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Correlation between Head Midline Shift CT-Scan with Glasgow Coma Scale in Head Injury Patient at Waled General Hospital, Cirebon, Indonesia

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ABSTRACT

Background: Findings on a head CT scan could use the midline shift (MLS) parameter to assess the severity of head injury. Midline shift was also known to serve as an indicator that was frequently associated with the Glasgow Coma Scale (GCS) in head injury patients. A greater degree of midline shift (> 5 mm) indicated a severe head injury that was significantly associated with a lower Glasgow Coma Scale score. The measurement could be performed quickly, although most of the findings that appeared when patients first arrived at the emergency department were generally mild.

Aims: This study aims to determine the correlation between midline shift on CT-Scan head and Glasgow coma scale in head injury patients at Waled General Hospital.

Methods: This research is analytical observational with a cross-sectional design. The total sampling technique took samples from the medical records of 38 patients out of 81 samples that had been excluded. The study was conducted at Waled General Hospital in June-July 2024 and analyzed using the Spearman correlation test.

Results: The results showed that most samples did not show a midline shift with 30 patients (78.9%) and had a GCS score of 13-15 with 22 patients (57.9%). A significant relationship exists between the midline shift on head CT-Scan with the GCS (p = 0.001, r = -0.770) in head injury patients at Waled General Hospital.

Conclusion: Most samples did not show a midline shift picture and had a GCS score of 13-15. There was a significant relationship between the midline shift on head CT scans and the GCS in head injury patients at Waled General Hospital. These findings had important implications in clinical practice, particularly in determining triage priorities, predicting the need for surgical intervention, and monitoring patients intensively.

Keywords: *Midline shift; Glasgow Coma Scale; Head injury; Traumatic brain injury.*
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1. Introduction

Head injury refers to damage occurring to the head that is not congenital or degenerative but is caused by external mechanical forces, such as impact or physical assault, either directly or indirectly. These injuries can impair consciousness and lead to cognitive, physical, and psychosocial dysfunction. According to the Centers for Disease Control and Prevention (CDC), the most common cause of head injury is falling (28%), followed by motor vehicle accidents (20%), impact from a hard object (19%), assault by another person (11%), and suicide attempts (1%) (CDC, 2023). According to the 2018 Basic Health Research (Riskesdas) data, the incidence of head injuries in Indonesia due to traffic accidents increased by 11.9%, with the highest number caused by motorcycle accidents (72.7%), particularly among young adults aged 15–24 years. In West Java, the incidence of head injuries was 12.3%, or 1,986 out of 16,150 cases. In Cirebon Regency, the number of traffic accidents reached 835 in 2022 (Kementrian Kesehatan Republik Indonesia, 2018). The classification of head injuries to assess symptoms and clinical signs is based on the severity of the injury, measured by the patient's level of consciousness using the Glasgow Coma Score (GCS). Initial assessment of patients with head injuries is crucial, and the GCS is one of the most frequently used methods due to its simplicity and speed. Monitoring the patient's consciousness is expected to aid in achieving better outcomes (Syarif et al., 2021). For head injuries, a CT scan is an accurate diagnostic tool for determining the location of lesions and can be performed quickly, although most initial findings in patients admitted to the emergency room are minor (Rogan, 2021).

The CT scan findings can be evaluated using the midline shift (MLS) parameter to assess the severity of the head injury. Midline shift is also known to be an indicator of increased intracranial pressure, brain edema, and brainstem injury, which are strongly correlated with the GCS in patients with head injuries.(Abdelaziz, 2021)

Brain midline shift is a crucial diagnostic marker for evaluating the severity of brain compression due to various pathologies. In intracranial pathology examinations, the brain midline shift is an essential diagnostic feature for assessing the extent of brain compression caused by different conditions. Midline shift is significant in predicting a patient's likelihood of survival and is used to measure brain symmetry changes, making it an essential indicator of the severity of the condition (Qasim, 2021).

The study conducted (Chaurasia A K. Gaur R. et.al, 2021) found that out of a total of 150 head injury patients, 115 showed no midline shift, while 35 showed the presence of a midline shift. The results of the study indicated that patients with severe head injuries (GCS 3–8) had higher mortality and morbidity rates, while those with moderate head injuries (GCS 9–13) were associated with better prognoses and lower mortality. A greater degree of midline shift (> 5 mm) indicated a severe head injury that was significantly associated with high mortality.

