JNI Jurnal Neuroanestesi Indonesia

Original Article

The Role of Basal Cistern as Prognostic Factor in Head Injury Cases

[*)]Tri Putra Nuur Fath, [**)]Agus Suhendar, [***)]Nia Kania, [****)]Agung Ary Wibowo, [*****)]Hery Poerwosusanta, [**)] Zainal Abidin, [******)]Huldani

[*)]Resident of General Surgery, Department of Surgery, Faculty of Medicine, Health Sciences, Lambung Mangkurat University, Banjarmasin, Indonesia, [**)]Department of Surgery, Neurosurgery Division, Faculty of Medicine, Health Sciences, Lambung Mangkurat University, Banjarmasin, Indonesia, [***)]Department of Pathology, Ulin Regional General Hospital, Faculty of Medicine, Health Sciences, Lambung Mangkurat University, Banjarmasin, Indonesia, [****)]Department of Surgery, Division of Digestive Surgery, Faculty of Medicine, Health Sciences, Lambung Mangkurat University, Banjarmasin, Indonesia, [*****)]Department of Surgery, Pediatric Surgery Division, Faculty of Medical Health Sciences, Lambung Mangkurat University, Banjarmasin, Indonesia, [******)]Department of Physiology, Physiology Division, Faculty of Medicine, Health Sciences, Lambung Mangkurat University, Banjarmasin, Indonesia

Received: May 04, 2024; Accepted: August 08, 2024; Publish: February 24, 2025

correspondence: triputranuurfath@gmail.com

Abstract

Background and Objective: Head injury is a medical condition affecting various individuals around the world and is characterized by high mortality and morbidity rates. Several studies have shown that accurate management and appropriate interventions are required to achieve favorable outcomes. In this context, head CT scan has been reported to be the gold standard in diagnostic imaging for patients with head injury. In addition, head CT scan can be used to evaluate basal cistern, which is an area around the brain with a significant role in consciousness due to its close association with the brainstem. Several factors are known to influence prognosis of head injury treatment, including age, gender, severity of head injury, type of bleeding lesion, and the condition of basal cistern, which play a crucial role in the outcome of patients' care. Therefore, this study aims to determine the role of basal cistern as a predictor of prognosis in cases of head injury.

Subject and Method: The study procedures were carried out using the prospective observational method, and the sample population comprised 67 head injury patients at Ulin Regional General Hospital (RSUD) from February to April in 2024. Based on the inclusion and exclusion criteria, a total of 60 patients were selected as participants, and their primary data were collected. Subsequently, each variable's data was analyzed using SPSS with Chi-square and Spearman correlation tests.

Results: Significant differences were observed between various variables, including 1) the type of bleeding lesion and the condition of basal cistern (p-value: 0.004), 2) action (surgery and non-surgery) and prognosis (p-value: 0.017), and 3) prognosis and the condition of basal cistern (p-value: 0.0001).

Conclusion: Based on the results, basal cistern could be used as a predictor of prognosis in patients with head injury. In addition, the severity of head injury was closely related to the condition of basal cistern. The more severe head injury, the worse prognosis for patients. The results also showed that the type of bleeding lesion affected the condition of basal cistern.

Keywords: Basal cistern, head injury, prognosis

J. neuroanestesi Indones 2025;14(1): 1–8

Introduction

There are cases of head trauma which are often referred to as a silent epidemic, which is usually abbreviated as TBI (Traumatic Brain Injury). The management of TBI patients is widely known to require significant resources and prolonged treatment time. Despite the recent advancements in healthcare, mortality and morbidity rates

doi: https://doi.org/10.24244/jni.v14i1.596
ISSN (Print): 2088-9674 ISSN (Online): 2460-2302

JNI is accredited as Sinta 2 Journal: https://sinta.kemdikbud.go.id/journals/profile/796

How to cite: Fath TPN, et al, "The Role of Basal Cistern as Prognostic Factor in Head Injury Cases".

