ORIGINAL ARTICLE

Bali Medical Journal (*Bali MedJ)* 2023, Volume 12, Number 3: 2891-2895
P-ISSN.2089-1180, E-ISSN: 2302-2914

Correlation between the degree of severity and type of intracranial hemorrhage with the incidence of coagulopathy in head injuries at the Ulin Regional General Hospital, Banjarmasin, Indonesia

Ardik Lahdimawan[1], Arif Handoko[2*], Meitria Syahadatina Noor[3], Agung Ary Wibowo[4], Sulandri Gusasi[5], Kenanga Marwan Sikumbang[6], Andreas Siagian[7]

ABSTRACT

Background: Trauma cases, especially head injuries, are cases that are often found in hospital emergency departments. Coagulopathy can occur in head injuries and intracranial bleeding, where a low Glasgow Coma Scale (GCS) is associated with coagulopathy. This study aims to evaluate the correlation between the degree of severity and type of intracranial hemorrhage and the incidence of coagulopathy in head injuries at the Ulin Regional General Hospital, Banjarmasin, Indonesia.
Methods: An observational analytic study with 74 sample populations was conducted among patients with a head injury treated at Ulin Regional General Hospital, Banjarmasin, in the 2019-2022 period taken by total sampling, which met the inclusion and exclusion criteria. The data of each variable was analyzed with the Kruskal-Wallis test. Data were analyzed using SPSS version 25.0 for Windows.
Results: There was a significant relationship between the two variables towards the occurrence of coagulopathy; namely, the degree of severity was 0.000 ($p < 0.05$), and the type of bleeding was 0.003 ($p < 0.05$).
Conclusion: There is a significant relationship between the degree of severity of the incidence of coagulopathy and the bleeding with the incidence of coagulopathy, so knowing the degree of severity by clinical examination of GCS and the type of intracranial bleeding by CT scan of the head, as well as blood tests to determine the incidence of coagulopathy are important so that management can be carried out and assessing outcomes.

Keywords: Coagulopathy, Degree Of Severity, Head Injury, Type of Bleeding.
Cite This Article: Lahdimawan, A., Handoko, A., Noor, M.S., Wibowo, A.A., Gusasi, S., Sikumbang, K.M., Siagian, A. 2023. Correlation between the degree of severity and type of intracranial hemorrhage with the incidence of coagulopathy in head injuries at the Ulin Regional General Hospital, Banjarmasin, Indonesia. *Bali Medical Journal* 12(3): 2891-2895. DOI: 10.15562/bmj.v12i3.4704

[1]Department of Surgery, Neurosurgery Division, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarmasin, Indonesia;
[2]Resident of Surgery, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarmasin, Indonesia;
[3]Department of Public Health Master Program, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarmasin, Indonesia;
[4]Department of Surgery, Digestive Division, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarmasin, Indonesia;
[5]Department of Surgery, Plastic Surgery Division, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarmasin, Indonesia;
[6]Department of Anesthesia and Intensive Care, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarmasin, Indonesia;
[7]Department of Orthopedics and Traumatology, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarmasin, Indonesia.

*Corresponding author:
Arif Handoko;
Resident of Surgery, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarmasin, Indonesia;
arifhandoko07@gmail.com

Received: 2023-06-10
Accepted: 2023-08-22
Published: 2023-09-26

INTRODUCTION

Trauma cases, especially head injuries, are cases that are often found in hospital emergency departments.[1-3] The Brain Injury Association of America defines head injury as damage that is not inherited, non-congenital, non-degenerative, or traumatic at birth. Overall, the incidence of head injuries per 100,000 population is highest in North America and Europe and least in Africa and the Eastern Mediterranean. The proportion due to road accidents, with the largest coming from Africa and Southeast Asia, was recorded at 56%, and the lowest was in North America at 25%. The incidence of traffic accidents is similar between Southeast Asia, 1.5% of the population, and Europe, 1.2% of the population.[2]