Although various previous studies had investigated the relationship between midline shift on head CT scans and Glasgow Coma Scale (GCS) scores as indicators of head injury severity, the results were not entirely consistent. Some studies, such as those conducted by (Abdelaziz, I., & Aljondi, 2021) and (Sah et al, 2014), showed a strong and significant correlation between midline shift and decreased patient consciousness. In contrast, other studies, such as the one reported by (Khambhati U, Shah R, Solanki V, Matadar H, 2020), found a weak or insignificant correlation, particularly in cases of diffuse brain injury that did not cause a displacement of the brain’s midline structures.

In addition, the study by (Tantowijaya B, 2025) showed a significant correlation between the types of intracranial bleeding lesions and the level of consciousness, as assessed by the Glasgow Coma Scale (GCS). These findings reinforced the importance of early radiological evaluation, not only in identifying the type of lesion but also in estimating the clinical severity of head injury patients.

That was the reason the researchers became interested in conducting further studies on the relevant population regarding the Correlation Between Midline Shift on Head CT Scans and the Glasgow Coma Scale in Head Injury Patients at Waled General Hospital, Cirebon, Indonesia.

2. Methods

Study design/Research procedures

This study employs an observational analytic research method with a cross-sectional approach to assess the correlation between CT scan midline shift findings and the Glasgow Coma Scale in head injury patients at Waled General Hospital in 2022. This study has received ethical approval from the Faculty of Medicine Ethics Committee, Universitas Swadaya Gunung Jati, and was subsequently approved by the National Unity and Political Agency (KESBANGPOL) of Cirebon Regency.

Population and samples

The population of this study consists of head injury patients who underwent head CT scans at Waled General Hospital, Cirebon Regency, in 2022. The sample was selected using inclusion criteria, consisting of patients aged 18 years or older who were diagnosed with a head injury at Waled General Hospital in 2022, head injury patients who underwent CT scan examinations, and those with documented Glasgow Coma Scale (GCS) assessments. The exclusion criteria include patients under 18 years old and those with a history of neurological deficits not caused by trauma, such as non-hemorrhagic stroke, hemorrhagic stroke, and brain tumors. The total number of samples obtained using the total sampling method from the overall data in 2022 was 81 samples, and after applying the exclusion criteria, it was reduced to 38 samples.

Measurements

Radiological data collection was based on the results of head CT scans attached to medical records or data from the radiology department, which had been interpreted by a radiology specialist, indicating the presence or absence of a midline shift. Meanwhile, the Glasgow Coma Scale (GCS) was obtained from the examination data of head injury patients at Waled General Hospital in 2022.

Statistical techniques

Data was collected through the medical records of head injury patients at Waled General Hospital in 2022. The radiological data were based on the results of the head CT scan examinations, as documented in the medical records or from the radiology department and interpreted by a radiologist. These results indicate the presence or absence of a midline shift. The data in this study were analyzed using computer-based statistical software. Data analysis was conducted through univariate and bivariate analysis, using SPSS version 26.

Data Analysis

The analysis presented involves the Spearman correlation test using statistical software. The data analysis includes univariate and bivariate tests. Univariate analysis was performed to describe the frequency distribution of the respondents, the independent variable (midline shift on head CT scans of patients with head injuries), and the dependent variable (Glasgow Coma Scale). Bivariate analysis was performed to assess the relationship between the independent and dependent variables. In this bivariate analysis, the Spearman correlation test was used, as the operational definitions of both the independent and dependent variables were categorical data, The data were ordinal in scale or not normally distributed and the analysis was conducted using a computer program.

Ethical Clearance

This research was conducted in accordance with the research procedures, after obtaining a research permit granted following the thesis proposal examination and ethical review by the Health Research Ethics Committee of Waled Regional General Hospital, with the number 000.9.2/053/KEPK/2024.

3. Results

The data in this study consists of secondary data obtained from medical records and CT scan results of head injury patients at Waled General Hospital in 2022, using a cross-sectional approach. A total of 81 samples were collected through the total sampling method, and after applying exclusion criteria, the sample size was reduced to 38. The sample consists of head injury patients aged over 18 years who underwent a CT scan at Waled General Hospital in 2022.

Table 1. Demographic, Clinical, and Radiological Characteristics of Head Injury Patients at Waled General Hospital in 2022

Age	**n**	**%**
Adults (19-59 years old)	27	71.1
Elderly (> 59 years old)	11	28.9
Gender		
Male	24	63.2
Female	14	36.8
Severity Stages		
Mild Head Injury	22	57.9
Moderate Head Injury	9	23.7
Severe Head Injury	7	18.4
Diagnosis		
EDH (Epidural Hematoma)	10	26.3
SDH (Subdural Hematoma)	14	36.8
SAH (Subarachnoid Hemorrhage)	5	13.2
Contusio Cerebri	3	7.9
Edema Cerebri	4	10.5
ICH (Intracerebral Hemorrhage)	2	5.3
Midline Shift Findings		
Yes	8	21.1
No	30	78.9
GCS		
GCS 3-8	7	18.4
GCS 9-12	9	23.7
GCS 13-15	22	57.9
Total	38	100

A total of 38 head injury patients were included in the study after applying the inclusion and exclusion criteria. Most participants (71.1%) were adults aged 19–59 years, while the remaining 28.9% were elderly (>59 years), indicating that the incidence of head trauma was higher among the productive age group. Male patients dominated the sample with 63.2%, which was consistent with global patterns showing that men were more frequently involved in high-risk activities leading to trauma.

