Indonesian Journal of Neurosurgery

Comparison of Neutrophil Lymphocyte Ratio in Traumatic Head Injury Patients With and Without Intracranial Hemorrhage at Dr. M. Djamil Hospital

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ABSTRACT

Background: Head injuries occur every 15 seconds worldwide, with patients dying every 12 minutes. The value of the Neutrophil Lymphocyte Ratio (NLR) is a factor that influences the assessment and prognostic value of patients with intracranial hemorrhage and without intracranial hemorrhage in head injury.

Objective: The aim of this study was to determine the relationship between increased NLR based on severity of head injury patients with or without intracranial hemorrhage.

Methods: This study is a retrospective cross sectional study of head injury patients with hemorrhage and without intracranial hemorrhage who were treated at Dr. M. Djamil Hospital Padang in 2020 from May to December 2020. Data was collected in the Medical Records Department of Dr. M. Djamil Hospital Padang who met the inclusion and exclusion criteria.

Results: The results showed that there was a significant relationship between NLR levels in moderate head injury patients with hemorrhage (14,20) and without intracranial hemorrhage (7,20) (p value = 0.029), whereas in severe head injury it could not be assessed because there was no sample without hemorrhage.

Conclusion: There is an association between increased NLR and intracranial bleeding in moderate head injury patients.

Keywords: Head injury, Intracranial hemorrhage, NLR.

Cite This Article: Hafiz, M.Z.A., Saanin, S., Ningsih, H.L. 2021. Comparison of Neutrophil Lymphocyte Ratio in Traumatic Head Injury Patients With and Without Intracranial Hemorrhage at Dr. M. Djamil Hospital. *Indonesian Journal of Neurosurgery* 4(1): 43-51. DOI: 10.15562/ijn.v4i1.169

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Received: 2021-02-06

Accepted: 2021-03-13

Published: 2021-04-30

INTRODUCTION

Head Injury is defined as changing of brain function or other evidence of brain pathology caused by external mechanic force. Altered brain function is temporary or permanent after trauma. Head injury becomes one of the leading health problems and caused major morbidity and mortality in young adult population. Globally, head injury causes major morbidity and mortality in traffic accident cases. Head injury is happened every 15 seconds worldwide with death patients every 12 minutes. It was predicted that head injury would be the third leading cause of death in 2020.^{1,2,3}

Based on Basic Health Research (Riskesdas) in 2018, head injury proportion nationally is 11.9%, with proportion in West Sumatera is 14.3%. Based on Medical Record Installation's data of RSUP Dr. M. Djamil Padang, the sums of head injury cases in 2017 are 356

cases, and in 2018 are 505 cases.⁴

Head injury is classified into focal and diffuse head injury. In Traumatic Coma Data Bank (TCDB), mortality rate of focal head injury is 39%, then diffuse head injury is 24%. There are 4 types of intracranial hemorrhage focal lesion: (1) subdural, (2) epidural, (3) subarachnoid, and (4) Intracerebral hematoma. Head injury without hemorrhage could be found in the form of brain oedema and diffuse axonal injury.³

Patients with head injury show many aspects of acute phase response, one of them is the elevation of cytokine. Intracerebral cytokine responsible for brain edema and trigger leukocyte adhesion right after the injury of the brain. These two effects influence the vessel permeability and activate the leukocyte.³ Because of that leukocyte is used as an indicator to predict the outcomes of the head injury. Elevation of leukocyte value could predict the outcomes of the head

injury.⁵

Leukocyte value is always assessed in every hospital. Leukocyte value could be used as a marker of higher inflammation status and contribute to significant bleeding and head injury.^{6,10} One hypothesis is appeared that patient with significant trauma should have an elevation of leukocyte value than the patient with a minor trauma.¹⁰

A research conducted by Al-Gahtany in Saudi Arabia 2015 shows that there is a significant relationship between leukocyte value and GCS, with leukocyte value more than $14,18 \times 10^6/L$ has a predictive value to lower GCS. This is thought to be an evidence of correlation between blood leukocyte value to GCS based on literature.³ Leukocyte also could determine the prognosis of traumatic head injury.⁶

