Prognostic Value Of Leukocytosis In Pediatric Head Trauma

Levent Sahin (✉ levsahin44@gmail.com)

Kafkas Universitesi Tip Fakultesi <https://orcid.org/0000-0003-0193-4393>

Murat Kayabas

Kafkas Universitesi Tip Fakultesi

Levent Aras

Kafkas Universitesi Tip Fakultesi

Original research

Keywords: Pediatric head trauma, Leukocytosis, Glasgow Coma Scale

Posted Date: May 7th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-25939/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Purpose

Our aim in this study is to investigate the relationship between age, gender, trauma etiology, presence of symptoms at the time of admission, Glasgow Coma Scale (GCS), brain CT findings and blood WBC levels at admission.

Methods

305 pediatric patients [between 0 and 18 years old] who applied to the emergency department of Kafkas University Medical Faculty Hospital between 2016 and 2019 after head trauma were included in the study. The data of these patients were analyzed retrospectively from the hospital records. Age, gender, head trauma etiology, GCS scores at the time of presentation, their symptoms, their brain CT findings and blood WBC levels were examined. Chi-square test was performed between patients with and without leukocytosis and independent variables.

Results

After applying exclusion factors, the data of 173 patients who underwent CT in the emergency room after head trauma and whose blood tests were studied were examined. When patients were analyzed according to gender, 111 (64.2%) were male and 62 (35.8%) were found to be female. In terms of age, it was seen that those between the ages of 0 and 2 were 54 (31.2%), and those between the ages of 2- and 18 were 119 (68.8%). Among the etiological causes of traumas, the most frequent ($n = 113$) 65.3% falls were seen. The number of patients with symptoms was 57 (32.9%). Patients with GCS $14 \geq$ constituted 69.4% of the total patients ($n = 120$). There was a pathological finding in 19.0% of the brain CT' s ($n = 33$) taken. Leukocytosis was detected in 17.3% of the patients [$n = 30$].

Conclusion

As a result of this study, it was found statistically significant that the blood WBC levels were higher in children who had head trauma, whose GCS was $13 \leq$ at the time of application, who had symptoms and who had pathology in brain CT compared to other groups.

Background

Head traumas are seen as the most common cause in pediatric age group who applied to emergency departments due to trauma [1]. Since the ratio of head / body surface area is greater and the skull bones are thin in children compared to adults, intracranial structures cannot be adequately protected [2]. For this reason, head traumas are the most common cause of morbidity and mortality in the childhood age group

[3]. In a comprehensive study conducted in the United States, it has been shown that more than 500,000 children apply to post-traumatic emergency services every year, 60,000 of them receive inpatient treatment, and 7000 children lost their lives due to trauma. It has been reported that approximately half of the deaths are due to head trauma [4].

GCS is commonly used to measure the clinical level of brain injury in patients with emergency head injuries and patients are classified according to this [5]. The most common diagnostic method used to determine traumatic brain injury in these patients is brain CT [6]. It is not appropriate to draw brain CT to all patients, both economically and due to radiation exposure, since emergency cases are admitted to a large number of cases of head trauma and most of them do not have an intracranial pathology. For this reason, various studies have been conducted on the indications of brain CT withdrawal in pediatric age group head trauma patients and protocols such as PEACARN, CATCH, CHALICE have been determined [7, 8].

In recent years, some biomarkers (lymphocyte, hemoglobin, hemotocrit, S100B, lactate, thiol) have been thought to assist in determining the prognosis in childhood head traumas and studies have been conducted associated with this [9, 10, 11]. In our study, the relationship between age, gender, trauma etiology, presence of symptoms at the time of admission, GCS, brain CT findings and blood WBC levels at the time of application in cases of head trauma between the ages of 0–18, who were admitted to the emergency department in Turkey's Kars province were examined. It was aimed to determine which variables the blood WBC values had a significant relationship with.

Methods

Patients with head trauma under the age of 18 who applied to the emergency department of Kafkas University Medical Faculty Hospital between 2016–2019 retrospectively were analyzed from the patient files. Patients' age, gender, causes of trauma, symptoms at admission, GCS scores, brain CT results and blood WBC levels were examined. All infection situations that will cause leukocytosis in the blood, cancers, patients with recent surgical history, under the hormone or drug treatment, and patients with more than one trauma along with head injury were excluded from the study.