Regarding the severity of head injury as assessed by the Glasgow Coma Scale (GCS), the majority of patients presented with mild head injury (GCS 13–15), accounting for 57.9%, followed by moderate (23.7%) and severe cases (18.4%). This was in line with existing data suggesting that a large proportion of head injury cases in emergency rooms were classified as mild.

In terms of diagnosis, the most common lesion found was subdural hematoma (36.8%), followed by epidural hematoma (26.3%) and subarachnoid hemorrhage (13.2%). The remaining cases included cerebral contusions, cerebral edema, and intracerebral hemorrhage. This suggested a diverse spectrum of intracranial pathologies within the cohort, requiring individualized management approaches.

When midline shift was evaluated as a radiological indicator of intracranial pressure and mass effect, only 21.1% of patients exhibited this finding, while the vast majority (78.9%) did not. This correlated with the predominance of mild cases in the sample. Conversely, severe GCS scores (3–8) were mostly observed in patients with midline shift (87.5%), highlighting the strong inverse relationship between anatomical displacement and the level of consciousness. These distributions established a clear clinical picture: head injuries were more prevalent in adults, particularly males; most cases were mild in severity and did not involve midline shift; however, the presence of midline shift strongly corresponded to lower GCS scores and likely indicated a greater need for urgent intervention.

Bivariate Analysis

Bivariate analysis was performed to evaluate the relationship between the independent variable and the dependent variable, as well as the strength and direction of the relationship. In this study, bivariate analysis was conducted using the Spearman correlation test.

Table 2. Correlation Analysis Between Midline Shift on Head CT Scan and Glasgow Coma Scale (GCS)

		Glasgow Coma Scale (GCS)						Total		p	r
		GCS 3-8		GCS 9-12		GCS 13-15					
		n	%	n	%	n	%	n	%		
Midline Shift	**Yes**	7	87.5	1	12.5	0	0	8	21.1	0.000*	-0.770
	No	0	0	8	26.7	22	73.3	30	78.9		
	Total	7	18.4	9	23.7	22	57.9	38	100		

Notes: n = frequency, % = percentage

* = Spearman Correlation Test

Based on the bivariate analysis using the Spearman correlation test, a correlation coefficient of 0.770 was obtained, with a p-value <0.001, indicating a strong correlation between the two variables. These results also suggest that patients with midline shifts tend to have lower GCS scores. As shown in Table 7, among patients with GCS scores of 3-8, 7 (87.5%) exhibited midline shift, while none (0.0%) without midline shift were in this GCS range. For patients with GCS scores of 9-12, 1 patient (12.5%) had a midline shift, while 8 patients (26.7%) did not. Lastly, none of the patients with GCS scores of 13-15 showed midline shift, while the remaining 22 patients (73.3%) without midline shift were in this GCS range. To assess the precision of the correlation coefficient, a 95% confidence interval (CI) was calculated. The results showed that the 95% confidence interval for the correlation coefficient ranged from -0.874 to -0.597.

