DOI: 10.37990/medr.1488845
Med Records 2024;6(3):329-34

MEDICAL RECORDS-International Medical Journal

Research Article

Pediatric Head Injuries Occur During the Play Childhood Period of 3-6 Years: A Sample from the South of Türkiye

Mustafa Oguz Cumaoglu[1], Abdussamed Vural[1], Mustafa Dogan[2], Burak Yuruk[3], Mustafa Ozcelik[1], Sabri Sekme[1]

[1]Niğde Ömer Halisdemir University, Faculty of Medicine, Department of Emergency Medicine, Niğde, Türkiye
[2]Niğde Ömer Halisdemir University, Faculty of Medicine,Department of Forensic Medicine, Niğde, Türkiye
[3]Niğde Ömer Halisdemir University, Training and Research Hospital, Department of Neurosurgery, Niğde, Türkiye

Abstract

Aim: Pediatric head traumas (HT) are of significant concern due to their potential for high mortality rates, which are influenced by the clinical progression of traumatic brain injury (TBI). HT poses a substantial risk of morbidity and mortality across all pediatric age groups, underscoring the importance of effective clinical management and follow-up procedures. The current study aims to evaluate the epidemiology, causes, and clinical outcomes of head injuries during childhood play between the ages of 3 and 6.
Material and Method: Focused on pediatric patients aged 3-6 years who were admitted to the emergency department (ED) for HT, and required consultation from a neurosurgeon. Data collected included patients' demographics, trauma etiology, cranial examination findings, laboratory results upon admission, cranial computed tomography findings, classification of TBI, treatment administered, and clinical progression.
Results: The median Glasgow Coma Scale (GCS) scores were found to be significantly lower in the group with intraparenchymal injury compared to the group without intraparenchymal injury (p=0.008). The group with intraparenchymal injury exhibited a higher than expected occurrence of moderate TBI (p=0.012). Females exhibited significantly lower mean rank scores for age compared to males (p=0.032). Patients hospitalized for HT had significantly lower GCS scores than those discharged (p=0.001). There is a higher prevalence of moderate TBI than expected in the group of hospitalized patients (p=0.008). The mortality rate among hospitalized patients was 5.6%, with lower GCS scores and hyperglycemia upon admission significantly associated with fatalities (p=0.015, p=0.045).
Conclusion: Identification and management of moderate TBI are imperative in children presenting to the ED with HT during early childhood play. Children with intraparenchymal injury should be hospitalized. Additionally, hyperglycemia in pediatric HT patients may signify high-energy trauma.

Keywords: Pediatric, head trauma, emergency department, neurosurgery, hyperglycemia

INTRODUCTION

Pediatric head traumas (HT) are of critical importance due to their high mortality potential. Traumatic brain injury (TBI) is at the root of being a significant social problem and burden on the healthcare system. Surviving children have high risks such as lifelong neurological sequelae, living dependent on others, deteriorated quality of life, and loss of productivity (1,2).

Most cases of pediatric HT admitted to Emergency Department (ED) are mild and do not require further examination and treatment. A few children develop serious TBI. However, in this group, early diagnosis and rapid intervention are critical for preventing neurological sequelae that may develop in the future (3,4,5). TBI in pediatrics are classified into mild (14-15), moderate (9-13) and severe (3-8) categories based on the Glasgow Coma Scale (GCS) score (6).

Approximately 500,000 children are admitted to ED in the United States of America (USA) every year with complaints of HT, and approximately 12% of them are hospitalized (7).

