

Traumatic Brain Injury and Covid-19

Nicholas Christian Tinambunan,¹ Ahmad Faried,² Teguh Marfen Djajakusumah,³ Raden Yohana,⁴
Kiki Ahmad Rizki,⁴ Mirna Sobana²

¹Department of General Surgery, Faculty of Medicine Universitas Padjadjaran/Dr. Hasan Sadikin General Hospital Bandung, Indonesia

²Department of Neurosurgery, Faculty of Medicine Universitas Padjadjaran/Dr. Hasan Sadikin General Hospital Bandung, Indonesia

³Division of Vascular and Endovascular Surgery, Department of Surgery, Faculty of Medicine Universitas Padjadjaran/Dr. Hasan Sadikin General Hospital Bandung, Indonesia

⁴Division of Oncology Surgery, Department of Surgery, Faculty of Medicine Universitas Padjadjaran/Dr. Hasan Sadikin General Hospital Bandung, Indonesia

Abstract

Head trauma is a head injury caused by external forces in the head or body that results in disruption of the normal functioning of the brain. According to the CDC, deaths from head injuries were about 60,000 in 2016, and rose to more than 61,000 in 2017. The COVID-19 pandemic had caused poor non-COVID patient care, especially in low- and lower-middle-income countries with limited access to health facilities, resulting in increased morbidity and mortality, including among patients with head injuries. The purpose of this study was to understand the characteristics, duration of hospital stay, and difference of time to surgery interval in Traumatic Brain Injury patients in Dr. Hasan Sadikin General Hospital Bandung before and during the COVID-19 pandemic. This study was performed through analytical methods with a cross-sectional study design using analysis of medical records of head trauma patients treated in Dr. Hasan Sadikin General Hospital Bandung, Indonesia in the period before the pandemic (February 2018–February 2020) and during the pandemic (March 2020–September 2021). Data analysis showed significant differences in length of hospitalization and operating intervals before and during the pandemic ($p=0.04$ and $p=0.03$), showing that there are differences in interval operation and duration of stay between patients with head trauma before the pandemic and during the pandemic.

Keywords: Comparative studies, COVID-19, traumatic head injury

Introduction

Traumatic brain injury (TBI) is a mechanical trauma that may cause a dysfunction of the neural system, physical, cognitive, and psychosocial temporarily or permanently.¹ Based on the Global Burden of Disease (GBD) 2019, there were approximately 27 million cases of TBI in 2016 with 3.6 million cases occurring in high-income countries, 5.5 million occurring in middle-high-income countries, 7.2 million occurring in middle-income countries, 8 million

occurring in low-middle income countries, and 2.6 million occurring in low-income countries.² As we know at the beginning of 2020, SARS-CoV 2 caused a global pandemic of severe pneumonia, which is now known as COVID-19 disease.³ This pandemic has caused a vital issue in the treatment of neurotrauma patients, especially TBI patients, who most often need immediate surgical intervention, yet had delays in reaching and receiving because of the COVID-19 pandemic. This issue can negatively affect mortality.^{4,5}

Throughout the pandemic, the limitation of traveling and the decreased number of pedestrians and vehicles have decreased causative mechanisms of trauma. A study in New York, one of the COVID-19 pandemic epicenters in the United States, showed decreased cases of TBI during the pandemic, which may be associated

Corresponding Author:

Ahmad Faried
Department of Neurosurgery, Faculty of Medicine
Universitas Padjadjaran/Dr. Hasan Sadikin General
Hospital Bandung, Indonesia
Email: ahmad.faried@unpad.ac.id

This is an Open Access article licensed under the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original author and source are properly cited.

with social limitations that consecutively limit non-essential activities, crowding, and traffic.^{6,7,8} While in Indonesia, Pukovisa et al., had the contrary findings in Dr. Cipto Mangunkusumo General Hospital, where admittance of patients with TBI during the COVID-19 pandemic had increased, especially moderate to severe TBI.⁹ However, this increase was not found to be statistically significant. A study in Norway found that the average hospital stay duration of TBI patients is 6,6–7,2±6 days.¹⁰ A study by Adam et al., at Dr. Hasan Sadikin General Hospital Bandung in 2019 reported the characteristics of mild to moderate TBI: duration of hospital stays in 65.8% of patients was 7–14 days, some were less than 7 days and the least patients had more than 14 days of hospital stay.¹¹ The average time to surgery in referred TBI patients is less than 4 hours until 8 hours. Based on the data of mild to moderate TBI patients at Dr. Hasan Sadikin General Hospital Bandung in 2019, the time to surgery interval is 2–24 hours (70.9%) and more than 48 hours (17.7%).¹¹ A study in the United States found that there has been a change in the characteristics of TBI. Based on its severity (GCS), there has been a decrease in severe TBI patients, but no significant change in moderate TBI patients.¹²