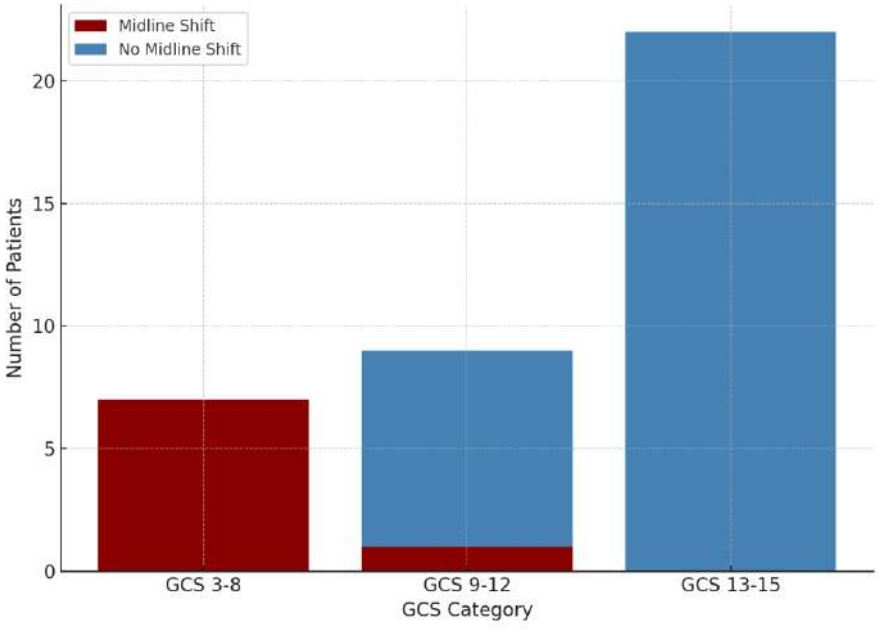

Figure 1. Distribution of Midline Shift by GCS Category

4. Discussion

Based on the analysis results on the midline shift CT scan variable in head injury patients, it was found that most of the samples did not exhibit midline shift, accounting for 78.9%. Head CT scan results showing midline shift were observed in 21.1% of head injury patients. Similar results were obtained in a study conducted by Palekar et al., where out of 83 patients with favorable outcomes, a midline shift >5 mm on CT scan was found in only 11 cases (13.25%), and in the poor outcome group of 25 patients, 7 (28%) experienced a midline shift >5 mm, while the remaining 52 did not have a midline shift (Palekar et al., 2021).

From the analysis of the Glasgow Coma Scale (GCS) variable, it was found that most patients had a GCS score of 13-15, accounting for 57.9%, followed by patients with a GCS of 9-12 at 23.7%, and those with a GCS of 3-8 at 18.4%. These findings are consistent with a study by Sah SK et al., where 54% of head injury cases were mild (GCS 13-15), 28% were moderate (GCS 9-12), and 18% were severe (GCS 3-8) (Sah et al., 2014). The difference could be attributed to the fact that the most common clinical definition of mild head injury, GCS 13-15, is used by over 60% of neurotrauma centers worldwide, while earlier studies used GCS 14-15 or GCS 15 alone as the definition for mild head injury. This could be because patients with a GCS of 13 may have more severe injuries compared to other mild traumatic injury groups (GCS 13-15) (Magnusson et al., 2020).

The analysis of the midline shift variable with the Glasgow Coma Scale (GCS) showed a significant correlation with a correlation coefficient (r) of -0.770 and a Spearman Rho significance value of $p < 0.001$. The correlation value of -0.770 indicates a strong negative correlation. Therefore, the hypothesis is accepted, as a significant correlation exists between midline shift on head CT scan and GCS, with a p-value < 0.001. The negative correlation implies that patients with midline shift tend to have lower GCS scores. This finding aligns with the study by Sah SK et al., which demonstrated that mixed lesions and midline shift, regardless of lesion background, were significantly associated with lower GCS scores. The more severe the head injury, the lower the GCS score, with a p-value < 0.001. The average GCS for multiple lesions and cases with midline shift (mean ± SD 6.22 ± 1.202) was also statistically significant (p-value < 0.001). Analyzing lesion types concerning GCS scores, it was found that (a) multiple lesions had lower GCS scores than single lesions and (b) multiple lesions with midline shift had lower GCS scores than single lesions or multiple lesions without midline shift (Sah et al., 2014).

In the context of triage in the emergency department, information regarding the presence of a midline shift from head CT scan results was used as a radiological indicator to support the prioritization of patient management. Patients with a midline shift and low GCS were at risk of rapid neurological deterioration and therefore required intensive monitoring, early stabilization, and prompt surgical evaluation. Thus, the combination of GCS scores and radiological findings such as midline shift enhanced the accuracy of risk stratification and triage decision-making (Abdelaziz, I., & Aljondi, 2021).

Additionally, this correlation was also used as a supporting tool to estimate the need for decompressive surgical interventions, such as craniotomy or craniectomy. Several studies showed that a midline shift greater than 5 mm was significantly associated with increased intracranial pressure and the presence of an intracranial mass that could lead to brain herniation if not promptly managed(Palekar, S. G., Jaiswal, M., Patil, M., & Malpathak, 2021). A low GCS score, when combined with a midline shift, served as a more accurate indicator in determining the urgency of surgical intervention.

Thus, the integration of clinical findings (GCS) and radiological findings (midline shift) held strategic value in the evidence-based clinical decision-making process, both during the initial diagnostic phase and in planning definitive therapy. This was also in line with recommendations from modern neurotrauma practice guidelines, which emphasized the importance of multimodal evaluation in the management of traumatic brain injuries.