Children's interest in the outside world increases during play childhood (ages 3-6). Children gain mobility and begin to walk and run without knowing what is or is not dangerous for them (8,9). Considering that this makes

CITATION
Cumaoglu MO, Vural A, Dogan M, et al. Pediatric Head Injuries Occur During the Play Childhood Period of 3-6 Years: A Sample from the South of Türkiye. Med Records. 2024;6(3):329-34. DOI:1037990/medr.1488845

Received: 23.05.2024 **Accepted:** 14.06.2024 **Published:** 29.08.2024
Corresponding Author: Mustafa Oguz Cumaoglu, Niğde Ömer Halisdemir University, Faculty of Medicine, Department of Emergency Medicine, Niğde, Türkiye
E-mail: mdmoc38@gmail.com

children aged between 3-6 more susceptible to HT, we focused on this group. Data on the epidemiology, etiology, and clinical course of clinically important HT during play childhood between the ages of 3-6 are limited. We think that our study will contribute to the literature at this point.

MATERIAL AND METHOD

Study Design and Ethical Considerations

The research was designed as a retrospective study. The study protocol was approved by Non-Interventional Ethics Committee of Niğde Ömer Halisdemir University, Faculty of Medicine (14.12.2023, No:2023/98). Written informed consent from the patients (or their parents or guardians) was not obtained as the study was designed as a retrospective study that does not publicize any personal medical data, and both the institutional/national code and World Medical Association Declaration of Helsinki do not require written informed consent in retrospective studies.

Population and Sample

The study includes pediatric patients aged 3-6 years who were admitted to Niğde Ömer Halisdemir University Training and Research Hospital ED between 15.01.2023 and 01.10.2023 and for whom a neurosurgeon's opinion due to HT was requested.

In the retrospective screening, patients whose data could not be accessed through our hospital's automation system, patients who had HT outside the 3-6 age range, cases with HT accompanied by abdomen, thorax, and large bone injuries, patients with active bleeding or known coagulopathy, patients who had had previous neurosurgery, and patients with neurological deficits or developmental delay, assessed as mild TBI in ED were evaluated by an emergency medicine specialist and discharged without the need for neurosurgery consultation were excluded from the study.

The patients' age, sex, trauma etiology, cranial examination findings, laboratory results at the time of admission, cranial computed tomography (CT) findings, classification of TBI, treatment applied, and clinical course were examined in the study. Data were obtained through the hospital automation system (Karmed). Microsoft Excel 2021 software was used to record the data.

Statistical Analysis

All statistical data were analyzed using SPSS version 22.0 for Windows (IBM Corp., Armonk, NY, USA). Sex, trauma etiology, cranial examination findings, CT results, classification of TBI and hospital discharge/hospitalization status data, which are categorical variables in statistics, were presented as numbers and percentages, while data on age, GCS score, length of hospital stay in inpatients, and blood glucose value at admission were given as mean±standard deviation for those with normal distribution and as median and interquartile range (IQR 25-75) for those with non-normal distribution. The Shapiro-Wilk test was applied to show whether the data were normally distributed. The Mann-Whitney U test was used to investigate the relationship between age, GCS score, and glucose values and sex, discharge/hospitalization status, and clinical outcome (survival/death). Fisher's exact test was used to research whether there was a significant relationship between the part of the head affected by impact and discharge/hospitalization status and clinical outcome. Fisher's exact test was conducted to examine the relationship between sex and discharge/hospitalization status and clinical outcome. A value of $p<0.05$ was considered statistically significant.

RESULTS

Thirty-six patients who met the study criteria were identified. The median age was 4 (IQR 4-6) years. Concerning age distribution, 7 patients were 3 years old (19.4%), 13 patients were 4 years old (36.1%), 4 patients were 5 years old (11.1%), and 12 patients were 6 years old (33.3%). Twenty cases were male (55.6%), and 16 were female (44.4%). The median GCS value of the patients was 13 (percentile 25-75%: 12-14), and the mean blood glucose value was 137±39 (min-max: 88-242) mg/dl. The median length of stay of the hospitalized patients was 3 days (min-max 1-15) (Table 1).