among TBI patients remain high at concerning levels. Therefore, early identification of risk factors contributing to the deteriorating outcomes is essential. The provision of accurate and timely information, as well as systematic interventions and therapy, plays a significant role in achieving a good prognosis and facilitating appropriate clinical decisions.[1]

Recent reports have shown that the global incidence rate of TBI is 369 per 100,000 lives.[2] The epidemiology in the United States shows that there are approximately 1.7–2.0 million cases of TBI annually. At present, TBI can be classified based on the Glasgow Coma Scale (GCS) into several categories, including severe (GCS 3–8), moderate (GCS 9–12), and mild (GCS 13–15).[3] The Basic Health Research - Riset Kesehatan Dasar (RISKESDAS) data from the Indonesian Ministry of Health in 2018 revealed that the incidence of head injury in South Kalimantan was 8.6% of the total incidents in Indonesia. The RISKESDAS results also showed that the total number of trauma incidents was 23,915 cases per year.[4] A previous study from 2018 to 2021 at Ulin Banjarmasin Regional General Hospital showed that cases of severe head injury were predominant in the age group >45 years, accounting for 41.2% (21 patients), followed by 17–45 years (37.3%, 19 patients), and <17 years (21.5%, 11 patients).[5]

In line with previous studies, head CT scan is the preferred diagnostic tool for assessing head injury due to its ability to provide comprehensive insights into brain tissue and skull injury. In addition, it offers various benefits, including wide availability, cost-effectiveness, and sensitivity for identifying abnormalities in the intracranial area.[6] Glasgow Coma Scale (GCS) was used to assess patients' level of consciousness after head injury, yielding a strong prognostic value. The results showed that age, motor GCS score, and pupil response were the strongest independent prognostic factors. The study also showed that the GCS upon hospital admission was the strongest prognostic factor. Therefore, it had the strongest prognostic value for analysis.[7] According to previous studies, basal cistern is part of the subarachnoid space and plays an essential role in cerebrospinal fluid (CSF) dynamics. The space typically comprises several empty voids that receive cerebrospinal fluid flow through communication with the ventricles, specifically at the Luschka and Magendie foramina from the fourth ventricle. Trabeculation and its relationship with these voids help in directing CSF from its production by the choroid plexus within the ventricles to its absorption by the arachnoid villi.

Basal cistern, located in the supratentorial and anterior area of the brainstem, is an important anatomical site related to the vascularization of the brainstem. Several studies showed that anatomical changes to this area can disrupt the function of the brainstem, which is the center of consciousness.[8] Age has a significant independent influence on survival. The study concluded that patients over 65 years had a worse prognosis compared to those younger.[9] In other research showed that patients <18 years old generally had better outcomes and lower mortality rates compared to adults.[10] Despite the availability of literature, there are no reports on the analysis of basal cistern in head trauma CT scans. Therefore, this study aims to assess the role of basal cistern located in the brainstem as a prognostic factor in head injury cases.

Method

This was an analytical observational study with a prospective design. All samples that met the inclusion and exclusion criteria were included as participants. In addition, the sample population comprised head injury patients receiving treatment at Ulin Banjarmasin Regional Hospital spanning from February 2024 to April 2024. The study was an unmatched categorical analysis, where data were obtained from patients who came to the emergency department with the following inclusion criteria, patient diagnosed with head injury (1) by a neurosurgical specialist with onset time from first trauma of maximum <48 hours; (2) aged ≥18 years and <65 years; (3) with no extracranial abnormalities found. All patients who arrived deceased at the emergency department were excluded.