Based on previous studies, it was reported that 11.9% of head injuries occurred in Indonesia, with a prevalence rate of 67.9% for mild head injuries and 32.7% for moderate-severe head injuries.[3-5] In head injury, primary damage to the brain cannot be avoided. Still, secondary injuries in the form of brain damage and coagulopathy can be avoided and can affect therapeutic interventions and patient outcomes. Head injury-associated coagulopathy contributes badly to both conditions: hypercoagulability, leading to expansion of intracranial hemorrhage, and hypercoagulability, leading to cerebral ischemia secondary to intravascular thrombosis in the injured brain.[3,4] Disseminated intravascular coagulation (DIC) is recognized as the main pathophysiological mechanism of Trauma-Induced Coagulopathy (TIC), which is caused by several factors, such as anemia, hemodilution, hypothermia, acidosis, hemorrhagic shock, and serious trauma itself.[3-5]

Previous studies have found that a low Glasgow Coma Scale (GCS < 8) or a high Injury Severity Score (ISS > 16), hypotension on admission, and the presence of cerebral edema, subarachnoid hemorrhage, and midline shift are independent risk factors for developing coagulopathy in patients with head injuries.[6,7] The GCS score reflects the severity of brain injury associated with the occurrence of coagulopathy and can be used as a predictor of death.[7] These results are consistent with the observation by Chen Y et al. of a much lower GCS score in patients with coagulopathy than those without coagulopathy, suggesting that patients with severe head injuries are more likely to develop coagulopathy.[7] In the study of van Gent JAN et al., patients in the study group frequently developed coagulopathy in the days following trauma.[8]

Criteria for coagulopathy include the presence of clinical conditions associated with coagulopathy, namely head injury associated with thrombocytopenia (platelet count < 150,000 mm3) or prolonged international normalized ratio (INR) (normal range 0.92 – 1.50) or activated partial thromboplastin time (aPTT). Prolonged (normal range 24-32 seconds).[9,10] Coagulopathy of one extracranial consequence affects 13% to 61% of patients with head injuries. According to Carrick MM et al., patients with moderate to severe head injuries have an incidence of coagulopathy between 27% and 93%. Head injury patients who experience coagulopathy have a worse prognosis than those who do not experience coagulopathy.[11] Coagulopathy that occurs after trauma is a disturbance of the homeostatic system caused by many factors. Dysfunction of fibrin formation, platelets, vascular endothelium, inhibition of clot formation and fibrinolytic processes play a role in coagulopathy.

The higher the risk of coagulation, the higher the mortality of patients with head injuries. Researchers are interested in knowing the condition of coagulopathy at various degrees of severity and types of intracranial bleeding in head-injured patients at Ulin General Hospital, Banjarmasin. So, in this study, the Glasgow Coma Scale (GCS) score will be used to evaluate the severity of head injuries and a head CT scan to determine the type of bleeding.

METHODS

The population in this study were patients with a head injury diagnosis. The reachable population in this study were patients diagnosed with head injury who were treated at Ulin Banjarmasin General Hospital in 2019-2022, a total of 150 patients and from total sampling, only 74 patients met the inclusion and exclusion criteria.

The inclusion criteria of this research are patients who come with head injuries and have complete data about GCS, Head CT scans and coagulopathy laboratory tests (PT, APTT, INR and Trombocyte). Incomplete examination data, patient received blood transfusion, anticoagulant therapy, multiple trauma or multiple intracranial hemorrhages are excluded from this research.

Variables were carried out by Univariate Analysis, aiming to describe the characteristics of the subjects based on the research group and to determine the distribution and presentation of each variable. Then, a bivariate analysis was carried out to determine the relationship between the two variables. Data analysis was determined with a total of 74 samples using the SPSS program version 25.0 with the Chi-Square test 3x2 table, but because they did not meet the requirements, an analysis was carried out with the Kruskal-Wallis test.

RESULTS

Based on Table 1, the male sex has a higher prevalence of head injuries than women, namely as much as 66.2%, while women are 33.8% of the 74 samples. Of all the samples analyzed, the ages of children (1-18) and adults (19-60) were almost the same, namely 47.3% and 52.7%, with an average age of 24 years.