This pandemic has caused various changes in every level of healthcare facilities. Relocation of hospital staff, including neurosurgeons, was very important to accommodate the needs of emergency life-threatening patients with COVID-19, and to decrease morbidity and mortality. During the pandemic, TBIs were still prioritized. There were no significant changes in the indications for surgical intervention of TBI before and during the pandemic. At the beginning of the pandemic, insufficient healthcare staff, bed capacity, intensive care, and selective admission of patients might have caused a delay in elective surgical procedures and more priority in emergency surgeries.⁹

Based on this, the writers interested to study about the characteristics, duration of hospital stay, and difference of time to surgery interval in TBI patients in Dr. Hasan Sadikin General Hospital Bandung before and during the COVID-19 pandemic.

Methods

This study was carried out through the analysis of medical records on head trauma patients at Dr. Hasan Sadikin General Hospital Bandung

Bandung in the period before the pandemic period February 2018–February 2020 and during the pandemic period March 2020–September 2021 to assess the comparison of the characteristics and time of operation intervals of head trauma patients in the RSHS emergency room before and during the COVID-19 pandemic using analytical methods with a cross-sectional study design. The sample was taken according to minimal sample for characteristic study and confidential sample method. This study was approved by the Health Research Ethics Committee of Dr. Hasan Sadikin General Hospital Bandung by number LB.02.01/X.6.5/348/2022. Data was then cleaned and categorized to know the characteristics of the respondents and then analyzed by Chi-Squared and Mann-Whitney to find the differences in characteristics before and after the pandemic COVID-19.

Results

The majority of head traumas both before and during the pandemic occurred in men (87.04% and 81.5%), adults (53.7% and 51.9%), due to traffic accidents (64.8% and 66.7%), and were accompanied by fractures of the anterior cranial base (22.2% and 3.7%). The majority of head traumas with open fractures before the pandemic (46.1%) and linear fractures during the pandemic (48.1%), cerebral contusion lesions before the pandemic (33.3%), and epidural hematoma lesions during the pandemic (38.9%), mild trauma degrees before the pandemic (44.4%) and moderate trauma degrees during the pandemic (51.9%). Of the number of samples with positive results of PCR examination, 14 of the samples (25.9%) was already had been undergoing surgery (Table 1).

The length of stay before the pandemic was 3-7 days and during the pandemic was >14 days (5.5% negative PCR, 25.9% positive PCR) (Table 2). Surgery intervals >24 hours occurred before and during the pandemic (38.89% and 64.8%) (Table 3). Data analysis showed significant differences in the length of hospitalization and operating intervals before and during the pandemic ($p=0.04$ and $p=0.03$)

Discussion

There are differences in interval operation and duration of stay between patients with head trauma before the pandemic and during the

Table 1 Differences between Characteristics of TBI Patients Before and During the COVID-19 Pandemic

Variable		Before the COVID-19 Pandemic (54)		During the COVID-19 Pandemic (54)		p-value
		n	%	n	%	
Sex	Male	47	87	44	81	0.428
	Female	7	13	10	19	
Age	Children	9	17	5	9	0.973
	Adolescents	3	6	8	15	
	Adults	29	54	28	52	
	Elderly	7	13	9	17	
	Seniors	6	11	4	7	
Clinical status	Mild	24	44	20	37	0.313
	Moderate	27	50	28	52	
	Severe	3	6	6	11	
Skull fracture	Linier	14	26	26	48	0.433
	Open	26	46	16	30	
	Closed	10	19	8	15	
	Diastases	3	6	2	4	
	Avulsion	1	2	2	4	
Skull Base Fracture	Anterior	12	22	2	4	0.388
	Media	4	7	0	0	
	Anterior & Media	1	1	0	0	
Intracranial Lesion	Cerebral contusion	18	33	17	32	0.404
	Epidural hematoma	17	32	21	39	
	Subdural hematoma	16	29	12	22	
	Intracerebral hematoma	16	29	12	22	
	Intraventricular hematoma	1	2	3	6	
	Subarachnoid hematoma	7	13	9	17	
Mechanism	Traffic accidents	35	67	40	74	0.372
	Sports accidents	0	0	0	0	
	Work accidents	15	28	12	22	
	Abuse	1	2	6	11	
	Other causes	2	4	2	4	

