CT-Scan In Mild Traumatic Brain Injury: Are We Over-Imaging: A Retrospective Study At A Hospital In Aceh

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Article Info
Article History:
Received: 7 August 2025
Revised: 15 August 2025
Accepted: 30 August 2025

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DOI : https://doi.org/10.37362/chc.v9i2.543

P- ISSN : 2722-1563
E -ISSN : 2580-7137

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ABSTRACT

Mild Traumatic Brain Injury (mTBI) constitute most traumatic brain injury cases. Although mTBI are not commonly life-threatening, they can cause diverse physical, emotional, and cognitive symptoms lasting from several days to months. A CT scan is deemed necessary for patients with mTBI if clinical conditions worsen, there is suspicion of a fracture, or there are signs of lateralization. The objective of this study is to evaluate the need for CT scan in patients with mTBI at a hospital in Aceh Province. This research is a descriptive study with a retrospective design. The study included 143 respondents. Data collection was conducted by reviewing the medical records of patients with mTBI using a checklist form that included demographic and clinical data. The data analysis used was univariate analysis, which produces distributions, frequencies, and percentages. The results of the study show that 84 respondents (58.7%) had no abnormalities, 13 respondents (9.1%) showed multiple lesion images, 12 respondents (8.4%) had scalp hematoma images, 9 respondents (6.3%) had EDH images, 7 respondents (4.9%) had SDH images, 7 respondents (4.9%) had SAH images, 7 respondents (4.9%) had ICH images, and 4 respondents (2.8%) had skull fracture images. Most CT scan findings in patients with mTBI at dr. Zainoel Abidin General Hospital in Banda Aceh were normal or negative (58.7%). The screening process for patients with mTBI must be conducted accurately and promptly according to indication criteria, thereby reducing unnecessary CT scan.

Keywords: CT-Scan; Mild traumatic; Brain injury

INTRODUCTION

Mild Traumatic Brain Injury (mTBI) is one of the most common brain injuries and develops when an external force, such as a blow, bump, or jolt to the head, causes rapid brain movement and functional disturbance (Katz, Cohen, & Alexander, 2015). Although mTBI are usually not life-threatening, they can cause a variety of physical, emotional, and cognitive symptoms lasting from several days to months (Fikriyanti, Kitrungrote, & Songwathana, 2021; Gaddam, Buell, & Robertson, 2015). mTBI accounts for the majority (almost 80%) of brain injury cases (Fadzil, Mei, Khairy, Kumar, & Azli, 2022). It may lead to various symptoms, including headache, nausea and vomiting, memory disturbances, vertigo, or insomnia. Therefore, the condition may not be truly "mild" for some patients, despite what the term implies. mTBI is defined by a Glasgow Coma Scale (GCS) score of 13–15 (American College of Surgeons [ACS], 2018; Taweesomboonyat, Kaewborisutsakul, Tunthanathip, Saeheng, & Oearsakul, 2020).

According to the Canadian CT Head Rule (CCHR), patients with mTBI are stratified into high, medium, and low risk levels. The criteria for high risk include a GCS score less than 15 two hours post injury, clinically suspected open or depressed skull fracture, signs of basilar skull fracture (such as hemotympanum, cerebrospinal fluid, raccoon eyes, rhinorrhea or otorrhea, and Battle's sign), repeated vomiting (more than two times) and age over 65 years. The criteria for medium risk include a GCS of 15, brief loss of consciousness (LOC), post-traumatic amnesia, vomiting, and headache. Low-risk criteria are characterized by the absence of symptoms at presentation, without other injury findings or focal neurological deficits, no alteration in LOC, normal pupils and memory, GCS of 15, comprehensive trauma history, mild mechanism of injury, injury within the past 24 hours, and no headache or only mild headache, no vomiting, and no high-risk factors (Molaei-Langroudi, et al., 2019).

Approximately 6% to 10% of patients with mTBI show abnormalities on brain imaging, such as intracranial hemorrhage (Wintermark, et al., 2015). In another study, 38 patients (33.9%) with mTBI were found to have abnormal or positive CT-scan results (Nugraha, et al., 2024). mTBI is often underestimated, leading to missed or delayed diagnostic imaging. A CT scan is considered necessary in patients with mild traumatic brain injury if there is clinical deterioration, suspected skull fracture, or signs of neurological lateralization (Fiddiyanti, Trimurtini, & Ghana, 2020).