Traumas were classified according to their causes. While the most frequent groups such as falls from highs and traffic accidents were included in the study, head injuries resulting from sports injuries and battered were excluded from the study without being included in any reliable group because of inconsistencies were detected in the epicrisms of patients.

In our study, the WBC value was over 17,000 / μL between 0–2 years old, over 15,000 / μL between 2–4 years old, over 14,000 / μL between 4–6 years old and over 13,000 / μL between 6–18 years old accepted as leukocytosis [12]. In cases where one or more symptoms of temporary loss of consciousness, vomiting, headache, dizziness at the time of the event, it is accepted that there is symptoms. All brain CT images reported by the radiologist were reviewed by the emergency specialist and neurosurgeons involved in the study. Skull fractures, intracranial contusions, pneumocephalus, epidural

hematoma, subdural hematoma and traumatic subarachnoid hemorrhage, which were detected in brain CT examination, were considered pathological. Student's T test and Pearson Chi-square test methods were used to determine significant differences between patients' leukocyte values and independent variables[age, gender, trauma etiology, presence of symptoms, GCS scores and brain CT results], and for linear correlation analysis. During the statistical analyzes, IBM SPSS 20.0 program was used. In all tests, p value was considered as < 0.05 significant.

Results

Data of 305 pediatric patients who applied to the emergency room after head trauma were collected. When all exclusion criteria were applied, a total of 173 (30.6%) patients between the ages of 0–18, whose in the emergency service both brain CT was taken and blood WBC level was studied, were included in the study.

When the patients were examined according to their sex, it was determined that there were 111 (64.2%) males and 62 (35.8%) females. In terms of age, 54 patients (31.2%) of those between 0 and 2 years old; and there were 119 patients (68.8%) of those between 2 and 18 years old were observed. According to the etiological causes of traumas, the number of patients who came after the fall was 113 (65.3%), the number of patients who came after the traffic accident was 60 (34.7%). When looking all cases, the number of patients with symptoms was 57 (32.9%). Patients without symptoms were 116 (67.1%). When the GCS scores of the patients were examined; There were 53 (30.6%) patients with $GCS \leq 13$ and 120 (69.4%) patients with $GCS \geq 14$. When the brain CTs that belong to the patients were examined, 140 (81%) patients' brain CTs were evaluated as normal, in 33 (19.0%) patients had pathological findings in brain CT. Distribution of patients with pathological findings; there were 12 patients (6.9%) who had cranial bone fractures, 7 (4%) who had contusion bleeding, 5 (2.9%) who had pneumocephalus, 4 (2.3%) with epidural bleeding, 3 (1.7%) with subdural bleeding, and 2 (% 1.1) patient who had traumatic subarachnoid hemorrhage (Table 1).

It was investigated whether there was a statistically significant difference between independent variables and the presence of leukocytosis. Statistically significant difference was not occur between age, gender and trauma etiology and the presence of leukocytosis. In patients with posttraumatic symptoms, patients GCS was ≤ 13 , and patients with brain CT pathology the presence of leukocytosis was statistically significant ($p = 0.001$, $p = 0.001$, $p = 0.001$, respectively) (Table 2).

Discussion

In this study, we aimed to determine the relationship between the levels of leukocyte, which is one of the acute phase reactants, in isolated head trauma patients during admission, and age, gender, trauma etiology, symptoms, GCS, and brain CT findings.

Childhood head injuries are most common in men 62.6% [13]. In our study, in accordance with the literature we found that there was a 64.2% male patient. In the etiology of head injuries, falls are in the first place, and then traffic accidents come [14]. In our study, falls were the most common cause with 65.3%. GCS is used as the most common assessment to measure the clinical level of brain injury in patients with head trauma [5]. Approximately 80% of patients who apply to the emergency department with head trauma constitute, whose GCS was $14 \geq$. In our study, we found that GCS was $14 \geq$ that 69.4% of our patients.