pandemic ($p=0.04$ and $p=0.03$). Diagnosed TBI alongside COVID-19 was shown to increase the duration of hospital stay, noting that quarantine of COVID-19 patients is vital to limit the spread of infection. This study found that the average duration of hospital stay has increased from 7.3 days before the pandemic

to 8.9 days during the COVID-19 pandemic with statistical analysis showing a significant increase. Longer duration of hospital stay might be caused by longer quarantine, need to repeat PCR until negative, increased morbidity and mortality caused by longer time to surgery interval, and co-morbidities (DM, hypertension,

Table 2 Differences between Duration of Hospitalization of TBI Patients Before and During the COVID-19 Pandemic

Duration of Hospitalization	Before COVID-19 Pandemic (n=54)		During COVID-19 Pandemic (n=54)				p-value
	n	%	PCR (-)		PCR (+)		
			n	%	n	%	
<3 days	13	24	2	3.7	0	0	0,036
3 to 7 days	20	37	28	51.8	0	0	
8 to 14 days	16	29.6	7	12.9	0	0	
>14 days	5	9.3	3	5.5	14	25.9	

Table 3 Differences between Surgical Intervals of TBI Patients Before and During the COVID-19 Pandemic

Surgical Intervals	Before COVID-19 Pandemic (n=54)		During COVID-19 Pandemic (n=54)				p-value
	n	%	PCR (-)		PCR (+)		
			n	%	n	%	
<4 hours	14	25.9	2	3.7	0	0	0,004
4-24 hours	19	35.2	17	31.5	0	0	
>24 hours	21	38.9	21	38.8	14	25.9	

other cardiovascular disease) in patients with COVID-19. Another cause might be an increase in severe TBI cases with multiple traumas during the pandemic which needed a multidisciplinary approach and consecutively increased the duration of hospital stay. This finding was by a study by Chun et al.¹³ that found a significant increase in the duration of hospital stay during the pandemic compared with before, which is caused by the obligation of COVID-19 screening before admission.

This study also found a significant difference in time-to-surgery interval of TBI patients before and during the COVID-19 pandemic. This significant increase was also happening in India, which in turn caused increased risk of severity in TBI cases and also mortality during the pandemic. At Dr. Hasan Sadikin General Hospital Bandung, where this study was conducted, we found three factors that could contribute to an increase in the surgery interval.¹⁴ The first one was a delay to see, which could be caused by lockdown and decrease of transportation. Since the Indonesian government implemented PPKM (Pemberlakuan Pembatasan Kegiatan Masyarakat) regulation throughout Indonesia, including where this research was conducted, community mobility was significantly reduced, restriction of transportation including the number of ambulances resulted in highly difficult

access for accident victims to be delivered to nearest health facility. A study in Lithuania found that trauma patients during the lockdown had more severe clinical findings and therefore more patients need surgeries. Moreover, more time was needed to transport patients to the ER and conduct the COVID-19 screening, laboratory examination, and Computed Tomography.¹⁵

The second factor was a delay in reach, which may be the result of increased ambulance transportation for COVID-19 patients. The implementation of the *Sistem Rujukan Terpadu* (Sisrute) at Dr. Hasan Sadikin General Hospital has significantly resulted in delays in delivering patients from referral hospitals due to delayed response. Before referring, special requests such as Covid-19 PCR swabs, laboratory tests, and other supports highly influence the outcome of the patient who will be referred. This delay was also found in a study in Pennsylvania during the pandemic, which showed a decrease in EMS (Emergency Medical Services) response by as much as 26.5% during the pandemic compared with before. This was caused by reception disturbance and transportation limitations.¹⁶ Another study in South Korea also found an increase in rejection of medical transportation during the pandemic (6.7% before the pandemic to 8.2% during).¹⁷

The third factor is the delay in receive which

could be the cause of long COVID-19 screening, height of laboratory and radiology examination requests, increased workload of physicians, and anesthetists, and the long queue of surgeries especially for multiple trauma cases or patients with co-morbidities that needed more experts and examinations. Faried et al.¹⁸ found an increased duration in patients' response during the pandemic, with an average of 1–2 hours before the pandemic, to 14 hours during the pandemic caused by lengthy protocol in patients infected with COVID-19. This resulted in a worse prognosis.

