MEDALION JOURNAL: Medical Research, Nursing, Health and Midwife Participation | ISSN(e): 2986-7754
Volumes 6 No. 2 (2025)

ANALYSIS OF GCS AS A PREDICTOR OF MIDLINE SHIFT ON NCCT SCAN IN PATIENTS WITH ACUTE TRAUMATIC SUBDURAL HEMATOMA

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Received	: 25 May 2025	Published	: 10 August 2025
Revised	: 01 June 2025	DOI	: https://doi.org/10.59733/medalion.v6i2.212
Accepted	: 25 June 2025	Published links	: https://medalionjournal.com/index.php/go

Abstract

The Glasgow Coma Scale (GCS) is commonly used to assess the severity of head trauma; however, it is not sufficiently accurate for predicting midline shift (MLS) without imaging support. This study aims to analyze the sensitivity and specificity of GCS in predicting MLS in patients with acute SDH. Subjects were patients diagnosed with acute traumatic SDH who underwent non-contrast head CT scans. Data were collected to assess the correlation between GCS scores and MLS values and to determine the GCS cut-off point for predicting MLS. Among 34 patients, the majority were male (76.5%) and aged between 18–34 years (35.3%). Most patients had a GCS score of 9–13 (38.2%) and showed subarachnoid hemorrhage on CT scan (44.1%). A strong correlation was found between lower GCS scores and increased MLS. The mean MLS increased significantly with decreasing levels of consciousness. The GCS cut-off score to differentiate significant MLS was 13, with a sensitivity of 100%, specificity of 79.3%, positive predictive value of 87%, and negative predictive value of 85%. GCS has a strong correlation with MLS and can be used as a reliable clinical indicator to predict MLS in patients with acute traumatic SDH.

Keywords: ***Glasgow Coma Scale, midline shift, acute subdural hematoma, CT scan, head injury***

INTRODUCTION

Traumatic brain injury (TBI) remains a significant cause of morbidity and mortality worldwide. The burden of TBI is particularly high in developing countries, where road traffic accidents are among the leading causes of head trauma. Subdural hematoma (SDH), a form of intracranial hemorrhage resulting from TBI, is a critical condition that requires rapid evaluation and management. SDH can exert mass effect on adjacent brain structures, leading to midline shift (MLS), increased intracranial pressure (ICP), and potentially fatal brain herniation. In emergency and critical care settings, quick and accurate assessment of neurological function is vital. The Glasgow Coma Scale (GCS), introduced in 1974, remains the most widely used clinical tool to assess the level of consciousness in patients with head injury (Teasdale & Jennett, 1974). It is simple, reproducible, and can be performed rapidly without specialized equipment. GCS scores are used to classify the severity of TBI and guide triage and treatment decisions. However, while GCS is useful for clinical assessment, it does not directly measure structural brain changes such as MLS, which can be visualized only with neuroimaging modalities like computed tomography (CT). Midline shift is a critical radiological finding that reflects increased ICP and mass effect due to hematomas, brain swelling, or other space-occupying lesions. It is measured as the displacement of brain structures from the mid-sagittal plane and serves as a prognostic indicator in TBI (Jacobs et al., 2011). Larger MLS is associated with higher mortality, poorer neurological outcomes, and the need for urgent surgical intervention. Identifying reliable clinical indicators that correlate with MLS could help improve early decision-making, especially in resource-limited settings where CT is not always readily available

(Chaurasia et al., 2021). Previous studies have suggested a correlation between GCS and MLS, indicating that decreased consciousness often parallels increased brain shift (Ross & Olsen, 1989). However, few studies have quantified this relationship using diagnostic accuracy metrics such as sensitivity, specificity, and ROC analysis. This study aims to bridge that gap by evaluating the predictive value of GCS for detecting significant MLS in patients with acute traumatic SDH. Such insights are essential for optimizing initial assessment and determining the urgency of neuroimaging and surgical referral. This study investigates the diagnostic accuracy of GCS in predicting MLS among patients with traumatic acute SDH.