The parameter in this study was to observe the condition of patients after receiving treatment at the hospital, whether the patients were discharged alive or deceased. The subjects in this study were selected after obtaining written and verbal consent from the medical records department, the radiology department, and informed consent from the patients. The instrument used was medical record data of the patients who showed for head trauma CT scan examination. The variables used in this study were age, gender, basal cistern condition, patient prognosis measured by the patient's condition at discharge, level of severity, and type of intracranial hemorrhage lesion. Data analysis was conducted using categorical data tested with correlation calculation formulas and compared with Chi-Square and Spearman's test. The significance criterion used was the p-value. When the result was ≤ 0.05, it could be concluded statistically that the variable was significant. In addition, this study was reviewed and approved by the ethics committee of the Faculty of Medicine and Health Sciences, Lambung Mangkurat University.

Results

The study sample was taken from medical record data and supporting examinations, spanning from February 2024 to April 2024. Initially, there were 67 patients with head injury who received treatment at Ulin Banjarmasin Regional General Hospital. After screening with inclusion and exclusion criteria, the total sample became 60 patients. The majority of patients were male with a young adult age range (≥18–40 years), totaling 37 patients. The severity of head injury was predominantly Mild Head Injury. The most common type of hemorrhage lesion was Subdural hematoma, with 11 cases, followed by epidural hematoma with 10 cases.

During the study, prognosis showed that 42 patients (70%) who underwent surgery or did not undergo surgery survived, while 18 patients (30%) died. The condition of the basilar cistern was mostly normal, with 26 cases (43.3%). Complete data on the characteristics of the study could be seen in Table 1.

Table 1. Study Characteristics

Variable	N=60
Age	
Young adults	37(61.7%)
Older Adults	23(38.3%)
Gender	
Male	41(68.3%)
Female	19(31.7%)
Head injury	
Mild	25(41.7%)
Moderate	19(31.7%)
Severe	16(26.7%)
Types of Bleeding Lesions	
Epidural hemorrhage	10(16.7%)
Subdural hemorrhage	11(18.3%)
Intracerebral hemorrhage	5(8.3%)
Subarachnoid hemorrhage	3(5.0%)
There are no bleeding lesions	31(51.7%)
Prognosis	
Die	18(13.3%)
Go home	32(53.3%)
Operation	20(33.3%)
Basal Cistern Condition	
Compressed	21(35.0%)
Normal	26(43.3%)
Absence	13(21.7%)

For the age variable, categorized into young adults (18–40 years) and older adults (40–65 years), compared with the condition of basal cisterna, it was shown that, in the compressed group, the young adult group dominated by 66.7%, while in the normal group, young adults accounted for 65.4%, and in the absence condition, older adults accounted for 53.8%.

Statistically, the P-value was >0.05, indicating that the difference in proportions between age and basal cisterna condition was insignificant. In the comparison of gender with the condition of basal cistern, it was found that the highest

Table 2. Age Comparison with Basal Cisterna Condition

Variable	Basal Cistern Condition			P value
	Compressed N=1	Normal N=26	Absence N=13	
Age				**0.428**
Young Adult	14(66.7%)	17(65.4%)	6(46.2%)	
Older Adults	7(33.3%)	9(34.6%)	7(53.8%)	

proportion of normal basal cistern was in male (57.7%), in compressed it was (71.4%), and in the absence condition, it was in male (84.6%). Statistically, the P-value was >0.05, showing that there was no significant difference in proportions between gender and basal cistern condition. Complete results could be seen in Table 3.

In the comparison of types of intracranial hemorrhage lesions with the condition of basal cistern, it was showed that the most common type of hemorrhage lesion in the reduced condition was epidural hemorrhage (28.6%), no hemorrhage lesions were found in the normal condition (80.8%), and in the absence condition, subdural hemorrhage was the most common, at 46.2%. Analysis of this variable showed a P-value < 0.05, indicating a significant difference in proportions between types of intracranial hemorrhage lesions

Table 3. Sex Comparison with Basal Cistern Condition

Variable	Basal Cistern Condition			P Value
	Compressed N=1	Normal N=26	Absence N=13	
Gender				**0.218**
Male	15(71.4%)	15(57.7%)	11(84.6%)	
Female	6(28.6%)	11(42.3%)	2(15.4%)	