In determining intracranial pathology in patients with head injury BT is still the most important diagnostic method [15]. Various protocols, such as PECARN, CATCH and CHALICE, have been identified for diagnosis and monitoring in children presenting with head trauma [7, 8]. According to PECARN, which is the most commonly used of these protocols, brain CT is recommended in patients whose GCS is $13 \leq$. In patients who had GCS was $14 \geq$, brain CT is recommended if there are signs of a skull fracture or if there is loss of consciousness, vomiting, severe headache, or a dangerous trauma mechanism. Brain CT is not recommended in patients who had GCS was $14 \geq$ and those who do not show these findings [7]. Nevertheless, indications of brain CT for diagnostic purposes still remain a controversial subject. Because it is difficult to evaluate the anamnesis and clinical examination findings in children under two years of age, physicians often request brain CT considering the possibility of brain damage [16]. Brain CT frequency has increased significantly in patients with head trauma in recent years [6]. Following after withdrawn brain CTs, the risk of malignancies occurrence associated with ionizing radiation in children increases [17]. Exposure to ionizing radiation during CT scans has been shown to increase the risk of brain tumor and leukemia per mGy in children by 0.016 and 0.033, respectively [18]. Also in another study which was made, radiation exposure after CT extractions in children creates a higher risk of cancer compared to adults [19]. Beside this, the agitation and be moving of young children can make CT shooting difficult. For this reason, physicians have to use sedative drugs in patients with head trauma. The use of these drugs carries the risks of respiratory or cardiovascular complications. In a study which was made, it was stated that clinical examination findings did not reduce brain CT request alone in head traumas, long-term observation is required to make a good decision [20].

In our study, we found that many patients who had GCS 14 according to PECARN and who did not show symptoms had CT withdrawn, although not recommended in the protocol. This indicates that there should be guiding biomarkers alongside the clinical examination. Traumatic brain injury is associated with increased serum catecholamine levels. With the activation of the systemic response after trauma, the inflammatory process begins. In the evaluation of trauma patients, parameters such as acute phase reactants, cytokines and lactate levels related to the systemic response of the organism are used [21]. Inflated WBC values are generally considered to be non-specific indicators of infection, inflammation, tissue necrosis, bleeding, or stressful situations. WBC is one of the first inflammatory parameters and that increase in inflammation [22]. Acar et al. investigated the usability of WBC as a screening test with the brain in patients with simple head injury and determined that WBC value could be a statistically significant variable with the presence of pathology in brain CT [23]. In our study, the presence of pathology in the brain CT in the patients and the presence of leukocytosis were statistically significant.

However, in 123 (87.2%) of the patients with normal brain CT, which constitutes the majority of cases, leukocytosis was not detected. In another study, it was shown that the number of WBCs of patients with severe head trauma was significantly high [24]. In a study showing the relationship between blood WBC levels and GCS, the presence of leukocytosis was found to be significant in patients with low GCS [25]. In our study, comparable with the literature, in patients with a GCS score of $13 \leq$ the presence of leukocytosis was significant ($p = 0.001$). When we searched the literature, we found that there was no relationship study between the presence of symptoms and leukocytosis in patients with head trauma aged 0–18 years. In our study, presence of leukocytosis was statistically significant, in the event that one or more of the symptoms of vomiting, headache, temporary loss of consciousness at the time of the event, dizziness.

Conclusions

As a result of our study, it was found that blood WBC levels were found to be high in children with head trauma who had statistically symptoms, GCS was $13 \leq$, and those who had pathology in brain CTs.

Be looked at the WBC level in blood is an advantage because of it is fast and cheap. It can be given information about the presence of traumatic brain injury in pediatric patients with head trauma. Multicentre and large patient population studies are needed to obtain more comprehensive results on this subject. We think that our work will provide preliminary contribution to this.

Declarations

Ethics approval and consent to participate

Prior to the study, the ethics committee approval dated 18.12.2019 and numbered 217 was obtained from the Ethics Committee of Kafkas University Faculty of Medicine. Since this study was designed as a retrospective study, no written consent was required from patients [from their parents or guardians]. Since it does not contain personal medical data, it does not require written consent in retrospective research according to institutional / national laws and the Helsinki Declaration of the World Medical Association.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

No external funding was received for this study. The authors financed all the costs incurred for the study.