METHOD

This was a retrospective observational study with a diagnostic test design. The study was conducted at the Department of Radiology, Adam Malik General Hospital, from December 2024 to March 2025. Inclusion criteria included patients ≥18 years old with acute traumatic SDH diagnosed by non-contrast head CT within 24 hours of injury. Exclusion criteria included prior neurosurgery, sedation or intoxication, pre-existing brain lesions, and other forms of intracranial hemorrhage. MLS was measured manually on axial CT slices at the level of the foramen of Monro. The GCS was recorded from initial emergency department assessments. ROC curve analysis was used to determine the optimal GCS cut-off point.

RESULTS AND DISCUSSION

Among 34 patients, 76.5% were male and 35.3% were aged 18-34. Most patients (38.2%) had GCS scores of 9-13. The average MLS was 6.6 mm. MLS was positively correlated with SDH thickness and negatively correlated with GCS. Patients with GCS 14-15 showed minimal MLS (mean 1.04 mm), while those with GCS 3-5 had a mean MLS of 11.6 mm.

Table 1. Patient Demographics and Clinical Characteristics

Characteristic	Frequency (%)
Sex	
Male	26 (76.5)
Female	8 (23.5)
Age Group	
18–34	12 (35.3)
35–44	8 (23.5)
45–54	5 (14.7)
55–64	3 (8.8)
>65	6 (17.6)
GCS Category	
14–15 (Alert)	11 (32.4)
9–13 (Drowsy)	13 (38.2)
6–8 (Stupor)	7 (20.6)
3–5 (Coma)	3 (8.8)

Table 2. Mean MLS by GCS Category

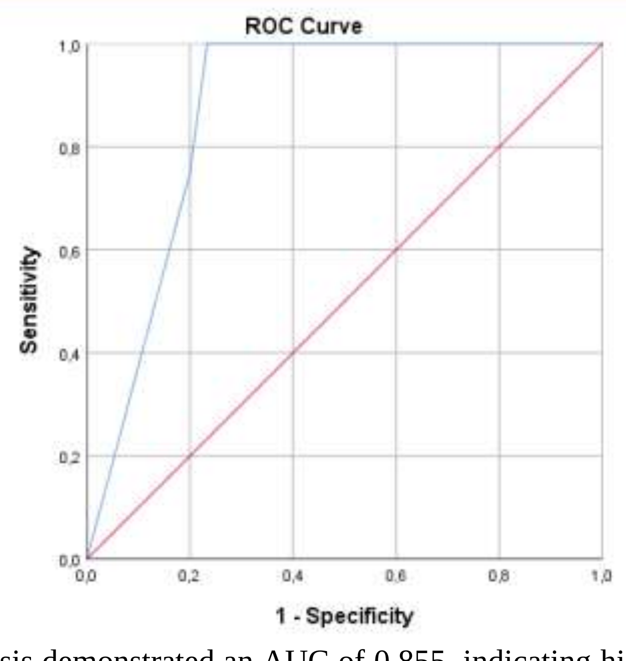
GCS Score Category	Mean MLS (mm) ± SD
14–15 (Alert)	1.04 ± 1.4
9–13 (Drowsy)	7.8 ± 4.6
6–8 (Stupor)	10.8 ± 5.0
3–5 (Coma)	11.6 ± 3.2

From these values, it is evident that as the level of consciousness declines, the degree of midline shift increases markedly. This provides clinical evidence that patients with lower GCS scores suffer from more severe brain displacement, likely due to increased intracranial pressure and mass effect from the hematoma. These findings are consistent with previous studies showing that MLS increases with hematoma volume and is associated with worse neurological function.