Table 4. Comparison between the Type of Bleeding Lesion and the Condition of Basal Cistern

Variable	Basal Cistern Condition			P Value
	Compressed N=1	Normal N=26	Absence N=13	
Types of bleeding lesions				**0.004***
Epidural hemorrhage	6(28.6%)	1(3.8%)	3(23.1%)	
Subdural hemorrhage	4(19.0%)	1(3.8%)	6(46.2%)	
Intracerebral hemorrhage	2(9.5%)	2(7.7%)	1(7.7%)	
Subarachnoid hemorrhage	2(9.5%)	1(3.8%)	0(0.0%)	
No lesions	7(33.3%)	21(80.8%)	3(23.1%)	

Table 5. Comparison of Action Variables on Prognosis

Variable	Prognosis		P value
	Life N=42	Die N=18	
Action			**0.017***
Operation	10 (23.8%)	10 (55.6%)	
Non-Operation	32 (76.2%)	8 (44.4%)	

Table 6. Comparison of Prognosis with Basal Cistern Condition

Variable	Basal Cistern			
	Compressed N=1	Normal N=26	Absence N=13	P Value
Prognosis				**0.0001****
Life	25(96.2%)	14(66.7%)	3(23.1%)	
Die	1(3.8%)	7(33.3%)	10(76.9%)	

and the condition of the basilar cistern. Complete analysis results are presented in Table 4.

In the variable of treatment towards prognosis, it was found that the majority of surviving patients were treated with non-operative management, while for deceased patients, the majority underwent surgical treatment at Ulin Banjarmasin Regional General Hospital. Analysis using the chi-square correlation test, showed a P-value < 0.05, showing a significant relationship between treatment in patients and prognosis. Complete tabulation is illustrated in Table 5. In prognosis variable with basal cisterns, the results obtained in normal basal cistern showed that the highest prognosis was life (96.2%), in the compressed group prognosis was life (66.7%), and in the absence group, prognosis was death (76.9%). Analysis using the chi-square formula showed that the analysis results had a p-value <0.05, which meant that the results were a significant difference between prognosis and the condition of basal cistern. Complete tabulation could be seen in Table 6.

Before measuring the abnormal basal cistern, the normal basal cistern was measured by analyzing the normal ratio of the anteroposterior line and the horizontal line through the Radiant DICOM viewer application in 63 patients with head CT scans without hemorrhage or tumor lesions in the age group of ≥18 - 65 years. The analysis showed that the normal ratio of the anteroposterior line was 2.17±0.452 cm and the horizontal line was 1.73±0.616 cm.

Discussion

Basal cistern as predictor of prognosis in cases of head injury was not extensively discussed in the literature. This was an analytical observational study with a prospective design from February 2024 to April 2024, with a total sample size of 67 patients. After analysis according to inclusion and exclusion criteria, the total number of samples was 60 patients. This study was aimed to examine the dynamics of the relationship between risk factors and their impacts or effects. Risk factors and their impacts or effects were being observed simultaneously, meaning that each study subject was observed until the final treatment result was obtained during hospitalization, and risk factors and impacts were measured according to their status at the time of observation. We found that there were differences in the size of basal cisterna as age increased. However, in this study, there were no statistically significant differences because the sample size was not large, resulting in poor data distribution.[11] Gender variable on the condition of basal cistern theoretically showed differences in the size of the basilar cistern between males and females. From the researchers' experiments on rats, differences in features of blood vessels, intracranial pressure (ICP), and brain blood flow were noted, which affected cerebral perfusion pressure (CPP).[12]