Table 1. Demographic and clinical data of patients

Parameters		Values
Age (year), (SD)		4.58±1.15
Sex	Male, n (%)	20 (55.6)
	Female, n (%)	16 (44.4)
GCS (25-75% percentile)		13 (12-14)
Glucose (mg/dl), (SD); min-max		137±39; 88-242
Hospital stay (day), min-max		3, 1-15

GCS: Glasgow Coma Score, %: percentage, min-max: minimum-maximum, mg/dl: milligram/deciliter, SD: standard deviation

The etiology of ED admissions included 11 falls from height (30.6%) (2 meters or higher), 10 falls from own height (27.8%), 7 in-vehicle traffic accidents (19.4%) and 7 out-vehicle traffic accidents (19.4%), and one natural disaster victim (2.8%) (earthquake). Seventeen children had isolated scalp hematoma (47.2%), 6 had local abrasion and laceration (16.7%), 3 had orbital edema and hyperemia (8.3%), 3 had scalp hematoma and convulsions due to generalized seizures (8.3%), 2 had scalp hematoma and laceration (5.6%), 1 had orbital laceration (2.8%), and 4 had normal physical examination findings (11.1%). In the computed imaging results, there were findings of multiple injuries (fracture and intraparenchymal hemorrhage) (33.3%) in 12 patients, contusion (25.0%) in 9 patients and isolated linear fracture (25.0%) in 9 patients, and isolated subdural (2.8%) and epidural hemorrhage (2.8%) in 1 patient each. There was no pathological CT finding in 4 patients (11.1%) (Table 2).

Table 2. ED admission etiologies of patients, cranial examination findings, cranial CT image results

Etiology	(n=36)	%
Falls from height	11	30.6
Falls from own height	10	27.8
In-vehicle traffic accidents	7	19.4
Out-vehicle traffic accidents	7	19.4
Natural disaster	1	2.8
Physical examination		
Isolated scalp hematoma	17	47.2
Local abrasion and laceration	6	16.7
Orbital edema and hyperemia	3	8.3
Scalp hematoma and convulsions	3	8.3
Scalp hematoma and laceration	2	5.6
Orbital laceration	1	2.8
Normal	4	11.1
Imaging		
Fracture and intraparenchymal hemorrhage	12	33.3
Contusion	9	25
Isolated linear fracture	9	25
Isolated subdural hemorrhage	1	2.8
Isolated epidural hemorrhage	1	2.8
Normal	4	11.1

After six hours of ED observation, 5 patients were discharged with recommendations regarding intracranial pressure (13.9%). Thirty-one patients were hospitalized and treated (86.1%). Surgical intervention was performed in only 2 of our cases (5.6%). The other 34 cases received symptomatic treatment (94.4%).

When patients were categorized into mild, moderate, and severe TBI groups using the GCS score, only 2 patients were classified in the severe TBI group. In order to perform appropriate statistical analysis, these 2 patients were added to the moderate TBI group. Thus, a total of 15 patients were classified as having mild TBI (41.7%), and 21 patients were classified as having moderate to severe TBI (58.3%).

Patients with intraparenchymal hemorrhage, subdural hematoma, epidural hematoma, and contusion on CT scans were categorized separately as "patients with intraparenchymal injury". A total of 23 patients (63.9%) were identified in this group.

There was no statistically significant difference between sex and the GCS score and blood glucose value mean rank scores (p=0.59, p=0.17). No significant relationship was identified between sex and discharge/hospitalization status and clinical outcome (p=0.35, p=0.69). There was no statistically significant difference between right, left, and bilateral head injuries, discharge/hospitalization status and clinical outcome (p=0.47, p=0.38).

The median GCS scores were found to be significantly lower in the group with intraparenchymal injury compared to the group without intraparenchymal injury (p=0.008) (Figure 1). The group with intraparenchymal injury exhibited a higher than expected occurrence of moderate TBI (p=0.012). There is a higher prevalence of moderate TBI than expected in the group of hospitalized patients (p=0.008) (Table 3).