Computed tomography (CT) is a commonly used diagnostic tool when neurological dysfunction is suspected (Burns, 2014). It helps detect abnormalities associated with head trauma, including skull fractures, hemorrhages, and increased intracranial pressure. Hemorrhagic findings on brain CT may include epidural hematoma (EDH), intracerebral hemorrhage (ICH), subdural hematoma (SDH), intraventricular hemorrhage (IVH), and subarachnoid hemorrhage (SAH) (American College of Surgeons [ACS], 2018; Hidayati, Akbar, & Rosyid, 2018). Based on the considerations above, this study aims to evaluate the utilization for CT scan in patients with mTBI at a General Hospital, Banda Aceh, Indonesia.

MATERIAL AND METHODS

This study used a descriptive research design with a retrospective approach, performed at dr. Zainoel Abidin General Hospital, Banda Aceh, during the period January to October 2024. The study population included all patients with mild traumatic brain injury (mTBI) who presented to the Emergency Department (ED) during the study period. Sampling was performed using purposive sampling according to the following inclusion criteria: (1) patients with head injury who underwent CT-Scan; (2) patients with complete medical records; and (3) patients diagnosed with mild traumatic brain injury (mTBI) determined by a Glasgow Coma Scale (GCS) score of 13–15. From a total of 666 patients who underwent CT-Scan, 193 were identified as head injury patients. Of these, 143 met all inclusion criteria as mTBI cases and were included as the final sample for analysis.

Data were collected through a review of medical records of head injury patients at the ED. Prior to data collection, the researchers obtained permission from various parties, including the ethics committee, faculty dean, and the head of the relevant department. The instrument used was a structured checklist form developed by the researchers, which included two main sections: (1) demographic data (age, gender, education, occupation, cause of injury, and severity based on GCS) and (2) clinical data (CT-Scan findings and characteristics). Data collection was assisted by two trained enumerators who had received explanation of the research procedures. To ensure accuracy, cross-checking was performed between the researchers and enumerators, and completeness of data was verified after entry.

This study obtained ethical permission from the Research Ethics Committee of dr. Zainoel Abidin General Hospital. The conduct of the study followed the CIOMS 2016 guidelines and the seven WHO (2011) standards for health research ethics, consisting of social/clinical value, equitable participant selection, research validity, favorable risk–benefit ratio, independent evaluation, informed consent, and participant dignity. Since the research used secondary data from medical records, informed consent was obtained in the form of official permission from the head of the ward and hospital authorities using a confirmation form. Patient confidentiality was protected by anonymizing data and using codes instead of personal identifiers. All data were used solely for scientific purposes without causing harm to patients.

RESULTS

Table 1 shows that the average age of patients with mTBI was 28.1 years, the ages ranging from 1 to 91 years. The 95% confidence interval (CI) for the mean age was between 25.0 and 31.2 years. Although the standard deviation and CI are relatively wide, this is acceptable in the context of a descriptive study. It reflects the natural variability in age among mTBI patients and supports the generalizability of the findings to diverse clinical populations.

Table 1. Age Distribution of Patients with mTBI (N = 143)

Variable	Mean	SD	Min	Max	95% CI	
					Low	Upp
Age (years)	28.1	18.7	1	91	25	31.2

Table 2 shows that the majority of patients with mTBI were male (55.2%). Most had senior high school education (46.2%), and the most common occupation was student (42.7%). The leading cause of injury was traffic accidents (51.0%), followed by falls (44.1%). Regarding severity, most patients (58.7%) had a GCS score of 15.