In one study done by Gurkanlar et al in 2009 to 59 patients of head injury, found that leukocyte value more than $17,5 \times 10^6/L$ has predictive value to poor GCS and

bad CT Scan results, without looking at the presentation of the focal lesion types, meanwhile the patients with low leukocyte value have a good result. Patients with leukocyte value $23,74 \times 10^6/L$ is associated with poor clinical state, and patients with leukocyte value $11,3 \times 10^6/L$ is associated with good clinical state.¹¹

The elevation of leukocyte and neutrophil is commonly thought as nonspecific indicator in infection, inflammation, tissues necrosis, bleeding, or stress condition. One of the inflammation markers that could be used is Neutrophil Lymphocyte Ratio (NLR). Neutrophil and Lymphocyte value could get from Leukocyte differential count which is one of the components of routine blood examination. Some studies show there were neutrophil value elevation (neutrophilia) and lymphocyte value demotion (lymphocytopenia) right after the tissue injury, including in head injury patients. The important role of the neutrophil in ischemic-reperfusion injury is argued by some studies that show close association between neutrophil accumulation and tissue injury.^{12,13}

NLR value has approved as prognosis predictor in patient which involves the state of the brain. A research was conducted by Chen et al in 2017 to 688 patients with a goal to know the changing of NLR in head injury patients and to analyze the relation between NLR value and head injury. The multivariate analysis of this research shows significant result ($p < 0,001$) of high NLR value association with head injury patient's outcomes.¹⁴ A retrospective research evaluates 316 patients who have severe *traumatic brain injury* (TBI). That research got significant result between maximum value of NLR and clinical prognosis of severe TBI.¹⁵

NLR value is a factor that influences the assessment and prognosis of head injury with or without intracranial bleeding. NLR value is easy to count and to apply, but research about NLR of head injury patient is still rarely conducted.

METHODS

Retrospective data was collected from patients with intracranial hemorrhage and without intracranial hemorrhage in head injury between May and December 2020.

Medical record data of patient with head injury who met the inclusion and exclusion criteria in Dr. M. Djamil Hospital Padang were used for the analysis. The sample size was determined by method simple random sampling. Inclusion criteria in this study included : head injury patients who were treated at Dr. M. Djamil Hospital Padang in 2020, head CT scan., and complete laboratory data had been carried out (there were neutrophil and lymphocyte data when entering the hospital). Whereas,

the exclusion criteria in this study were head injury patients with a history of comorbidities (diabetes mellitus, positive PCR COVID-19 results, previous infection history, and immunodeficiency such as use of immunosuppressant drugs, HIV-AIDS, leukemia, multiple myeloma).

Data obtained by observing the results on the medical records by collecting data on gender, age, disease severity level based on GCS, leukocytes, neutrophils, lymphocytes, NLR, treatment and

Table 1. Characteristics of Head Injury Patient Based on Gender, Severity of Head Injury, Zone of the Ward Room, and Treatment

Variable	N	%
Gender		
Male	64	69,6
Female	28	30,4
Severity of the head injury		
Minor	48	52,2
Moderate	28	30,4
Severe	16	17,4
Zone of the ward room		
Yellow Zone	23	25,0
Green Zone	69	75,0
Treatment		
Conservative	76	82,6
Craniotomy	16	17,4
Total	92	100

Table 2. Characteristics of Head Injury Patient Based on Mean Value of NLR, GCS, Leukocyte, Lymphocyte, Total Neutrophil and Age

Variable	Mean	Median	Sd	Min-Max
RNL	11,72	10,55	7,31	0,60-31,60
GCS	12,02	14,00	3,16	4,00-15,00
Leukosit	17.154,89	16.765,00	5.861,85	7.220-35.560
Limfosit	11,21	8,00	9,10	3-58
Neutrofil Total	82,82	86,00	10,27	36-95
Umur	32,34	23,50	21,67	2-85