According to the Monro-Kellie doctrine, these differences showed variations in size and pressure in the basilar cistern between males and females. However, the study results showed no significance due to a statistically insufficient sample size, leading to inadequate statistical distribution.[12] The variable of intracranial hemorrhage lesion in this study resulted in a p-value <0.05, meaning that this type of intracranial hemorrhage lesion could be considered as one of the variables for assessing the condition of the basilar cistern in head injury patients. The most common types of intracranial hemorrhage were epidural hematoma

(EDH) and subdural hematoma (SDH). EDH was classically caused by direct trauma to the temporal area resulting in skull fracture, which disrupted the middle meningeal artery. Venous vessel injury such as disturbance of the transverse sinus could also cause EDH in the posterior location, leading to an increase in size and decreased consciousness followed by brain herniation due to high intracranial pressure (ICP). Subdural hematoma (SDH) occurred through acceleration/deceleration of the brain surface against the skull base, causing tears in bridging veins. SDH could be accompanied by cerebral edema, often a significant factor leading to midline shift and brain herniation when left untreated. Basal cistern in both types of hematoma could narrow and result in low consciousness in patients.[13-15]

The degree of head injury could be a prognostic factor in cases of head injury. This was supported by a p-value <0.05 and was consistent with the theory. Patients who were present with severe head injury could result in narrower or absent basal cistern compared to those with mild or moderate head injury. A narrowed or absent basal cistern condition affected prognosis of the patient, making it worse. Patients admitted with severe head injury had a worse prognosis.[16] This was closely related to the function of the brainstem as the center of consciousness. When there was pressure on the area surrounding the brainstem caused by hemorrhage, brain swelling, or head tumors, the Monro-Kellie doctrine applied, leading to the narrowing of the basilar cistern and resulting in ischemia of the brainstem.[17]

Conclusion

In conclusion, this study was conducted based on the scientific gap regarding the diagnosis and prognosis data of head injury patients in Indonesia. The results showed that the most common types of intracranial hemorrhage were epidural hematoma (EDH) and subdural hematoma (SDH). The condition of basal cistern in both types of hemorrhage tended to be compressed or narrowed. Furthermore, in cases of moderate and severe head injury, the condition of the patients' basal cistern was also found to be compressed or absent. For patients undergoing surgical intervention, the difference in outcomes between those who survived and those who died was insignificant. Meanwhile, patients who did not undergo surgery had a good prognosis with the majority surviving. When compared to other countries, these results were similar to the previous studies. In addition, it provided new data worldwide, such as the normal size ratio of basal cistern used to determine abnormal basal cistern conditions.

This was crucial for surgeons to determine prognosis of head injury patients. The results were also consistent with previous reports in different populations, but there were some differences. This suggested that the assessment of prognosis figures could vary from diverse countries. The study served as a new foundation for explorations on basal cistern and prognosis of head injury in Indonesia. Future prospective studies with a longer duration, a larger sample size, and more prognostic variables such as blood pressure, Glasgow outcome scale, the influence of the timing of the operation on outcomes etc, are needed to provide a more accurate picture of prognosis of head injury patients in Indonesia.

References

1. Golden N, Mardhika PE, Niryana W, Sukarya IM, Prabawa IPY. Risk factors and novel prognostic score for predicting the 14-day mortality of severe traumatic brain injury patients. Intisari Sains Medis. 2020;11(3):1020–8. Doi: 10.15562/ism.v11i3.831

2. James SL, Bannick MS, Montjoy-Venning WC, Lucchesi LR, Dandona L, Dandona R, et al. Global, regional, and national burden of traumatic brain injury and spinal cord injury, 1990-2016: A systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol. 2019;18(1):56–87. Doi: 10.1016/S1474-4422(18)30415-0

3. Wang KK, Yang Z, Zhu T, Shi Y, Rubenstein R, Tyndall JA, et al. An update

on diagnostic and prognostic biomarkers for traumatic brain injury. Expert Rev Mol Diagn. 2018;18(2):165–80. Doi: 10.1080/14737159.2018.1428089