Based on Table 1, the characteristics of the data on the degree of head injury varied from mild head injuries in 39 (52.7%) patients, moderate in 28 (37.8%) patients and severe in 7 (9.46%) patients. Cases of bleeding in head injuries based on the results of CT scans at the Ulin Regional General Hospital varied. Still, only three types of bleeding were sampled for analysis: EDH in 50 patients, SDH in 14 patients, and ICH in 10 patients from 74 samples. Of the sample, 10 (13.5%) had coagulopathy, while 64 (86.5%) did not.

In Table 2, the relationship between the degree of severity and coagulopathy above shows that the majority of patients experienced severe degrees of severity with coagulopathy in 6 patients (85.7%) and moderate head injuries in 3 patients (10.7%). In contrast, the least number of patients were patients with head injuries. Lightheadedness in 1 patient (2.6%). So, of all cases of head injury based on the degree of severity, 10 patients (13.5%) had

Table 1. Data characteristics of respondents

Variable	Total (n=74)	Mean±SD
Gender, n (%)		
Male	49 (66.20)	
Female	25 (33.80)	
Age (Years)		24.84±16.53
1 – 18	35 (47.30)	
19 – 60	39 (52.70)	
Degree of Severity		
Severe	7 (9.46)	
Moderate	28 (37.80)	
Mild	39 (52.70)	
Bleeding type		
ICH	10 (13.50)	
SDH	14 (18.90)	
EDH	50 (67.60)	
Coagulation Events		
Coagulation	10 (13.50)	
No coagulation	64 (86.50)	

Table 2. Relationship between degree of severity and coagulopathy

Degree of Severity	Coagulopathy		No Coagulopathy		Total		p
	Total (n=10)	Percentage (%)	Total (n=64)	Percentage (%)	Total (n=74)	Percentage (%)	
Mild	1	2.60	38	97.30	39	52.70	
Moderate	3	10.70	25	89.30	28	37.80	0.000*
Severe	6	85.70	1	14.30	7	9.50	

*Statistically significant if p-value less than 0.05

Table 3. Relationship of Bleeding Type With Coagulopathy

Bleeding Type	Coagulopathy		No Coagulopathy		Total		p
	Total (n=10)	Percentage (%)	Total (n=64)	Percentage (%)	Total (n=74)	Percentage (%)	
SDH	5	35.70	9	64.30	14	18.90	
ICH	3	30.00	7	70.00	10	13.50	0.003*
EDH	2	4.00	48	96.00	50	67.60	

*Statistically significant if p-value less than 0.05

coagulopathy. Based on these data, there was a significant relationship between the degree of severity and the incidence of coagulation in head injuries with a result of 0.000 ($p < 0.05$). Also, from these data, it can be seen that the tendency for coagulopathy to occur at a more severe degree of severity, where the more severe the degree of head injury, the greater the prevalence of coagulopathy.

Table 3 shows a significant relationship between bleeding type and coagulopathy ($p < 0.05$). The type of bleeding was determined based on the CT scan of the head, each of which showed a bleeding type SDH in 5 patients (35.7%) out of a total of 9 patients who had SDH, and for ICH in 3 patients (30%) out of a total of 10 patients who had ICH. Whereas in EDH, 2 (4%) patients experienced coagulopathy out of 48 patients who experienced EDH. In this study, 13.5% of patients with intracranial hemorrhage developed coagulopathy. From the data in Table 3, it can also be seen that the tendency for coagulopathy to occur in the type of bleeding, namely SDH, rather than other types of intracranial bleeding, namely ICH and EDH.

DISCUSSION

Based on the results of this study, it was found that the degree of severity of head injury was related to coagulopathy, where the greatest presentation was in severe head injury, namely 85.7% of a total of 7 patients, for moderate head injury 10.7% of a total of 28 patients and mild 2.6 % of a total of 39 patients. In head injuries, coagulopathy is influenced by several factors, namely hypothermia, acidosis, dilution factors and the severity of the head injury. Many mentioned that the release of tissue factors due to damage to the brain parenchyma has a major influence on coagulation. Damage to the brain and cerebral blood vessels due to head injuries, especially moderate and severe, can produce inflammatory pathways through endothelial damage. Platelet dysfunction also contributes to coagulation and inflammatory pathways via the complement system. The inhibition of Adenosine Diphosphate and Arachinodic Acid receptors causes platelet dysfunction.[12]