Although there was a strong negative correlation between midline shift and GCS, some patients in this study exhibited low GCS scores despite the absence of a midline shift. This suggested the presence of alternative mechanisms or confounding factors that could affect the level of consciousness. One possible explanation was the presence of diffuse brain injuries such as diffuse axonal injury (DAI), which did not always cause a shift in midline structures but could lead to significant impairment of consciousness. In addition, global cerebral edema, diffuse subarachnoid hemorrhage, or cerebral hypoxia could also result in decreased GCS without producing a

detectable midline shift on CT scans(Abdelaziz, I., & Aljondi, 2021).

The study by (Khambhati U, Shah R, Solanki V, Matadar H, 2020) found that not all patients with low GCS exhibited a midline shift, and that some patients with mild midline shift still maintained good consciousness. The study concluded that midline shift alone was not sufficient to predict the level of consciousness without considering other factors such as lesion size, location, and brainstem involvement. These differing results could have been due to variations in study design, GCS measurement methods, timing of radiological assessments, or heterogeneity of the patient population. Therefore, although the findings in this study supported a relationship between midline shift and GCS, interpretation needed to be made with caution, taking into account that other parameters also played a role in determining the neurological status of the patient.

The results of this study supported the findings of (Tantowijaya B, 2025), who, in his study at Gunung Jati Regional Hospital, Cirebon, reported a correlation between the types of brain hemorrhage and GCS scores in head injury patients. In his study, subdural hematomas and intracerebral hemorrhages were more closely associated with significantly reduced levels of consciousness compared to other types of bleeding. These findings were consistent with ours, in which patients with certain lesions, especially those causing midline shift, had lower GCS scores, indicating a heavier lesion burden and higher clinical risk.

The limitations of this study include insufficient investigation into the degree of midline shift affecting GCS. Many data points were excluded, resulting in a limited sample size. The study was delayed due to the completion of research administration, which caused a delay in data collection. The research location was also quite far, which shortened the data collection period due to limited working hours. Inter observer reliability assessment was not conducted in the interpretation of head CT scan results. All radiological interpretations were based on a single report without independent verification by another radiologist, allowing for potential subjectivity in the assessment of midline shift. This study did not involve prospective validation, so the relationship found between midline shift and Glasgow Coma Scale (GCS) scores was merely correlational and based on retrospective data. This design limited the ability to draw causal conclusions and to systematically control for confounding factors. There was also a possibility of selection bias, as several patients were excluded from the analysis due to not meeting the inclusion criteria or having incomplete data. This may have led to limited sample representativeness and reduced the generalizability of the findings to the broader population of patients with head injury.

The authors recommended that healthcare facilities adopt an integrative approach combining radiological data with clinical assessment, such as incorporating both GCS scores and midline shift findings into initial assessment algorithms for head injury patients. Additionally, the implementation of emergency radiology training including midline shift evaluation as a core clinical competency in emergency units was suggested.

5. Conclusion

The conclusion drawn is that an increase in the degree of midline shift on head CT scans in patients with mass lesions following head trauma is significantly associated with the severity of head injury (GCS = 3-12) and ultimately results in poorer clinical outcomes. Further correlation between CT scan findings and GCS is necessary to predict the severity of head injury and patient outcomes more accurately, rather than treating the two parameters as separate factors. Clinically, these findings had important implications for triage practices and the initial management of head injury patients, particularly in the emergency department. Early identification of midline shift through head CT scans could be used as an additional indicator to expedite decision-making, such as initiating intensive monitoring, referring to neurotrauma facilities, or considering decompressive surgical intervention. Therefore, these results supported the development of evidence-based clinical protocols for managing head injury patients.

Recommendation

For future researchers, it was recommended that further studies be conducted to investigate the degree of midline shift and its relationship with the Glasgow Coma Scale (GCS) or other relevant variables, such as radiographic findings on head CT scans, the number of lesions, or the need for surgical intervention. The timing of the study was also suggested to be reconsidered to enable more effective data collection. The public was encouraged to be more aware and vigilant about the dangers of head injuries, their association with decreased levels of consciousness, and the long-term effects that might occur. Educational institutions were encouraged to use the findings as additional teaching material for medical education, focusing on the characteristics of midline shift on head CT scans and the assessment of the Glasgow Coma Scale (GCS) in head injury patients. This was intended to serve as a learning resource for medical students and other healthcare professionals to help guide clinical decision-making in patient care.

Conflict of Interest

The authors are grateful to the Universitas Swadaya Gunung Jati 2025 Internal Research Fund for funding this study.

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