In this research, head injuries due to child abuse during the COVID-19 pandemic era were found. However, it is still unclear how the trauma mechanism itself is related to the COVID-19 pandemic situation. Currently, the prevalence of abusive head trauma in children across Indonesia is not reported during the COVID-19 pandemic. Thus, the represented actual data in Indonesia could not be our reference. A nine-center in the United States retrospective review of child physical abuse with a total of 319 cases concluded that there were no significant differences in child physical abuse cases between the COVID-19 pandemic period to pre-pandemic period. Apparent rates of new injuries related to child physical abuse did not increase in the COVID-19 pandemic. There were also no significant differences in the types of injuries and outcomes. While this may suggest that pediatric physical abuse was not impacted by pandemic restrictions and stresses, it is possible that under-reporting, under-detection, or delays in presentation of abusive injuries increased during the pandemic.

Some factors that sped up the time to surgery interval were a compact referral system (*Sistem Rujukan Terpadu*), pre-referral PCR examination, and other evaluations that depleted the need for isolation for patients not infected with COVID-19. This altogether decreased the time to surgery interval for TBI patients.

In this study, some of the factors that increased the time to surgery interval were ambulance response, triage, waiting time for laboratory examination, and availability of radiology for patients infected with COVID-19. Another factor was the hospital's lack of preparation to face the COVID-19 pandemic, which forced a lot of adaptations and changes to be made to tackle COVID-19. Some new policies, such as obligated consultation with the COVID-19 team caused a delay in time to surgery interval. Other factors were limited Personal Protective Equipment

(PPE), only one operating theatre for COVID-19-infected patients, and limited experts. Unfortunately, with allocation of one operating theatre for COVID-19-infected patients also limited emergent surgeries for patients not infected with COVID-19.

This research is expected to be used as a reference by doctors and management in conducting the introduction, diagnosis, and appropriate therapy of head injuries. Especially neurosurgeons, the Pinere Team and operating room team and other multi-disciplinary teams, this research can provide an overview of the characteristics of head trauma patients so that appropriate and fast therapy can be conducted.

In addition, the authors also hope that this research can assist service management in health facilities. Among the expected benefits is that this research can serve as a reference so that the patient's screening process in triage will run more selectively, rapidly, and precisely, for patients to be operated on quickly.

Furthermore, it is expected that patient management will shorten the operating interval. At last, it is hoped that head trauma patients who come to the emergency room with confirmed COVID-19 can receive adequate and appropriate therapy to result in a better prognosis.

Limitations of this study are the need to further address these factors that affected the time to surgery interval. Another limitation is the association of the factor in increasing time to surgery interval was not divided in accordance to the pandemic period where at the beginning of the pandemic, systems and policies had not been done as well as 1–2 years after the first declaration of the pandemic. Another study to address other confounding factors is also needed. A pre-hospital study, relating to risk factors that can increase time to surgery interval, such as ambulance response time, triage, laboratory examination duration, and availability of radiology facilities also needs to be conducted.

References

1. Lindsay KW, Bone I, Fuller G. Neurology and neurosurgery illustrated e-book. 5th ed. Amsterdam: Elsevier Health Sciences; 2010.
2. James SL, Castle CD, Dingels Z V., Fox JT, Hamilton EB, Liu Z, et al. Global injury morbidity and mortality from 1990 to 2017: [published correction appears in *Inj Prev*. 2020;26(Supp 1):i165. doi: 10.1136/injuryprev-2019-043494corr1]. *Inj Prev*.