Patients with moderate and severe head injuries will have a higher risk of damage to the brain parenchyma, which is rich in Tissue and Platelet-activating factors. Tissue factor release will result in excessive coagulation activation through the extrinsic pathway.[13] Whereas in mild head injury (GCS 13-15), coagulopathy can occur through Platelet or platelet dysfunction with the mechanism of ADP inhibition occurring in more than 60% of thrombocytopenic samples evaluated using TEG or Platelet mapping. Platelet dysfunction includes platelet adhesion, activation and aggregation.[14-16] head injury cases result in 50% of deaths from total injury deaths.[3] One example in the United States, head injury is the 4th death case in Mexico, resulting in 38 deaths, 8 per 100,000 population. This event is more common in men, which range in age from 15 to 45 years.[18,19] The main causes are motor vehicle accidents and the use of alcohol. [21] In Rosyidi RM et al. study in Lombok, it was found that GCS < 5 in head injuries had a mortality rate of 54.96%, caused by traffic accidents and falls.[21] In Chen Y et's study al, patients with lower GCS were associated with the development of coagulopathy ($p < 0.001$) and his study also stated that patients with coagulopathy were more likely to develop intracranial hemorrhage ($p < 0.001$), subdural hematoma ($p < 0.001$), subarachnoid hemorrhage ($p < 0.001$), and midline shift ($p < 0.004$).

In this study, there was also 1 patient (2.6%) with mild head injury who experienced coagulopathy, namely with thrombocytopenia (145,000/uL); this is comparable to the study by Rosyidi RM et al., who obtained 20 patients (19.6%) from 102 samples of mild head injury.[21] Research Nakae R et al. stated that 108 patients who survived and 16 died found a relationship between the GCS score, Tomography results or the location of bleeding on death. However, the study did not look at the coagulation status of the patients.[11] Another study by Talving P et al., through logistic regression analysis, found that an independent risk factor for the development of head injury to coagulopathy was in GCS < 8, then from samples that had been divided into coagulopathy and not coagulopathy, the results showed a higher risk of death in coagulopathy, namely 50% versus 7

%. This study found 10 patients with coagulopathy, or 13.5% of the total sample, but researchers did not conduct further monitoring regarding the outcomes of patients with coagulopathy.[6]

Viscoelastic examinations, such as Thromboelastography (TEG) and Rotational Thromboelastometry (ROTEM), allow more detailed analysis of the coagulation system over time, but these technologies are only available in some head injury centers. Thus, Bohm J et al. studied coagulation characteristics in head injury using conventional parameters INR, aPTT and platelets as the main outcome markers indicating coagulopathy using thresholds based on previous studies.[21] Patients with moderate to severe head injury (GCS between 3 and 12) Frequently, these intracranial hemorrhages or a combination thereof may be accompanied by secondary injury. Deteriorating clinical prognosis can be evaluated by examining the GCS and CT scan of the head to diagnose the type of bleeding.[9,22]

This study found a relationship between bleeding type and coagulopathy, with SDH being the most common, followed by ICH and EDH. Then, it is also more common in men than women. Intracranial bleeding causes compression of the cisterns and severe contusions, which are associated with an increased incidence of coagulopathy; a previous study, namely Bohm J et al., subdural hematoma in 37 patients (49.3%) of 75 samples with subdural hematoma, whereas in extradural hematoma there were 11 patients (14.7%).[22] The results of this study are also in accordance with the research of Gent J et al., namely in an observational cohort study of 108 patients with intracranial hemorrhage, there were 22 (20%) patients who developed coagulopathy and had a poor prognosis because they died within 96 hours. In this study, looking at the type of bleeding, there were 10 patients with ICH, 14 with SDH, and 50 with EDH. Three percent were male, and 15.7% were female. This study also measured the prevalence of various types of bleeding using CT scans; the incidence of SAH was 45.7%, SDH was 40%, ICH was 21.4%, and EDH was 5.7% cases. In several cases of head injury, there was not only one type of intracranial hemorrhage, but also, in general, bleeding events were associated with changes in midline shift in 14.3% of cases and edema in 12.9% of cases.