Table 3. Diagnostic Test for GCS Cut-Off ≤13 Predicting MLS >5 mm

Parameter	Value
Sensitivity (%)	100
Specificity (%)	79.3
Positive Predictive Value (%)	87
Negative Predictive Value (%)	85

Table 4. ROC Curve Coordinate Points for GCS Score



The ROC curve analysis demonstrated an AUC of 0.855, indicating high diagnostic accuracy of GCS in identifying patients with significant MLS. The perfect sensitivity (100%) suggests that all patients with MLS >5 mm had GCS scores ≤13, making it a safe lower-bound threshold for clinical decision-making. Although the specificity is lower (79.3%), this is acceptable in acute trauma settings where over-triage is preferred over under-triage. These results emphasize the potential utility of GCS in early triage decisions, especially in prehospital and rural settings. Clinicians could consider a GCS threshold of ≤13 as an indication for expedited imaging or neurosurgical consultation, even before CT is available. Given that 100% sensitivity was observed, this cut-off is especially useful in avoiding missed cases of severe MLS that could lead to rapid clinical deterioration if untreated. The results of this study strengthen the understanding that GCS is not merely a descriptive neurological score but also holds predictive value for identifying serious radiologic pathology such as MLS. This is important in clinical settings where immediate access to CT scanning is limited or delayed. The strong negative correlation between GCS and MLS found in our analysis is consistent with previous studies showing that deteriorating consciousness often mirrors increased intracranial mass effect (Chaurasia et al., 2021; Ross & Olsen, 1989).

From a surgical perspective, early recognition of MLS through clinical scoring may facilitate timely decompression, potentially preventing progression to irreversible brain herniation (Ross & Olsen, 1989). Furthermore, the high sensitivity of GCS ≤13 supports its use as a screening threshold for further imaging or neurosurgical consultation (Jacobs et al., 2011). In high-volume trauma centers, such criteria can help streamline patient prioritization and resource allocation. It is also worth noting that additional factors such as hematoma thickness and concurrent hemorrhages (e.g., subarachnoid hemorrhage) could influence MLS and clinical deterioration, reinforcing the need for holistic radiologic evaluation in conjunction with GCS (Bartels et al., 2015; Jacobs et al., 2011). Additionally, although our study focused on initial CT findings, future work should evaluate dynamic changes in MLS over time and their correlation with clinical trajectory and long-term outcomes (Kido et al., 1992).

Overall, this study affirms that GCS is not only a bedside neurologic assessment tool but also a valuable predictor for significant intracranial shifts. Incorporating it into structured trauma protocols can enhance early risk stratification, especially in settings where imaging capabilities are constrained. In addition to confirming previous findings, our study reinforces the practical application of the GCS in environments with limited access to advanced imaging modalities (Teasdale & Jennett, 1974). The strong inverse correlation between GCS and MLS provides further support for utilizing bedside neurologic evaluations as a triage tool (Chaurasia et al., 2021). This is especially relevant in rural or prehospital settings, where decision-making must often precede CT availability.

Furthermore, the high sensitivity of the GCS cut-off (≤13) for predicting MLS >5 mm indicates its safety for ruling in patients requiring urgent attention (Jacobs et al., 2011; Ross & Olsen, 1989). While some specificity is sacrificed, this tradeoff is acceptable in trauma care, where false negatives carry higher clinical risk than false positives (Ross & Olsen, 1989). Our findings also align with those of Bartels et al. and Jacobs et al., who demonstrated the prognostic implications of increasing MLS and SDH thickness (Bartels et al., 2015; Jacobs et al., 2011). Lastly, the importance of incorporating radiological progression over time is underscored. As shown by Kido et al., follow-up imaging can reveal evolving intracranial pathology that may not be clinically obvious at first presentation (Kido et al., 1992). Integrating serial imaging with dynamic neurologic assessments like GCS may enhance early detection of deterioration and improve outcomes through timely intervention.

CONCLUSION

GCS is a reliable clinical predictor of MLS in patients with acute traumatic SDH. A GCS score of ≤13 may serve as an early indicator for imaging and potential surgical intervention in resource-limited settings. This finding highlights the importance of integrating clinical evaluation with imaging modalities when managing patients with head trauma. In facilities where CT imaging is not immediately accessible, GCS can act as a valuable triage tool to prioritize care and expedite referrals. Future studies with larger and more diverse populations are needed to strengthen the external validity of these results and guide standardized clinical protocols.

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