- 2020;26(Supp 1):i96-i114. doi:10.1136/injuryprev-2019-043494.
3. WHO. WHO director-general's opening remarks at the media briefing on covid-19. World Health Organization. <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-atthe-media-briefing-on-Covid-19-11-march-2020>; 2020.
 4. Chatterjee K, Chatterjee K, Kumar A, Shankar S. Healthcare impact of COVID-19 epidemic in India: A stochastic mathematical model. *Med J Armed Forces India*. 2020;76(2):147–55. doi:10.1016/j.mjafi.2020.03.022
 5. Tripathy S, Vijayaraghavan BK, Panigrahi MK, Shetty AP, Haniffa R, Mishra RC, et al. Collateral impact of the COVID-19 pandemic on acute care of non-COVID patients: an internet-based survey of critical care and emergency personnel. *Indian J Crit Care Med*. 2021;25(4):374–81. doi:10.5005/jp-journals-10071-23782
 6. Yue JK, Krishnan N, Chyall L, Haddad AF, Vega P, Caldwell DJ, et al. Predictors of extreme hospital length of stay after traumatic brain injury. *World Neurosurg* 2022;167:e998–1005. doi:10.1016/j.wneu.2022.08.122
 7. Levant S, Chari K, DeFrances C. National hospital care survey demonstration projects: traumatic brain injury. *Natl Health Stat Report*. 2016;(97):1–16
 8. Rosyidi RM, Wisnu Wardhana DP, Apriawan T, Al Fauzi A, Priyanto B, Gunawan K, et al. Algorithm of traumatic brain injury management at Indonesia in the COVID 19 pandemic ERA. Retrospective cohort study. *Ann Med Surgery*. 2021;1(62):98–103.
 9. Salazar LRM, Agrawal D, Deora H, Agrawal A. Neurotrauma in the time of SARS-COV 2: a checklist for its safe management. *J Neurosci Rural Pract*. 2020;11(3):474–7. doi:10.1055/s-0040-1712553
 10. Tverdal C, Aarhus M, Andelic N, Skaansar O, Skogen K, Helseth E. Characteristics of traumatic brain injury patients with abnormal neuroimaging in Southeast Norway. *Inj Epidemiol*. 2020;7(1):1–13. doi:10.1186/s40621-020-00269-8
 11. Adam A, Ariono C, Arifin MZ, Faried A. Cognitive function outcomes of post-operative mild to moderate traumatic brain injury using combination of minimal state examination, digit span, and constructional praxis. *Open Access Maced J Med Sci*. 2020;8:1180–4.
 12. Grevfors N, Lindblad C, Nelson DW, Svensson M, Thelin EP, Rubenson Wahlin R. Delayed neurosurgical intervention in traumatic brain injury patients referred from primary hospitals is not associated with an unfavorable outcome. *Front Neurol*. 2021;11:1799. doi:10.3389/fneur.2020.610192
 13. Chun SY, Kim HJ, Kim HB. The effect of COVID-19 pandemic on the length of stay and outcomes in the emergency department. *Clin Exp Emerg Med*. 2022;9(2):128–33
 14. Shah B, Krishnan N, Kodish SR, Yenokyan G, Fatema K, Burhan Uddin K, et al. Applying the three delays model to understand emergency care seeking and delivery in rural Bangladesh: a qualitative study. *BMJ Open*. 2020;10(12):e042690. doi:10.1136/bmjopen-2020-042690
 15. Aukstakalnis V, Blaziene K, Cepla J, Vileitaite G, Stasaitis K, Vaitkaitis D. Impact of the COVID-19 lockdown on trauma team activations in a single major Lithuanian trauma center: A retrospective single-center study. *Int J Crit Illn Inj Sci*. 2022;12(1):17–21. doi:10.4103/ijciis.ijciis_66_21.
 16. Satty T, Ramgopal S, Elmer J, Mosesso VN, Martin-Gill C. EMS responses and non-transportations during the COVID-19 pandemic. *Am J Emerg Med*. 2021;42:1–8.
 17. Ryu MY, Park HA, Han S, Park HJ, Lee CA. Emergency transport refusal during the early stages of the COVID-19 pandemic in Gyeonggi Province, South Korea. *Int J Environ Res Public Health*. 2022;19(14):8444. doi:10.3390/ijerph19148444
 18. Faried A, Hidajat NN, Harsono AB, Giwangkencana GW, Hartantri Y, Imron A, et al. Delayed definitive treatment of life-threatening neurosurgery patient with suspected coronavirus disease 2019 infection in the midst of pandemic: Report of two cases. *Surg Neurol Int*. 2021;12:18. doi:10.25259/SNI_828_2020
 19. Russell KW, Acker SN, Ignacio RC, Lofberg KM, Garvey EM, Chao SD, et al. Child physical abuse and COVID-19: Trends from nine pediatric trauma centers. *J Pediatr Surg*. 2022;57(2):297–301. doi:10.1016/j.jpedsurg.2021.09.050