Table 3. Results of Patients' COVID19 Test and Ward Room Zone

PCR	Zone		Total
	Green Zone n (%)	Yellow Zone n (%)	
Negative	69 (75)	23 (25)	92 (100)

Table 4. Relationship Between Severity of the Head Injury and Gender

Gender	Severity of the Head Injury			Total	p value
	Minor n(%)	Moderate n(%)	Severe n(%)		
Male	33 (51,6)	21 (32,8)	10 (15,6)	64 (100)	0,676
Female	15 (53,6)	7 (25,0)	6 (21,4)	28 (100)	

*Pearson Chisquare test

Table 5. Relationship between Severity of the Head Injury with Age

	Severity	N	Mean	SD	p value
Age	Minor	48	29,42	20,30	0,209
	Moderate	28	32,68	20,88	
	Severe	16	40,50	25,96	

*One Way Anova Test

Table 6. Correlation Between Severity of the Head injury with Surgical Treatment

Tindakan	Tingkat Keparahan			Total	p value
	Ringan n(%)	Sedang n(%)	Berat n(%)		
Konservatif	44 (57,9)	22 (28,9)	10 (13,2)	76 (100)	0,023
Kraniotomi	4 (25,0)	6 (37,5)	6 (37,5)	16 (100)	

*Uji Pearson chisquare

Table 7. Result of Head Injury Patients' Analysis Based on Leukocyte Value

	Cedera Kepala	n	%	Kadar Leukosit			
				Mean	Std. Deviasi	Std. Error	p-Value
Perdarahan	Ringan	20	41,7	15.688	5.031,08	1.124,98	0,388
	Sedang	22	78,6	17.730,91	5.717,83	1.219,04	0,630
	Berat	16	100	18.773,13	5.946,85	1.486,71	-
Tanpa Perdarahan	Ringan	28	58,3	17.031,79	5.417,58	1.023,83	-
	Sedang	6	21,4	16.191,67	10.375,28	4.235,69	
	Berat	0	0	0	0	0	

Table 8. Result of Head Injury Patients' Analysis Based on Neutrophil Value

	Cedera Kepala	n	%	Kadar Leukosit			
				Mean	Std. Deviasi	Std. Error	p-Value
Perdarahan	Ringan	20	41,7	82,65	9,95	2,23	0,487
	Sedang	22	78,6	86,41	5,75	1,23	0,016
	Berat	16	100	83,63	10,42	2,61	-
Tanpa Perdarahan	Ringan	28	58,3	80,46	11,11	2,10	-
	Sedang	6	21,4	74,33	20,06	8,19	
	Berat	0	0	0	0	0	

Table 9. Result of Head Injury Patients' Analysis Based on Lymphocyte Value

	Cedera Kepala	n	%	Kadar Leukosit			
				Mean	Std. Deviasi	Std. Error	p-Value
Perdarahan	Ringan	20	41,7	11,90	8,71	1,95	0,745
	Sedang	22	78,6	8,05	4,91	1,05	0,017
	Berat	16	100	16	8,94	7,11	-
Tanpa Perdarahan	Ringan	28	58,3	12,75	8,96	1,69	-
	Sedang	6	21,4	19,33	19,45	7,94	
	Berat	0	0	0	0	0	

management. The data were processed and analyzed using SPSS version 22. Data were presented in tables and diagrams. Univariate analysis was performed using the one-way ANOVA test to see the relationship between severity and RVL increase. This study also used the T-test independent too see the average difference in lymphocyte and neutrophil levels in mild, moderate, severe head injury patients in the patients with intracranial hemorrhage and without intracranial hemorrhage. The results are different if the P value < 0,05.

RESULTS

Table 1 Characteristics of head injury patient shows that 69.6% of respondents are male and 30.4% of respondents are female. 52.2% of respondents have minor head injury, 30.4% moderate head injury, and 17.4% severe head injury. As much as 75% of respondents are situated in the green zone and 25% of respondents are in the yellow zone. Most of the sample (82.6%) are received conservative treatment dan 17.4% got an operative treatment.

