of brain injuries.[5] The Glasgow Coma Scale (GCS), one of the several clinical tools used to assess the severity of TBI and predict its outcomes, is commonly utilized in these evaluations.[6]

The Best Motor Response (BMR) has become a crucial metric on this scale for evaluating neurological function and predicting health outcomes for people having severe traumatic brain injury. However, neither score is sufficiently reliable to guide treatment restrictions. According to a previous study both the motor response and the overall Glasgow Coma Scale score provide useful indicators of long-term outcomes, but there is limited consistency between observers and no direct correlation between mortality and the complete Glasgow Coma Scale.[7] The motor response should be preferred over the full Glasgow Coma Scale, as it is easier to assess, shows a linear relationship with mortality, and offers predictive value similar to the complete GCS.[7] According to another recent study on patients with aneurysmal subarachnoid hemorrhages highlighted that the BMR score of 4 significantly predicts positive recovery, with an odds ratio of 3.76.[8] Similarly, On other hand it has been reported that the individuals with severe traumatic brain injury, recovery outcomes are largely influenced by the BMR score.[9,10] Lower BMR scores have been associated with worse survival rates, with a score of ≤3 indicating a significant decline in survival, underscoring the prognostic importance of this parameter.[9,10] However, no more recent studies found for above association specifically at local level. Therefore, this study has been conducted to evaluate the significance of BMR in predicting outcomes among patients presenting with severe brain injury in the local context.

Methodology

This was a prospective cross-sectional study conducted in the Neurosurgery and ICU Departments of the Pakistan Institute of Medical Sciences (PIMS), Islamabad. The study was conducted over one year, from June 2023 to May 2024, after approval from the College of Physicians and Surgeons Pakistan (CPSP). Patients aged 18 to 60 years, of both genders, presenting with a diagnosis of severe traumatic brain injury (TBI) and a Glasgow Coma Scale (GCS) score of 3 to 8 at the time of admission were included.

Patients presenting with non-traumatic brain injuries (e.g., stroke), those with incomplete clinical records or history, patients with a GCS score >13, patients with multiple injuries and unstable hemodynamics, spinal injuries, multiple fractures, or paralytic conditions were excluded from the study.

All included patients underwent treatment involving comprehensive approaches, including surgical interventions, monitoring of intracranial pressure (ICP), and conservative (medical) management. Surgical interventions aimed to alleviate raised ICP, prevent secondary brain injuries, evacuate hematomas, and manage skull fractures as indicated to prevent mass effect and address structural damage.

Pharmacological management included the use of osmotic agents to reduce cerebral edema, sedatives to manage agitation and decrease cerebral metabolic demand, antiepileptic medications to prevent seizures, and neuroprotective agents to mitigate secondary brain injuries. All treatments were administered based on specific clinical indications for each patient, in strict adherence to hospital protocols and guidelines.

Informed consent was obtained from each patient or their caretakers after ensuring that personal information would remain strictly confidential and that participation in the study would not affect their treatment plan. It was emphasized that the collected data would be solely utilized to evaluate patient recovery using standardized scales for research purposes, with no impact on clinical care or treatment outcomes.

The Brain Motor Response (BMR) score was categorized into six domains: No motor response, Extensor response, Abnormal flexion, Flexion to pain, Localized pain, Obeying all commands

Final recovery was assessed using the Glasgow Outcome Scale (GOS), which was categorized into five classes: Good recovery, Moderate disability, Severe disability, Persistent vegetative state (poor outcome), Mortality.

All patients were assessed prior to discharge from the hospital. Data for the study were collected using a predesigned proforma. Statistical analysis was performed using SPSS version 26.

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Results

The mean age of the patients was 27.55 years (SD ± 13.96 years). Male patients constituted 80.8% of the cohort, while females accounted for 19.2%. The majority of injuries (61.5%) were caused by road traffic accidents (RTAs), while 38.5% were due to falls. Regarding the site of injury, 36.5% of patients had right-sided injuries, 32.7% had left-sided injuries, 21.2% had central injuries, and 9.6% had bilateral injuries.

Pupil assessment revealed that 53.8% of patients had normal pupils, 23.1% had constricted pupils, 15.4% had dilated pupils, and 7.7% had pinpoint pupils. Light reactivity of pupils was observed in 44.2% of cases, with an equal proportion (44.2%) showing non-reactive pupils, and 11.5% displaying sluggish reactions. The mean Glasgow Coma Scale (GCS) score at admission was 9.38, indicating a moderate level of consciousness impairment in most cases (Table I).

Out of all cases, 44.2% underwent surgical interventions, while 55.8% were managed conservatively. Motor responses were observed in 84.6% of patients, with the distribution detailed in Figure 1.