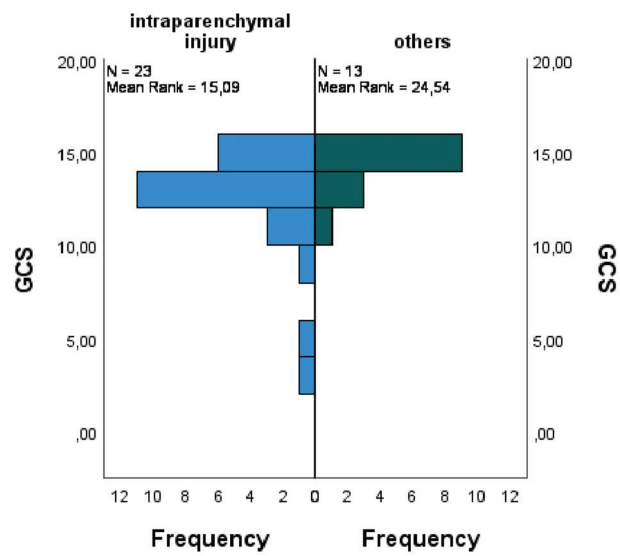

Figure 1. The median GCS value is lower in patients with intraparenchymal injury (p=0.008)* GCS: Glasgow Coma Scale, *: Mann-Whitney U test

Table 3. The association between TBI with the patients of hospitalization and intraparenchymal injury

		TBI		
		Mild	Moderate	p value*
Intraparenchymal injury	Count	6	17	0.012
	Expect	9.6	13.4	
Hospitalized patients	Count	10	21	0.008
	Expect	12.9	18.1	

* Chi-Square Tests, TBI: Traumatic Brain Injury

When comparing age and sex, lower age mean rank scores were revealed in females, which was found to be statistically significant (p=0.032). GCS score was found to be statistically significantly lower in hospitalized patients compared to discharged patients (p=0.001). Two of the hospitalized patients died in the intensive care unit (Mortality rate: 5.6%). A low GCS score and hyperglycemia at the time of admission in patients who died after trauma were found to be statistically significant compared to surviving patients (p=0.015, p=0.045) (Table 4).

Table 4. Analysis of statistically significant demographic and clinical data of patients

		n	Mean rank	Sum of ranks	U	p*
Age	**Male**	20	21.7	434	96	0.032
	Female	16	14.5	232		
GCS	**Discharge**	5	33	165	5	0.001
	Hospitalization	31	16.16	501		
GCS	**Survival**	34	19.5	663	0.0001	0.015
	Death	2	1.5	3		
Glucose	**Survival**	34	17.65	600	5	0.045
	Death	2	33	66		

GCS: Glasgow Coma Scale, *Mann-Whitney U

DISCUSSION

Children in the play childhood period (ages 3-6) have a higher affinity for the environment compared to the newborn and infancy periods. Furthermore, reality, danger perception, and person and place orientation are lower in comparison with the school childhood period (10,11).

In children between the ages of 0 and 4, the risk of brain damage due to HT is approximately twice as high compared to other age groups (6). In line with these data, more than half of the children in our study were 3 and 4 years old. The fact that children have not fully acquired the ability to walk in this period and the balance problem that occurs due to the change in the center of gravity due to the higher head-to-body ratio may explain the higher incidence of HT in this age group.

HT is more common in males than in females in all pediatric age groups (5). Our results are compatible with this situation, which can be called general acceptance. We think that this is caused by the fact that boys are more active and aggressive than girls, and family members such as fathers, uncles, and elder brothers play rougher games with boys.

The etiology of pediatric HT is multifactorial. However, the most common cause is falling during play childhood. Falls may occur from one's own height or a greater height (12). Falls were the cause of HT in approximately 60 percent of the children in our study. Cranial fracture or parenchymal hemorrhage occurred in all children who fell from a significant height. In some cases, both clinical pictures were observed together. Children who fell from their own height had a history of either hitting the hard floor or colliding with a sharp object at home. We think that this situation developed due to high trauma energy.