In head injury-related coagulopathy, there is increased activity of tissue factors in the brain and activity of fibrinolysis in parts of the brain that are rich in blood vessels, such as the choroid plexus and the meninges. The tissue factor is abundant in the gray matter, i.e., its main producer is astrocyte cells. Other factors, such as tissue plasminogen activator (t-PA), are found in capillary-rich brain areas and indicate fibrinolytic activity.[9,16,23] In head injury patients who experience coagulopathy associated with Progressive Hemorrhage Injury (PHI), surgical intervention is strongly associated with death in hospital. Progressive Hemorrhage Injury is an increase in the volume of bleeding in the initial lesion or the development of a new intracranial hemorrhage in a different location from the previous bleeding lesion. Therefore, patients with head injuries must be monitored closely because they may develop coagulopathy and adverse effects daily after trauma.[9,24,25]

The advantages of this study are the latest research conducted at Ulin Hospital, Banjarmasin, with different sample characteristics and variables, namely the degree of severity and type of bleeding. The limitations of this study were that the sampling was observational analytic, did not periodically monitor coagulation factors, did not collect final data on whether the patient was dead or alive, and did not see whether the patient underwent surgical intervention. The presence of massive fluid resuscitation or a history of transfusion was also not included in the sampling criteria, so the effect of these variables could not be determined. Suggested future research can be carried out prospective studies to assess coagulation in head injury at regular intervals, e.g., 24 hours, 48 hours, and 72 hours after trauma and further studies of other variables such as age, comorbidities, history of resuscitation and transfusion, and post-surgical intervention.

CONCLUSION

There is a significant relationship between the degree of severity of the incidence of coagulopathy and the bleeding with the incidence of coagulopathy, so knowing the degree of severity by clinical examination of GCS and the type of intracranial bleeding by CT scan of the head, as well as blood tests to determine the incidence of coagulopathy are important so that management can be carried out and assessing outcomes.

CONFLICT OF INTEREST

The authors declare that they are unaware of any competing financial or personal relationship interests that appear to have influenced the work reported in this paper.

ETHICAL CONSIDERATIONS

This research was approved by the Research Ethics Committee of the Faculty of Medicine, University of Lambung Mangkurat Banjarmasin, for approval of research conducted No 062/KEPK-FK ULM/MEC/IV/2023.

FUNDING

There is no source of funding for this research.

AUTHOR CONTRIBUTIONS

All authors equally contribute to the study from the conceptual framework, methodology, validation, formal analysis, review and editing until reporting the study results through publication.

REFERENCE

1. Holling S. Head injury. *Nurs Stand*. 2013;27(18):58.
2. Dewan MC, Rattani A, Gupta S, Baticulon RE, Hung YC, Punchak M, et al. Estimating the global incidence of traumatic brain injury. J Neurosurg. 2019;130(4):1080-1097.
3. Siahaya N, Huwae LBS, Angkejaya OW, Bension JB, Tuamelly J. Prevalensi Kasus Cedera Kepala Berdasarkan Klasifikasi Derajat Keparahannya Pada Pasien Rawat Inap Di Rsud Dr. M. Haulussy Ambon Pada Tahun 2018. Molucca Medica. 2020;12(1):14-22.
4. Abidin Z, Wibowo RAP, Illiandri O, Gunawan S, Husair A, Sikumbang KM. Mortalitas Pasien Cedera Kepala Berat Berdasarkan Nilai Mean Arterial Pressure di RSUD Ulin Banjarmasin Januari 2018-Oktober 2021. Jurnal Neuroanestesi Indonesia. 2023;12(1):9-15.
5. Khalilati N, Humaidi M. Pengaruh Terapi Murottal Al-Qur'an Terhadap Penurunan Skala Nyeri Pada Pasien Cedera Kepala Di Ruang

Bedah Umum RSUD Ulin Banjarmasin. Al Ulum J Sains Dan Teknol. 2019;5(1):30-36.