Based on the correlation between BMR scores and overall recovery (GOD score), revealed a significant relationship (p- = 0.001). Out of all patients, 42.3% with localizing pain (BMR score 5) and 15.4% with obeying all commands (BMR score 6) achieved GOS score V (good recovery). In contrast, 3.8% with no response (BMR score 1) and 11.5% with decerebrate posture (BMR score 2) had poor outcomes (GOS score I and II). These results demonstrate that higher BMR scores correlate with better recovery, while lower scores was associated to adverse outcomes. Table II

Table I: Descriptive analysis for demographic and clinical variables. (n=51)

Variables		Statistics	
Patients' age		27.55±13.96 years	
Sex	Males	42	80.8
	Females	10	19.2
	Total	52	100.0
Mode of injury	RTA	32	61.5
	Fall	20	38.5
	Total	52	100.0
Site	Left	17	32.7
	Right	19	36.5
	Central	11	21.2
	Left or right both	5	09.6
	Total	52	100.0
Pupillary size	Normal	28	53.8
	Pin point	4	7.7
	Dilated	8	15.4
	Constricted	12	23.1
	Total	52	100.0
Reaction to light	Reactive	23	44.2
	Non-reactive	23	44.2
	sluggish	6	11.5
	Total	52	100.0
Mean GCS score at admission		9.38±2.47	

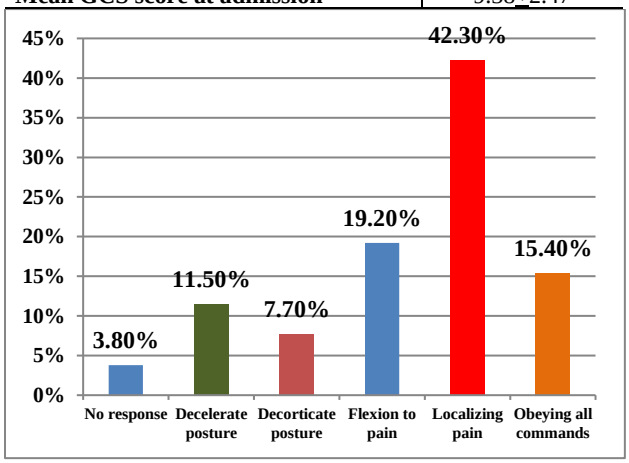

Figure 1. BMR scoring, (n=52)

Table II: Association between BMR Scores and overall recovery (GOS) n=51

Outcomes	GOS score (recovery)						p-value
	I	II	III	IV	V	Total	
No response	2	0	0	0	0	2	0.001
	3.8%	0.0%	0.0%	0.0%	0.0%	3.8%	
Decerebrate posture	2	4	0	0	0	6	
	3.8%	7.7%	0.0%	0.0%	0.0%	11.5%	
Decorticate posture	0	2	2	0	0	4	
	0.0%	3.8%	3.8%	0.0%	0.0%	7.7%	
Flexion to pain	0	0	2	7	1	10	
	0.0%	0.0%	3.8%	13.5%	1.9%	19.2%	
Localizing pain	0	0	0	0	22	22	
	0.0%	0.0%	0.0%	0.0%	42.3%	42.3%	
Obeying all commands	0	0	0	0	8	8	
	0.0%	0.0%	0.0%	0.0%	15.4%	15.4%	
Total	4	6	4	7	31	52	
	7.7%	11.5%	7.7%	13.5%	59.6%	100.0%	

Discussion

Severe traumatic brain injuries are among the most critical types of head injuries, resulting in significant morbidity and mortality. These injuries are usually categorized using a GCS score of ≤8, which indicates significant impairment of neurological functions. However, the prognosis of patients with these injuries varies significantly and depends on several factors, including the severity of the injuries, the patient's age, comorbidities, and the time to management. The BMR, a component of the GCS scale, serves as an analytical parameter for evaluating the neurological condition of patients with STBI. It assesses the motor response to stimuli, reflecting the integrity of the brain's motor pathways and overall neurological function. This study has been done on 52 patients, to evaluate the significance of BMR in the evaluation of outcomes of STBI, with an overall mean age of 27.55 years and males predominance 80.8%. In aligns to this study Yaqoob U et al[11] reported that the mean age of the patients with traumatic brain injuries was 26.8±3.7 years and like this study males were in majority 73.1% compared to females 26.9%.