4. Riskesdas Kalsel. Laporan Provinsi Kalimantan Selatan RISEKDAS [Internet]. Laporan Riskesdas Nasional 2019. 2020. 493 p. Available from: https://ejournal2.litbang.kemkes.go.id/index.php/lpb/issue/view/253

5. Abidin Z, Wibowo RAP, Illiandri O, Husair A, Gunawan S, Sikumbang KM. Mortality severe head injury patients based on mean arterial pressure at Ulin Hospital Banjarmasin since January 2018-October 2022. J Neuroanestesi Indones. 2023;12(1): 9–15. Doi: https://doi.org/10.24244/jni.v12i1.529

6. De Souza MR, Pipek LJ, Fagundes CF, Fontoura Solla DJ, Lucena da Silva GC, Godoy DA, G Kolias A, Amorim RLO, et al. External validation of the Glasgow coma scale-pupils in low- to middle-income country patients with traumatic brain injury: Could " motor score-pupil " have higher prognostic value ? Surg Neurol Int. 2022;13(510):1–6. Doi: 10.25259/SNI_737_2022

7. Kulesza B, Litak J, Grochowski C, Nogalski A, Rola R. The initial factors with strong predictive value in relation to six-month outcome among patients operated due to extra-axial hematomas. Diagnostics. 2020;10(3). Doi: 10.3390/diagnostics10030174

8. Wang SS, Zheng HP, Zhang FH, Wang RM. The microanatomical structure of the cistern of the lamina terminalis. J Clin Neurosci 2011;18(2):253–59. Doi: 10.1016/j.jocn.2010.03.035

9. Munro PT, Smith RD, Parke TRJ. Effect of patients' age on management of acute intracranial haematoma: Prospective national study. BMJ. 2002;325(7371):1001–3. Doi: 10.1136/bmj.325.7371.1001

10. Dhandapani SS, Manju D, Sharma BS, Mahapatra AK. Prognostic significance of age in traumatic brain injury. J Neurosci Rural Pract. 2012;3(2):131–5. Doi: 10.4103/0976-3147.98208

11. Wilk R, Kluczewska E, Likus W. Evaluation of subarachnoid space and subarachnoid cisterns in children and teenagers based on computed tomography studies. Pol J Radiol. 2019;84:e295–306. Doi: 10.5114/pjr.2019.87806

12. Friedrich V, Bederson JB, Sehba FA. Gender influences the initial impact of subarachnoid hemorrhage: An experimental investigation. PLoS One. 2013;8(11):1–11. Doi: 10.1371/journal.pone.0080101

13. Tenny S, Thorell W. Intracranial hemorrhage [Internet]. StatPearls. 2023 [cited 2024 Jan 24]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470242/

14. Atsumi H, Sorimachi T, Nonaka Y, Matsumae M. Basal cistern effacement and pseudo–subarachnoid hemorrhage on computed tomography images of chronic subdural hematoma. World Neurosurg [Internet]. 2019;132:e109–15. Available from: https://doi.org/10.1016/j.wneu.2019.08.249

15. Galgano M, Toshkezi G, Qiu X, Russell T, Chin L, Zhao LR. Traumatic brain injury. Cell Transplant. 2017;26(7):1118–130. Doi: 10.1177/0963689717714102

16. Syarif H, Nadila N. Glassgow coma scale and outcome on head injury patients in emergency room at general hospital of pemerintah Aceh. J Keperawatan Respati Yogyakarta. 2021;8(1):38. Doi: http://dx.doi.org/10.35842/jkry.v8i1.587

17. Klemenc-Ketis Z, Bacovnik-Jansa U, Ogorevc M, Kersnik J. Outcome predictors of Glasgow Outcome Scale score in patients with severe traumatic brain injury. Ulus Travma ve Acil Cerrahi Derg. 2011;17(6):509–15. Doi: 0.5505/tjtes.2011.35336