6. Talving P, Benfield R, Hadjizacharia P, Inaba K, Chan LS, Demetriades D. Coagulopathy in severe traumatic brain injury: A prospective study. J Trauma - Inj Infect Crit Care. 2009;66(1):55-61.
7. Chen Y, Tian J, Chi B, Zhang S, Wei L, Wang S. Factors associated with the development of coagulopathy after open traumatic brain injury. J Clin Med. 2022;11(1):185.
8. van Gent JAN, van Essen TA, Bos MHA, Cannegieter SC, van Dijck JTJM, Peul WC. Coagulopathy after hemorrhagic traumatic brain injury, an observational study of the incidence and prognosis. Acta Neurochir (Wien). 2020;162(2):329-336.
9. Wada T, Shiraishi A, Gando S, Yamakawa K, Fujishima S, Saitoh D, et al. Pathophysiology of Coagulopathy Induced by Traumatic Brain Injury Is Identical to That of Disseminated Intravascular Coagulation With Hyperfibrinolysis. Front Med. 2021;8:1-12.
10. Carrick MM, Tyroch AH, Youens CA, Handley T. Subsequent development of thrombocytopenia and coagulopathy in moderate and severe head injury: Support for serial laboratory examination. J Trauma - Inj Infect Crit Care. 2005;58(4):725-730.
11. Nakae R, Murai Y, Morita A, Yokobori S. Coagulopathy and Traumatic Brain Injury: Overview of New Diagnostic and Therapeutic Strategies. Neurol Med Chir (Tokyo). 2022;62(6):261-269.
12. Yutami A, Sikumbang KM, Asnawati A. Hubungan skor glasgow coma scale (gcs) dengan jumlah trombosit pada pasien cedera kepala. Berkala Kedokteran. 1879;12(2):289-296.
13. Luo C, Zhang H. The Role of Proinflammatory Pathways in the Pathogenesis of Colitis-Associated Colorectal Cancer. Mediators Inflamm. 2017;1(1):1-8.
14. Zhang J, Zhang F, Dong JF. Coagulopathy induced by traumatic brain injury: Systemic manifestation of a localized injury. Blood. 2018;131(18):2001-2006.
15. Marwan SK, Umar N, Saleh SC, Wargahadibrata AH. Gangguan Koagulasi dan Hubungannya dengan Luaran Pascacedera Otak Traumatik. J Neuroanestesi Indones. 2014;4(2):132-140.
16. Levi M. Diagnosis and treatment of disseminated intravascular coagulation. Int J Lab Hematol. 2014;36(3):228-236.
17. McCully SP, Schreiber MA. Traumatic brain injury and its effect on coagulopathy. Semin Thromb Hemost. 2013;39(8):896-901.
18. Jadhao S, Bairwa BL, Sharma V, Chopra S. Impact of coagulopathy in geriatric traumatic brain injury. Int J Res Med Sci. 2022;10(10):2139.
19. Vernon T, Morgan M, Morrison C. Bad blood: A coagulopathy associated with trauma and massive transfusion review. *Acute Med Surg*. 2019;6(3):215-222.
20. Böhm JK, Güting H, Thorn S, Schäfer N, Rambach V, Schöchl H, et al. Global Characterisation of Coagulopathy in Isolated Traumatic Brain Injury (iTBI): A CENTER-TBI Analysis. Neurocrit Care. 2021;35(1):184-196.
21. Rosyidi RM, Priyanto B, Laraswati NKP, Islam AA, Hatta M, Bukhari A, et al. Characteristics and clinical outcome of traumatic brain injury in Lombok, Indonesia. Interdiscip Neurosurg Adv Tech Case Manag. 2019;18:100470.
22. 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),1020-1028.
23. Laode R, Djoko A, Mansyur A, Burhanuddin B. The Role of Blood Lactate Levels as Outcome Predictor of Isolated Traumatic Brain Injury Patients. Bali Medical Journal. 2012;1(1):22–28.
24. Syahrul, S., Imran, I., & Fajri, N. Clinical characteristics of traumatic brain injury patients in Dr. Zainoel Abidin Public Hospital Banda Aceh, Indonesia. Bali Medical Journal. 2020;9(1):194–200.
25. Bangun EC, Prasetyo E, Oley MC. Correlation between the level of interleukin-6 serum and blood peripheral leukocyte in patients with severe traumatic brain injury. Bali Medical Journal. 2019;8(3):SS784-S787.