Authors' contributions

L.S. designed, supervised the study and wrote the article; M. K. did the literature review, analyzed the biochemical parameters and wrote the article; L.A. He collected the data and designed the table.

Acknowledgement

We would like to thank Associate Professor Binali Catak who had important contribution to the measurement of statistical analyses.

Limitations

The limitations of our study are Turkey's Kars province and surrounding provinces have low population, and the collection of data from a single hospital.

References

1. Dalbayrak S, Gumustas S, Bal A, Akansel G. Early and delayed CT findings in patients with mild-to-moderate head trauma. *Turk Neurosurg.* 2011;21(4):591–8.
2. Güzel A, Ceylan A, Tatli M, Başoğlu M, Ozer N, Kahraman R, et al. Falls from height in childhood in Diyarbakir province: A questionnaire study combined with clinical data. *Turkish Journal of Trauma Emergency Surgery.* 2009;15(3):277–84.
3. Simşek O, Hiçdönmez T, Hamamcioğlu MK, Kılınçer C, Parsak T, Tiryaki M, et al. Pediatric head injuries: a retrospective analysis of 280 patients. *Ulus Travma Derg.* 2005;11(4):310–7.
4. Bowman SM, Bird TM, Aitken ME, Tilford JM. Trends in hospitalizations associated with pediatric traumatic brain injuries. *Pediatrics.* 2008;122(5):988–93.
5. Ghaffarpasand F, Razmkon A, Dehghankhalili M. Glasgow Coma Scale Score in Pediatric Patients with Traumatic Brain Injury; Limitations and Reliability. *Bulletin of Emergency Trauma.* 2013;1(4):135–6.
6. Blackwell CD, Gorelick M, Holmes JF, Bandyopadhyay S, Kuppermann N. Pediatric head trauma: Changes in use of computed tomography in emergency departments in the United States over time. *Ann Emerg Med.* 2007;49(3):20–4.
7. Easter JS, Bakes K, Dhaliwal J, Miller M, Caruso E, Haukoos JS. Comparison of PECARN, CATCH, and CHALICE rules for children with minor head injury: a prospective cohort study. *Ann Emerg Med.* 2014;64(2):145–52. e5.
8. Babl FE, Lyttle MD, Bressan S, Borland M, Phillips N, Kochar A, et al. A prospective observational study to assess the diagnostic accuracy of clinical decision rules for children presenting to