Table 2. Distribution of Patients by Gender, Education Level, Occupation, Cause of Injury, and injury Severity (N = 143)

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	79	55.2
Female	64	44.8
Education Level		
No formal education	12	8.4
Elementary school	23	16.1
Junior high school	16	11.2
Senior high school	66	46.2
Higher education	26	18.2
Occupation		
Unemployed	20	14
Student	61	42.7
Civil servant/military/police	13	9.1
Entrepreneur	11	7.7
Private employee	10	7.0
Housewife	14	9.8
Farmer	8	5.6
Others	6	4.2
Cause of Injury		
Traffic accident	74	51
Fall	63	44.1
Hit by object	2	1.4
Sports injury	3	2.1
Physical assault	1	0.7
Injury Severity (GCS)		
GCS 13	22	15.4
GCS 14	37	25.9
GCS 15	84	58.7

As shown in Table 3, 84 patients (58.7%) had normal CT scan results, indicating no detectable intracranial abnormalities. This suggests that most patients with mTBI did not exhibit structural damage visible on imaging. Among those with abnormal findings, the most common was multiple lesions (9.1%). Other abnormal findings included scalp hematoma (8.4%), EDH (6.3%), and individual hemorrhages such as SDH, SAH, and ICH, each accounting for 4.9% of cases. The least frequent abnormality was skull fracture, found in 4 patients (2.8%).

Table 3. CT Scan Findings among Patients with mTBI (N = 143)

CT Scan Findings	Frequency (n)	Percentage (%)
No abnormality detected	84	58.7
Skull fracture	4	2.8
Scalp hematoma	12	8.4
Subdural hematoma (SDH)	7	4.9
Subarachnoid hemorrhage (SAH)	7	4.9
Intracerebral hemorrhage (ICH)	7	4.9
Epidural hematoma (EDH)	9	6.3
Multiple lesions	13	9.1

DISCUSSION

The findings of this study show that the everage age of patients with mTBI was 28.1 years, the age range of 1 to 91 years and a 95% confidence interval (CI) of 25.0–31.2 years. Although the standard deviation and CI appear relatively wide, this is appropriate in a descriptive study, as it reflects the natural variation in the population. The wide age distribution demonstrates the broad demographic profile of patients presenting with mTBI and enhances the external validity and generalizability of the results to real-world settings. This is consistent with previous studies conducted in Papua New Guinea, where the majority of patients with head injuries were between the ages of 18 and 40—an age group generally considered to be productive and active, with higher exposure to injury risk due to outdoor activity and motor vehicle use (Chen, et al., 2023).

As shown in Table 2, most patients with mTBI were male (55.2%), which aligns with previous literature indicating a higher prevalence of traumatic brain injury in males. Biological differences, such as the presence of neuroprotective hormones like estrogen and progesterone in females, as well as anti-inflammatory and antioxidant mechanisms, may contribute to a lower incidence and better prognosis in female patients (Ma, et al., 2019).

In terms of education level, the majority of patients (46.2%) had completed senior high school, a pattern also observed in a Malaysian study where most road traffic accident victims with head trauma had secondary education (Teh, et al., 2023). This suggests a potential link between educational background and risk behaviors associated with injury, such as traffic violations or lack of safety awareness. Regarding occupation, students were the largest group affected (42.7%). This is likely due to their age group being part of the young, mobile population, with frequent travel to and from school or university, and increased exposure to environmental risk factors. This supports the idea that young adults represent a high-risk demographic for mTBI. The leading cause of injury was traffic accidents (51%), followed by falls (44.1%), consistent with national and regional data showing road traffic incidents as a primary source of head trauma (Kemenkes RI, 2019). Factors such as non-compliance with traffic rules, high-speed driving, lack of pedestrian infrastructure, and limited helmet use may contribute to these findings.

CT scan remains the gold standard for imaging in head injury cases due to its non-invasive nature, high accuracy, and ability to detect structural brain abnormalities (Satyanegara, 2013). As shown in Table 3, most CT scans were normal (58.7%), indicating that most mTBI patients did not have radiologically evident lesions. Among those with abnormal findings, the most common was multiple lesions (9.1%), involving combinations of ICH, EDH, IVH, SAH, and/or SDH. The least common finding was skull fracture (2.8%).

These results are consistent with a study conducted at Zagazig University Hospital in Egypt, where 90.7% of patients with mTBI had normal CT scans (Saied, et al., 2020). While the high proportion of negative scans could be interpreted as overutilization, it also reinforces the need for selective CT scanning guided by validated criteria e.g., the Canadian CT Head Rule (CCHR). Unnecessary CT imaging involves exposure to ionizing radiation and is associated with increased healthcare expenditure, while providing limited diagnostic benefit in low-risk cases (Salehi, et al., 2020). Radiation absorption from CT scans carries both deterministic and stochastic risks, including skin damage, cataracts, and increased lifetime risk of cancer or genetic effects (Maleachi & Tjakraatmadja, 2018). Thus, reducing unnecessary scans is not only cost-effective but also critical for long-term patient safety.