On the other hand Ashraf M et al[12] found lower mean age of the patients with traumatic brain injuries as 14.7 years, while consistently they found almost males 98.2% in their study and the difference in the mean age may because they included the underage motorcycle driving population. In this study 61.5% of injuries were caused by road traffic accidents (RTAs), and 38.5% were due to falls, which were correlated studies by Yaqoob U et al[11], Ashraf M et al[12] and Samad A et al[13]. Based on age, gender, and etiology, it is estimated that males, particularly around 30 years of age, are more frequently involved in high-risk activities such as sports, hazardous occupations, and vehicular accidents, primarily due to unsafe motor driving practices, which are the main cause of their injuries, increasing their likelihood of sustaining BTI.

In this study out of all 44.20% cases underwent surgical interventions and 55.80% patients were treated by conservative treatment. Among all of the cases, motor responses were categorized as: 3.8% showed no response, 11.5% had Decerebrate posture, 7.7% had decorticated posture, 19.2% exhibited flexion to pain, 42.3% localized pain, and 15.4% obeyed all commands. Overall most patients (84.6%) demonstrated some level of motor response. These findings were correlated to the study by Buitendag JJ et al[9]. Furthermore, in the study by Piyapadungkit S et al [10] reported that, among 84 patients, 84 had a BMR score of 1–3, while 130 patients had a BMR score of 4–5. Similarly, Born JD et al[14] categorized patients into three groups based on their actual outcomes after six months: 44 patients were classified as deceased, 13 as in a persistent vegetative state or with severe disability, and 52 as having moderate disability or good recovery.

Furthermore, in this study, the correlation between BMR scores and overall recovery (GOS score) revealed a significant relationship ($p = 0.001$). Among all patients, 42.3% with localizing pain (BMR score 5) and 15.4% with obeying all commands (BMR score 6) achieved a GOS score of V (good recovery). In contrast, 3.8% with no response (BMR score 1) and 11.5% with decerebrate posturing (BMR score 2) had poor outcomes (GOS scores I and II). These results demonstrate that higher BMR scores correlate with better recovery, while lower scores are associated with adverse outcomes.

In alignment with these findings, a recent study on patients with aneurysmal subarachnoid hemorrhages reported that a Best Motor Response (BMR) score of 4 was a significant predictor of positive recovery, with an odds ratio of 3.76.[8] Similarly, it has been consistently reported that recovery outcomes in individuals with severe traumatic brain injury are strongly influenced by the BMR score. Lower BMR scores have been linked to poorer survival rates, with a score of ≤3 indicating a marked decline in survival, thereby highlighting the prognostic significance of this parameter.[9,10]

In the comparison of this study Fortune PM et al[7] concluded that the both the complete Glasgow Coma Scale (GCS) score and the motor response offer valuable insights into long-term outcomes; however, neither is precise enough to dictate treatment decisions. The GCS does not exhibit a direct correlation with mortality, and interobserver agreement is often low. For children, the motor response is preferable to the full GCS, as it provides similar predictive accuracy, shows a direct relationship to mortality, and is easier to assess reliably.[7]

According to a previous study by Born JD et al[14] when compared the prognostic abilities of motor responses alone, using the Glasgow criteria, and brain stem reflexes, employing an original approach, through multiple group logistic regression and finally the analysis revealed that the predictive capabilities of brain stem

reflexes were superior to those of motor responses. Our findings were also some partially correlated with few other previous studies.[15,16] In parallel with this study, et al. reported a higher mortality rate, with 65.2% of patients surviving and 34.8% dying. The FOUR score accurately predicted 82% of these outcomes; therefore, it is considered a valuable, sensitive, and specific diagnostic tool for predicting outcomes in patients with traumatic brain injuries.[17] On the other hand Dang H et al[18] observed that the genetic algorithm-modified backpropagation neural network can forecast motor function in patients with traumatic brain injury, serving as a useful reference for risk and prognosis evaluation and assisting in clinical decision-making.[18] There are only a few relevant studies found in the literature related to this study, and only a few parallel studies were discussed, some of which were partially correlated with this study.

However, this study also possesses certain limitations, including a limited sample size, a lack of long-term follow-up for outcomes, and unspecified comorbidities. Therefore, further large-scale longitudinal studies are recommended to validate our findings, covering long-term outcomes, comorbidities, and other significant factors that may restrict recovery.

Conclusion

Based on the study findings, BMR is observed to be a reliable and early prognostic indicator among patients with STBI, which may guide clinical decision-making and management. The results clearly underscore that higher BMR scores—specifically, the ability to localize pain (BMR score 5) and obey commands (BMR score 6)—are significantly associated with favorable recovery outcomes, as evidenced by the majority of cases achieving a GOS score of V (good recovery). Conversely, lower BMR scores (1 = no response) were linked to poor outcomes, including severe disability and mortality. However, due to certain study limitations, further large-scale studies are recommended to validate these findings. Additionally, future longitudinal studies could provide valuable insights into the long-term outcomes of patients with severe brain injuries.

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