Table 2 shows that mean value of Neutrophil and Lymphocyte Ratio is 11.72 with variation 7.31. Mean value of GCS is 12.02 with variation 3.16. Mean value of leukocyte is 17.154,89/mm³ with variation 5.861,85/mm³. Mean value of Lymphocyte is 11.21% with variation 9.10%. Mean value of total neutrophil is 82.82% with variation 10.27%. And mean value of respondents' age is 32 years old with variation 22 years old.

Table 3 shows that 100% of the head injury patients that situated in the yellow zone criteria have negative result of PCR COVID19 test

Table 4 shows that minor head injury of in males are 51.6% and females are 53.6%. Moderate head injury in males are 32.8% and females are 25%. Severe head injury in males are 15.6% and females are 21.4%. Result of statistic test shows that there was no significant relationship between gender and the severity of the head injury (p value = 0,676).

Table 5 shows that mean of severity of the head injury based on age is 40.50 years old on severe head injury, 32.68 years old on moderate head injury, and 29.42 years old on minor head injury. Result of statistic

Table 10. Difference of Mean NLR Value Based on Head injury With and Without Intracranial Hemorrhage

Variabel	Head Injury	n	Mean	Std. Deviasi	Std. Error	p-Value
Kadar RNL	Hemorrhage	58	12,91	7,43	0,98	0,041
	No hemorrhage	34	9,69	6,71	1,15	

Table 11. Difference of Mean NLR Value Based on Severity of the head Injury

Variabel	Head Injury	n	Mean	Std. Deviasi	Std. Error	p-Value
Kadar RNL	Minor	48	10,15	6,38	0,92	0,066
	Moderate	28	12,70	7,09	1,34	
	Severe	16	14,69	9,30	2,32	

Table 12. Result of Head Injury Patients' Analysis Based on NLR

	Cedera Kepala	n	%	Kadar Leukosit			
				Mean	Std. Deviasi	Std. Error	p-Value
Perdarahan	Ringan	20	41,7	10,05	5,65	1,26	0,930
	Sedang	22	78,6	14,20	6,87	1,46	0,029
	Berat	16	100	16	14,69	9,30	-
Tanpa Perdarahan	Ringan	28	58,3	10,22	6,96	1,31	
	Sedang	6	21,4	7,20	5,22	2,13	
	Berat	0	0	0	0	0	

test shows that there was no relationship of severity of the head injury based on age (p value = 0,209).

Table 6 shows that 57.9% of respondents with conservative treatment have minor head injury and 37.5% of respondents with craniotomy treatment have moderate and severe head injury. Result of statistic test shows that there was a correlation between craniotomy treatment with severity of the head injury (p value = 0,023).

Table 7 shows that there was no major differentiation of leukocyte value in minor head injury with and without intracranial hemorrhage (p value = 0,388), and there was no major differentiation of leukocyte value in moderate head injury with and without intracranial hemorrhage (p value = 0,630).

Table 8 shows that there was no major differentiation of neutrophil value in minor head injury with and without intracranial hemorrhage (p value = 0,487) and there was no major differentiation of neutrophil value in moderate head injury

with and without intracranial hemorrhage (p value = 0,016).

Table 9 shows that there was no major differentiation of lymphocyte value in minor head injury with and without intracranial hemorrhage (p value = 0,745). But there was major differentiation found of lymphocyte value demotion in moderate head injury with and without intracranial hemorrhage (p value = 0,017).

Table 10 shows that there was major differentiation of mean NLR Value in head injury patient with and without intracranial hemorrhage (p value = 0,041).

Table 11 shows that there was no major differentiation of mean NLR value based on its severity (p value = 0,066).

Table 12 shows that there was no major differentiation between NLR value in minor head injury with and without intracranial hemorrhage (p value = 0,930). Result of the research shows that there was major differentiation of NLR Value in moderate head injury with and without intracranial hemorrhage (p value = 0,029).