In practice, high-risk patients (e.g., those with seizures, focal neurological deficits, or GCS < 15) should undergo prompt CT imaging. Conversely, low-risk patients (e.g., GCS 15 with no additional symptoms) may not require immediate imaging. Moderate-risk patients, showing one or more clinical symptoms based on CCHR, warrant careful evaluation (Aramvanitch, et al., 2018). Additionally, comorbidities, such as hypertension, may worsen outcomes in mTBI by increasing the risk of hemorrhage due to small vessel fragility, especially in the first 6 hours post-injury (Yuksen, et al., 2017).

In summary, clinical decision-making regarding CT scan utilization in mTBI patients should be guided by validated criteria and an individualized assessment of patient risk factors, clinical symptoms, cost considerations, and potential radiation exposure. While the majority of patients in this study had normal CT scan results, a notable proportion exhibited significant findings, underscoring the importance of appropriate screening. Patients without clinical indicators or with only a single minor risk factor may be considered for discharge without imaging, provided that proper observation is ensured. However, this study is not without limitations. Its retrospective nature, single-center scope, potential variability in clinical judgment, and lack of follow-up data may limit the generalizability and depth of interpretation. These limitations should be addressed in future prospective, multicenter studies with standardized protocols and outcome tracking to strengthen the evidence base for CT scan utilization in mTBI.

CONCLUSION

The findings of this study show that most mTBI patients at a hospital in Aceh Province had normal or negative CT scan results (58.7%). Nonetheless, a considerable proportion of patients exhibited abnormal findings, including multiple lesions and various types of intracranial hemorrhage. These results emphasize the importance of implementing accurate and timely screening based on established clinical criteria to ensure appropriate use of CT imaging. Selective imaging not only improves diagnostic accuracy but also helps minimize unnecessary radiation exposure and healthcare costs.

It is recommended that future research focus on developing and evaluating the effectiveness of educational interventions for medical personnel regarding indications and clinical guidelines for CT scan use in mTBI. Additionally, further studies employing prospective, multicenter designs with standardized protocols and long-term follow-up are needed to enhance the evidence base and support more consistent decision-making in the management of mTBI patients.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the hospital for providing access to medical record data used in this study. We also thank the Nursing Faculty, Syiah Kuala University, for the scholarly support throughout the research process. Special appreciation is extended to the medical record staff and emergency department personnel for their assistance during data collection.

REFERENCES

American College of Surgeons (ACS). (2018). *Advanced trauma life support (ATLS)* (10th ed.). American College of Surgeons.

Aramvanitch, K., Muengtaweepongsa, S., Supamas, A., Sittichanbuncha, Y., Patumanond, J., & Sawanyawisuth, K. (2023). Age-appropriateness of decision for brain CT scan in elderly patients with mild traumatic brain injury. *World Journal of Emergency Medicine*, *14*(3), 144–148.

Burns, S. M. (2014). *AACN essentials of critical care nursing* (3rd ed.). McGraw-Hill Education.

Chen, P., Deng, Y., Yu, X., Huan, T., & Huang, J. (2023). Retracted: Analysis of clinical characteristics and prognosis of traumatic brain injury in Papua New Guinea. *Computational and Mathematical Methods in Medicine*, *2023*(1).

Fadzil, F., Mei, A. K. C., Mohd Khairy, A., Kumar, R., & Mohd Azli, A. N. (2022). Value of repeat CT brain in mild traumatic brain injury patients with high risk of intracerebral hemorrhage progression. *International Journal of Environmental Research and Public Health*, *19*(21), 1–12.

Fiddiyanti, I., Trimurtini, I., & Ghana, A. T. (2020). Korelasi CT-scan kepala dengan Glasgow Coma Scale (GCS) 13–15 pada pasien cedera kepala ringan di Rumah Sakit Dustira Cimahi. *Medika Kartika: Jurnal Kedokteran dan Kesehatan*, *3*(2), 113–125.