Another cause of HT in children is traffic accidents. Children may be exposed to HT inside or outside the vehicle (13). The cause of HT in 14 of the children in our study was a traffic accident. In addition to HT, traffic accident cases in our also had orbital injuries, facial abrasions and lacerations. Therefore, we believe that it would be more appropriate to take a multidisciplinary approach in children who develop TBI secondary to a traffic accident by consulting not only neurosurgery but also other surgical branches such as ophthalmology and plastic surgery.

Earthquake disasters can lead to clinical conditions such as TBI, spinal cord injury, peripheral nerve damage, and limb loss in children (14). In one of our cases, the HT was caused by an earthquake. A psychiatric opinion was also received after the HT follow-up. We think that providing psychosocial support after trauma follow-up in children in case of disasters such as earthquakes would be an appropriate clinical approach.

Lesions after HT in children usually occur in the area that receives the impact. Various physical examination findings such as erythema, hematoma, abrasion, and laceration can be detected (12). The most common examination finding in our study was scalp hematoma. There is no clear information about a linear relationship between the presence of scalp hematoma and TBI. However, scalp hematoma may be the only clue we have in predicting TBI. A large hematoma size and scalp hematomas outside the frontal region increase the risk of TBI (15). In three cases with generalized seizures in our study, there was a scalp hematoma in the temporoparietal region. We think that more care should be taken in terms of convulsion follow-up in children with scalp hematoma outside the frontal region.

Ophthalmological problems may accompany HT in children (16). Four of our cases had an orbital injury in addition to HT.

Cranial CT is the standard diagnostic test to diagnose TBI (17). CT imaging was performed in all of our cases. In line with the literature (18), our imaging results consisted of linear fracture, parenchymal hemorrhage, contusion, subdural and epidural hemorrhage.

The most common pathological CT imaging finding in HT cases causing TBI is cranial bone fractures (19,20). Our data are in line with this situation, and the most common finding we observed was parenchymal hemorrhage accompanied by cranial bone fracture, which we call the multiple injury finding. Moreover, nine of our cases had isolated cranial linear fractures.

While Tavor et al. (21) observed epidural hemorrhage most frequently in their study, contrary to these data, in our study, isolated epidural hemorrhage was observed in only one case after a traffic accident.

According to Hung (22), subdural hemorrhage is the most common pathological CT finding observed in abused children. There was no abused child among our cases, and isolated subdural hemorrhage due to a traffic accident was detected in only one case.

There is no clear information in the literature about the length of hospital stay after HT. However, if there is an intracranial injury finding, observation for at least 24 hours is recommended (23). In our study, cases that were hospitalized were predominantly those with intraparenchymal injuries and moderate TBI. Therefore, our current data suggest a possible proportional relationship between the presence of any brain parenchymal injury and hospitalization. The 31 cases in our study were followed up with hospitalization for an average of 3.5 days. GCS score was found to be statistically significantly lower in hospitalized patients compared to discharged patients.

It is known that the presence of hyperglycemia at the time of admission in pediatric HT cases increases the length of hospital stay and mortality (24). The mean blood glucose level of our cases measured at the ED admission was above the laboratory glucose upper limit. We predict that hyperglycemia occurs with the elevation of stress hormones due to trauma. However, no statistically significant relationship was found between the presence of hyperglycemia and sex, GCS score and clinical outcome. We think that if the number of cases in our study had been higher, we would have obtained a statistically significant result in the inpatient group.

TBI is considered an important cause of mortality in the pediatric group (25,26). Two of our cases died due to falling from height and out-vehicle traffic accidents. In patients who died, a low GCS score and high blood glucose level at the time of admission were found to be statistically significant. We think that these data are valuable in terms of contributing to the literature.

Limitations of the Study

The main limitations of the present study are that the retrospective case screening period was approximately 1 year, our hospital is located in a small province with a population of 237 thousand, and the number of cases in our study was low. Since the presence of moderate TBI was predominant in our cases, detailed comments regarding severe TBI could not be made.