DISCUSSION

In this study, 92 patients were included in inclusion criteria. The sex comparison of the data analysis showed that the incidence of head injury was more common in males (69.6%) than in females (30.4%). A similar thing was obtained in research conducted by Alexiou et al. (2020), there were 85 male patients and 45 female patients.⁷⁰ The higher incidence of head injury in men is because they have aggressive behavioral risk, higher mobility than women.^{70,71,72}

This study, as much as 52.29% experienced minor injury, 30.4% moderate injury, and 17.4% severe injury. As similar thing was obtained in research conducted by Capizi et al. (2020) in United States that head injuries that occur are dominated by minor head injuries (80%) and moderate and severe head injuries each 10% of total head injuries.⁹⁰

This study was conducted during the COVID-19 pandemic so that more than half (75%) of the respondents were in the green zone and 25% in the yellow zone.

In this study, most of the sample (82.6%) received conservative action and 17.4% performed operative action. In accordance with the literature that 25% of head injury patients in the United States require surgery.⁸⁸

The results of this study indicate that the mean value of the neutrophil lymphocyte ratio is 11.72 with a variation of 7.31. As similar thing was obtained in research conducted by Gieroba et al. (2029) in Poland where the mean NLR in head injury patients was 11.74.⁵⁰

In this study, the mean GCS value was 12.02 with a variation of 3.16. Research by Masoum et al in Iran in 2018 showed the same result, namely the mean GCS score at admission was $8,6 \pm 3,5$, and at the of the study was $12,9 \pm 3,5$.^{59,64,65}

As the result of this study, the mean value of leukocytes was $17.154,89 \text{ mm}^3$ with a variation of $5861,85 \text{ mm}^3$. In a study conducted by Wang et al (2014) in Taiwan obtained the range of leukocytes in head injury was 10.400 mm^3 to 16.300 mm^3 .¹

In this study, the mean lymphocyte value was 11,21% with a variation of 9,10%. Research conducted by GedeFebby et al in 2019 at Sanglah General Hospital Denpasar found that the average number of lymphocytes in TBI patients was in

the normal range and only 28.2% had lymphopenia. A decrease in the number of lymphocytes in TBI patients can occur due to an increase in the release of hormone cortisol by the adrenal glands in response to TBI stress.^{78,79}

In this study, the total neutrophil value was 82,82% with variation of 10,27%. As similar thing was obtained in research conducted by Gede et al. (2019) that the mean value of total neutrophil levels is above 75%.⁷⁸

The age of the respondents in this study had a mean of 32 years with a variant of 22 years. Mateu et al conducted a study in Denmark on the incidence of head injuries. The results of this study indicate that the age population that has the most incidence of head injuries, namely 16 to 35 years, is influenced by the higher mobility of young adults.⁶⁹

As the results of this study, obtained head injury patients treated at the yellow zone room based on Covid-19 screening team were 23 people and with a negative covid-19 swab result. Huang et al's research in 2020 showed that a lower lymphocyte count was a parameter of the assessment of covid-19 patients associated with increased mortality, ARDS, ICU care needs.^{54,55,56,57,58} while a decrease in the number of lymphocyte in TBI patients could occur due to increased release of the hormone cortisol by adrenal glands in response to TBI stress.^{78,79}

The results of statistical tests in this study showed that there was no correlation between sex and the severity of head injury ((*p value*=0,676). The results of this study differ from the literature which shows that gender has a significant correlation with head injury. In a research conducted by Ashok et al in 2018 showed that female patients experienced head injuries with more severe injury severity than male patients in the middle and old age groups.^{72,73}

The results showed that the mean level of the severity based on age had a value 40,50 years at a severe level of severity and 29,42 years at a moderate severity level and 29,42 years at a minor severity level. The results of statistical tests showed that there was no correlation between age and the severity (*p value* = 0,209). This is consistent with a study by Vineet et al in India (2014)

which showed that the age distribution of patients with moderate or severe head injury showed the highest incidence in the 21-30 years age group (29,68%) followed by 31-40 years (18,07%).⁷²