- emergency departments after head injuries (protocol): the Australasian Paediatric Head Injury Rules Study (APHIRST). *BMC Pediatr.* 2014;14(1):148.
9. Dolanbay T, Gül HF, Şimşek AT, Aras M. Severe traumatic brain injury cases among children younger than 24 months. *Pediatric neurosurgery.* 2020: 1–5.
 10. Sezer AA, Akıncı E, Öztürk M, Coşkun F, Yılmaz G, Karakaş A, Toksöz T. Çocuk ve erişkin minör kafa travmalarında kan S100B ile laktatin rolü ve bilgisayarlı beyin tomografisi ile korelasyonu. *Turkish Journal of Trauma Emergency Surgery.* 2012;18(5):411–6.
 11. Giden R, Gokdemir MT, Erel O, Buyukaslan H, Karabag H. The relationship between kan thiol levels and thiol/disulfide homeostasis with head trauma in children. *Chin Lab.* 2018;64(1):163–8.
 12. Kaya Z. Interpretation of automated blood cell counts. *Dicle Medical Journal.* 2013;40(3):521–8.
 13. Atmış A, Tolunay O, Çelik T, Gezercan Y, Dönmezer Ç, Reşitoğlu S, et al. Çocukluk Dönemi Kafa Travmalarında İkilem: Hafif Kafa Travmalı Hastalarda Bilgisayarlı Beyin Tomografisi Gerekli mi, Değil mi? *J Pediatr Emerg Intensive Care Med.* 2016;3:27–31.
 14. Boran BO, Barut N, Akgün C, Çelikoğlu E, Bozbuğa M. Indications for computed tomography in patients with mild head injuries. *Ulus Travma Acil Cerrahi Derg.* 2005;3:218–23.
 15. Schonfeld D, Fitz BM, Nigrovic LE. Effect of the duration of emergency department observation on computed tomography use in children with minor blunt head trauma. *Ann Emerg Med.* 2013;62(6):597–03.
 16. Mannix R, Bourgeois FT, Schutzman SA, Bernstein A, Lee LK. Neuroimaging for pediatric head trauma: do patient and hospital characteristics influence who gets imaged? *Acad EmergMed.* 2010;17:694–700.
 17. Brenner DJ, Hall EJ. Computed tomography—an increasing source of radiation exposure. *N Engl J Med.* 2007;357(22):2277–84.
 18. Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, Kim KP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. *Lancet.* 2012;380(9840):499–505.
 19. Gonzalez AB, Salotti JA, McHugh K, Little MP, Harbron RW, Lee C, et al. Relationship between paediatric CT scans and subsequent risk of leukaemia and brain tumours: assessment of the impact of underlying conditions. *Br J Cancer.* 2016;114(4):388–94.
 20. Lorenzo N. Minor Head Trauma: One of the Most Common Reasons for Emergency Department Care and Neurosurgical Referral: A Chronological Overview about the Management and Major Issues from the Advent of CT Scan. *Journal of Surgery Emergency Medicine.* 2017;1(1):1.
 21. Akköse Ş, Bulut M, Armağan E, Balcı V, Yolgösteren A, Özgüç H. Kan lökosit değeri travmanın şiddetini yansıtır mı? *Ulus Travma Derg.* 2003;9(2):111–3.
 22. Shah SS, Shofer FS, Seidel JS, Baren JM. Significance of extreme leukocytosis in the evaluation of febrile children. *Pediatr Infect Dis J.* 2005;24:627–30.

23. Acar E, Demir A, Alatas ÖD, Beydilli H, Yıldırım B, Kırılı U, et al. Evaluation of hematological markers in minor head trauma in the emergency room. *Eur J Trauma Emerg Surg.* 2016;42(5):611–6.
24. Algahtany M. kan leukocyte count (WBC) levels as an indicator for severity of traumatic brain injury in Saudi Arabia patients. *Egyptian Journal of Neurosurgery.* 2015;30(2):145–50.
25. Rovlias A, Kotsou S. The blood leukocyte count and its prognostic significance in severe head injury. *Surgical neurology.* 2001;55(4):190–6.

Tables

Table 1: Distribution of Brain CT results

Brain CT Results	n	%
Normal	140	81.0
Cranial bone fractures	12	6.9
Contusion hemorrhage	7	4.0
Pneumocephalus	5	2.9
Epidural hemorrhage	4	2.3
Subdural hemorrhage	3	1.7
Traumatic subarachnoid hemorrhage	2	1.1

n: number

Table 2: Relationship of leukocytosis with independent variables

Indepent Variables		The presence of leukocytosis		Toplam	P
		Yes	No		
		n (%)*	n (%)*	n (%)**	
Sex	Male	19 (17,1)	92 (82,9)	111 (64,2)	0,917
	Female	11 (17,7)	51 (82,3)	62 (35,8)	
Age	0-2 age	7 (13)	47 (87)	54 (31,2)	0,306
	2-18 age	23 (19,3)	96 (80,7)	119 (68,8)	
GCS	14 ≥	10 (8,3)	110 (91,7)	120 (69,4)	0,001
	13 ≤	20 (37,7)	33 (62,3)	53 (30,6)	
Trauma	Fall	21 (18,6)	92 (81,4)	113 (65,3)	0,553
Type	TA***	9 (15)	51 (85)	60 (34,7)	
Brain CT	Normal	18 (12,8)	123 (87,2)	141 (81,5)	0,001
	Pathological	12 (37,5)	20 (62,5)	32 (18,5)	
Symptom	Yes	25 (43,9)	32 (56,1)	57 (32,9)	0,001
	No	5 (6,0)	111 (94,0)	116 (67,1)	
Total*		30 (17,3)	143 (82,7)	173	

n: number, * row percentage, ** column percentage, *** TA: Traffic Accident,

p <0.005 significant