Fikriyanti., Kitrungrote, L., & Songwathana, P. (2021). Manajemen gejala pasca gegar otak pada pasien cedera kepala ringan di Aceh. *Jurnal Ilmu Keperawatan*, *9*(1)

Gaddam, S. S. K., Buell, T., & Robertson, C. S. (2015). Systemic manifestations of traumatic brain injury. In D. I. Katz, S. I. Cohen, & M. P. Alexander (Eds.), *Handbook of Clinical Neurology* (Vol. 127, pp. 205–218). Elsevier.

Hidayati, N. A., Akbar, M. I. A., & Rosyid, A. N. (2018). *Gawat darurat medis dan bedah*. Airlangga University Press.

Katz, D. I., Cohen, S. I., & Alexander, M. P. (2015). Mild traumatic brain injury. In D. I. Katz, S. I. Cohen, & M. P. Alexander (Eds.), *Handbook of Clinical Neurology* (Vol. 127, pp. 131–156). Elsevier.

Kementerian Kesehatan Republik Indonesia. (2019). *Laporan nasional RISKESDAS 2018*. Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan.

Ma, C., Wu, X., Shen, X., Yang, Y., Chen, Z., Sun, X., & Wang, Z. (2019). Sex differences in traumatic brain injury: A multi-dimensional exploration in genes, hormones, cells, individuals, and society. *Chinese Neurosurgical Journal*, *5*, 1–9.

Maleachi, R., & Tjakraatmadja, R. (2018). Pencegahan efek radiasi pada pencitraan radiologi. *CDK*, *45*(7), 537–539.

Molaei-Langroudi, R., Alizadeh, A., Kazemnejad-Leili, E., Monsef-Kasmaie, V., & Moshirian, S. Y. (2019). Evaluation of clinical criteria for performing brain CT-scan in patients with mild traumatic brain injury: A new diagnostic probe. *Bulletin of Emergency and Trauma*, *7*(3), 269–277.

Nugraha, E. W., Tumboimbela, M. J., Ngantung, D. J., Wariki, W. M. V., Tumewah, R., & Warouw, F. (2024). Indicators of abnormal CT scan findings in clinically mild traumatic brain injury patients. *Neurology Asia*, *29*(1), 207–213.

Salehi, Z. S., Rafiei, H., Torabi, F., Salehi, A., & Rezaei, B. (2020). Evaluation of causes of brain CT scan in patients with minor trauma. *International Journal of Surgery Open*, *27*, 220–224.

Saied, S., Metwali, A., Taha, M., & Elsharkawi, A. (2020). Mild head injury patients: Correlation between admission computed tomography brain scan and outcome. *Zagazig University Medical Journal*, *28*(2), 174–180.

Satyanegara. (2013). *Ilmu bedah syaraf* (4th ed.). Gramedia Pustaka Utama.

Taweesomboonyat, C., Kaewborisutsakul, A., Tunthanathip, T., Saeheng, S., & Oearsakul, T. (2020). Necessity of in-hospital neurological observation for mild traumatic brain injury patients with negative computed tomography brain scans. *Journal of Health Science and Medical Research*, *38*(4), 267–274.

Teh, J., Mazlan, M., Danaee, M., Waran, R. J., & Waran, V. (2023). Outcome of 1939 traumatic brain injury patients from road traffic accidents: Findings from specialist medical reports in a low to middle income country (LMIC). *PLoS ONE*, *18*(9).

Wintermark, M., Sanelli, P. C., Anzai, Y., Tsiouris, A. J., Whitlow, C. T., Druzgal, T. J., & Zeineh, M. (2015). Imaging evidence and recommendations for traumatic brain injury: Advanced neuro- and neurovascular imaging techniques. *American Journal of Neuroradiology*, *36*(2), 1–11.

Yuksen, C., Sittichanbuncha, Y., Patumanond, J., Muengtaweepongsa, S., Aramvanitch, K., Supamas, A., & Sawanyawisuth, K. (2017). Clinical factors predictive for intracranial hemorrhage in mild head injury. *Neurology Research International*, *2017*, 1–5.