The results of this study showed 16 patients (21%) of the total sample underwent surgery. The results of statistical tests showed that there was a correlation between craniotomy and the severity of head injury (*p value* = 0,023). In accordance with the literature that 25% of head injury patients in the United States require surgical intervention according to clinical indication of severity and brain CT-scan images.⁸⁸

As the result of this study the mean of leukocyte level based on the severity of the minor head injury patients with intracranial hemorrhage was 15688 mm³, Moderate head injury with intracranial hemorrhage was 17.730,91 mm³ and in severe head injury with intracranial hemorrhage was 18.773,13 mm³. The mean level of leukocyte in mild head injury patient without intracranial hemorrhage was 17.031,79 mm³. The mean level of leukocyte in moderate head injury patient without intracranial hemorrhage was 16.191,67 mm³ and there was no sample severe head injury without intracranial hemorrhage, and there was no correlation between leukocyte level in patient with mild head injury with hemorrhage or without hemorrhage (*p value* = 0,388) and there was no correlation between leukocyte levels in moderate head injury patients with intracranial hemorrhage or without intracranial hemorrhage (*p value* = 0,630).

The inflammatory response, activation of endothelial cells, and release of inflammatory mediators in head injury can increase the number of leukocytes. Head injury is associated with a marked acute phase response with leukocytosis due to elevated epinephrine and cortisol. Subramanian PS et al in 2018 explained that in brain injury a traumatic microvascular rupture occurs which will be followed by physical occlusion. The nature of leukocyte that difficult to change shape when compared to erythrocytes so that it requires greater pressure so that leukocytes can pass through small diameter capillaries. In conditions where

tissue perfusion decreases, the capillaries function as filters that filter out leukocytes so that there is an increase in leukocytes in the peripheral blood. After trapped in the capillaries, leukocytes and endothelial adhesions occur so that the leukocyte will not be released even though the perfusion pressure returns to normal. In a study conducted by Bangun at Sanglah General hospital Denpasar 2019, it was found that the average examination of peripheral blood leukocytes was 22,5 x 10³ / μ L. Leukocyte counts exceeding 17.5x10⁶ / L have a poor predictive value of GCS scores and longer length of stay in hospital.^{40,81,82,83}

The results showed that the mean level of neutrophils based on severity of mild head injury with intracranial hemorrhage was 82,65%, moderate head injury with intracranial hemorrhage was 86,41%, and severe head injury with intracranial hemorrhage was 83,63%. The mean neutrophil level in mild head injury patients without intracranial hemorrhage was 80,46%, moderate head injury patients without intracranial hemorrhage was 74,33%, and there was no severe head injury sample without intracranial hemorrhage.

There is no significant correlation of neutrophil levels in minor head injury patients with intracranial hemorrhage and without intracranial hemorrhage (*p value* = 0,487) and there was a correlation between increased neutrophil level in moderate head injury patients with intracranial hemorrhage and without intracranial hemorrhage (*p value* = 0,016). From some literature it was found that neutrophils are among the cells repons to the early phase of inflammation. Increased number of neutrophils can cause damage to the blood brain barrier and nerve cell death.^{64,65,66}

In a study conducted by Gede et al in 2019 found that there was an increase in the mean number of neutrophils in TBI patients, and most TBI patients had neutrophilia (neutrophil count > 7,5 x 10³ / μ L). These results support several previous studies, which also found that there was increase in number of neutrophils in TI patients.^{14,15,81}

Research conducted by Yang et al in 2018 indicated that rapid increased

levels of blood neutrophils can occur due to the increase in catecholamine and glucocorticosteroids induced by TBI, neutrophils play an important role in BBB disorders. Increased neutrophils were associated with increased intracranial pressure and were significantly higher in non-survivors than survivors after TBI.^{84,85,86,87}

This study showed that the mean lymphocyte level based on the severity of minor head injury with intracranial hemorrhage was 11,90%. The mean lymphocyte level with moderate head injury with intracranial hemorrhage was 8,05%. The mean lymphocyte level with severe head injury with intracranial hemorrhage was 16,00%.

The mean lymphocyte level in minor head injury patients without intracranial hemorrhage was 12,75%, moderate head injury without intracranial hemorrhage was 19,33% and there was no sample of severe head injury without intracranial hemorrhage.

Based on the result of this research, there was no significant correlation between lymphocyte levels in minor head injury patient injury with intracranial hemorrhage and without intracranial hemorrhage (p value = 0,745). However, there was correlation of decreased lymphocyte levels in moderate head injury patients with intracranial hemorrhage and without intracranial hemorrhage (p value = 0,017).

Research conducted by Gede Febby et al in 2019 at Sanglah Hospital Denpasar found that the average number of lymphocytes in TBI patients was in the normal range and only 28,2% had lymphopenia. A decrease in the number of lymphocytes in TBI patients can occur due to increased release of hormone cortisol by the adrenal glands in response to TBI stress.^{78,79}

Based on the result of this research, the mean NLR level based on head injury with intracranial hemorrhage was 12,91 and without intracranial hemorrhage was 9,69. This study showed that there was a significant difference in the mean of NLR levels in the head injury patients with intracranial hemorrhage and without intracranial hemorrhage (p value = 0,041). The correlation between high NLR and

short-term mortality is complex and can involve many other factors. After the onset of ICH, neutrophils are the earliest leukocytes that appear in the hematoma peaking within 2-3 days and then gradually disappearing.⁸⁹

The results of this study showed that the NLR level in minor head injury patients was 10,15, in moderate head injury patients was 12,70, and in severe head injury patients was 14,69. In this research, there was no significant correlation between the mean on NLR levels based on the severity of head injury (p value = 0,066). In a study conducted by Fei et al in 2018 among 181 patients, 74 had high NLR ($>7,35$) and the others 107 had low NLR (7,35). The group with incidence of death within 30 days was 37,8% (28/74) in the high NLR group and 6,5% (7/107) in the low NLR group ($P < 0,001$).⁸⁹ There was no statistically significant difference between NLR levels and the severity of head injury due to absence of a sample of severe head injury without intracranial hemorrhage.

The results of this study showed that the mean NLR level based on the severity of minor head injury with intracranial hemorrhage was 10,05. The mean NLR level of moderate head injury with intracranial hemorrhage was 14,20. The NLR level for the severe head injury with intracranial hemorrhage was 16.

The mean NLR in mild head injury patients without intracranial hemorrhage was 10,22. The mean NLR on moderate head injury patients without intracranial hemorrhage was 7,20 and there was no sample of severe head injury without intracranial hemorrhage.

A retrospective study assessed 316 patients who experienced severe TBI in January 2013 to January 2017. The aim of this study was to analyze the correlation between peak NLRs examined on day 1 to day 12 of patient care with a prognosis 1 year after the incidence of severe TBI. This study obtained significant result between the maximum value of the neutrophil and lymphocyte ratio with the clinical prognosis after the incidence of severe TBI. The NLR peak limit sensitivity of 74,3% and a specificity of 72,9%, this can determine a poor diagnosis after the incidence of severe TBI.⁴⁹

A study conducted by Chen et al in 2017 on 688 patients aimed to examine changes in NLR in head injury patients and to analyze the correlation between NLR values and head injury. The best threshold of the NLR value obtained in this study was 13,05 with a sensitivity of 60,29% and a specificity of 71,1%. A total of 248 patients (36%) died within 1 year of the head injury incident, which is associated with a high NLR value. The results of the multivariate analysis of this study showed that a significant ($p < 0,001$) result on high NLR values related to the outcomes of head injury patients.⁴⁸

Research by Alexiou et al in 2020 showed that data from 130 patients with minor TB, 74 patients were found to be CT positive. Patients with positive CT findings had significantly higher NLR values.⁵³ In a study conducted by Rabekah et al in the United States in 2020, the same results were obtained, the overall mean NLR was $4,30 \pm 6,00$ in the 12 hours after injury ($N = 156$), $5,10 \pm 5,95$ at 24 hours ($N = 58$), $6,03 \pm 3,59$ at 48 hours ($N = 27$), and $8,10 \pm 9,98$ at 72 hours ($N = 21$). NLR is an objective, readily available and inexpensive indicator of inflammation. NLR is a broad marker of secondary damage caused by neutrophils and their products to brain tissue. A higher NLR value is an independent predictor of poorer functional outcome and a higher mortality rate in patients with head injury and correlates with a lower GCS score.^{59,60}

Based on the result of this research, there was no significant correlation between NLR levels in minor head injury patients with intracranial hemorrhage or without intracranial hemorrhage (p value = 0,930). The results showed that there was a correlation between an increase in NLR levels in moderate head injury patients with intracranial hemorrhage and without intracranial hemorrhage (p value = 0,029).

The correlation between high NLR and clinical deterioration suggests that using NLR to measure the rate of neutrophil response to head injury and potential sequelae is the first step in understanding the pathophysiology of this process and for its proper management. The NLR is an easily available clinical marker that can aid in assessing the severity of head injury.^{59,62}

CONCLUSIONS

Head injury in males is more common than in females with males 69.4% and females 30.4%. Based on severity of the head injury, minor head injury is 52.2%, moderate head injury 30.4%, and severe head injury 17.4%. Based on zone of the ward room from COVID19 screening, 75% patients of head injury are situated in the green zone, and 25% patients in the yellow zone. Patients of head injury who got operative treatment are 17.4%.

Head injury patients' characteristic from mean value of NLR is 11.72, mean value of GCS is 12.02, mean value of leukocyte is 17.154,89/mm³, mean value of lymphocyte is 11.21%, mean value of total neutrophil is 82.82%, and mean value of age is 32 years old.

All of the sample patients (100%) who are situated in the yellow zone ward room, have negative result of PCR COVID19 test.

There was no significant relationship between the severity of the head injury and gender (*p value* = 0,676), age (*p value*=0,209), and there was correlation between severity and surgical treatment (*p value*=0,023).

There was no relationship of leukocyte value in minor head injury with and without intracranial hemorrhage (*p value* = 0,388), and there was no relationship of leukocyte value in moderate head injury with and without intracranial hemorrhage (*p value* = 0,630). The relationship between leukocyte value in severe head injury patients with and without hemorrhage cannot be measured, because there were no sample patients without hemorrhage.

There was no major differentiation of neutrophil value in minor head injury with and without intracranial hemorrhage (*p value* = 0,487) and there was no major differentiation of neutrophil value in moderate head injury with and without intracranial hemorrhage (*p value* = 0,016). The relationship between neutrophil value in severe head injury patients with and without hemorrhage cannot be measured because there were no sample patients without hemorrhage.

There was no significant relationship of lymphocyte value in minor head injury with and without intracranial hemorrhage (*p value* = 0,745). But there was major differentiation found of lymphocyte value

demotion in moderate head injury with and without intracranial hemorrhage (*p value* = 0,017). The correlations between lymphocyte value in severe head injury patients with and without hemorrhage cannot be measured because there were no sample patients without hemorrhage.

There was major differentiation of mean NLR Value in head injury patient with and without intracranial hemorrhage (*p value* = 0,041), there was no major differentiation of mean NLR value based on its severity (*p value* = 0,066), there was no major differentiation between NLR value in minor head injury with and without intracranial hemorrhage (*p value* = 0,930), there was major differentiation of NLR Value in moderate head injury with and without intracranial hemorrhage (*p value* = 0,029). The correlations between NLR value in severe head injury with and without hemorrhage cannot be measured because there were no sample patients without hemorrhage.

It is hoped that there will be further research with a larger sample in order to obtain a heterogenous sample that can be compared to measure the correlations of NLR with intracranial hemorrhage based on the severity of the head injury.

DECLARATIONS

Ethical approval

Has met the requirements of the ethical clearance.

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