CONCLUSION

During the period of 3-6 years when neuronal development is not yet completed, the progression of HT into the intraparenchymal region and the hospitalization status of patients are directly proportional to the severity of TBI. Identification and management of moderate TBI are imperative in children presenting to the ED with HT during early childhood play. Children with intraparenchymal injury such as GCS scores below 14 should be hospitalized for close monitoring and rapid access to treatment, as well as for the surveillance of potential complications. Additionally, hyperglycemia in pediatric HT patients may signify high-energy trauma. Clinical implications of study are recognizing demographic differences and prioritizing clinical indicators, such as GCS scores and blood glucose levels, can enhance patient outcomes and decrease mortality rates.

Financial disclosures: *The authors declared that this study has received no financial support.*

Conflict of interest: *The authors have no conflicts of interest to declare.*

Ethical approval: *The study protocol was approved by Non-Interventional Ethics Committee of Niğde Ömer Halisdemir University, Faculty of Medicine (14.12.2023, No:2023/98).*

REFERENCES

1. Chong SL, Barbier S, Liu N, et al. Predictors for moderate to severe paediatric head injury derived from a surveillance registry in the emergency department. Injury. 2015;46:1270-4.
2. Neumane S, Câmara-Costa H, Francillette L, et al. Functional outcome after severe childhood traumatic brain injury: Results of the TGE prospective longitudinal study. Ann Phys Rehabil Med. 2021;64:101375.
3. Amaranath JE, Ramanan M, Reagh J, et al. Epidemiology of traumatic head injury from a major paediatric trauma centre in New South Wales, Australia. ANZ J Surg. 2014;84:424-8.
4. Satapathy MC, Dash D, Mishra SS, et al. Spectrum and outcome of traumatic brain injury in children <15 years: A tertiary level experience in India. Int J Crit Illn Inj Sci. 2016;6:16-20.
5. Dewan MC, Mummareddy N, Wellons JC 3rd, Bonfield CM. Epidemiology of global pediatric traumatic brain injury: qualitative review. World Neurosurg. 2016;91:497-509.e1.
6. Gelineau-Morel RN, Zinkus TP, Le Pichon JB. Pediatric head trauma: a review and update. Pediatr Rev. 2019;40:468-81.
7. Chen C, Peng J, Sribnick EA, et al. Trend of age-adjusted rates of pediatric traumatic brain injury in U.S. emergency departments from 2006 to 2013. Int J Environ Res Public Health. 2018;15:1171.

8. Letelier A, Watt RG, Heilmann A. Head injuries in early childhood in the UK; is there a social gradient?. J Epidemiol Community Health. 2022;76:600-5.

9. Spencer NJ, Ludvigsson J, Bai G, et al. Social gradients in ADHD by household income and maternal education exposure during early childhood: Findings from birth cohort studies across six countries. PLoS One. 2022;17:e0264709.

10. Ruffini C, Osmani F, Bigozzi L, Pecini C. Semantic fluency in 3-6 years old preschoolers: which executive functions?. Child Neuropsychol. 2024;30:563-81.

11. Marques PDN, Oliveira RM, Correa J. Contributions of executive functions and linguistic skills to verbal fluency in children. Child Neuropsychol. 2022;28:1031-51.

12. Haydel MJ, Weisbrod LJ, Saeed W. Pediatric Head Trauma. In: StatPearls. Treasure Island (FL): StatPearls Publishing; November 12, 2022.

13. Mihić J, Rotim K, Marcikić M, Smiljanić D. Head injury in children. Acta Clin Croat. 2011;50:539-48.

14. Yang ZQ, Zhang QM. Rehabilitation care for children after trauma in the earthquake disaster. Zhongguo Dang Dai Er Ke Za Zhi. 2013;15:431-4.

15. Burns EC, Grool AM, Klassen TP, et al. Scalp hematoma characteristics associated with intracranial injury in pediatric minor head injury. Acad Emerg Med. 2016;23:576-83.

16. Hansen JB, Killough EF, Moffatt ME, Knapp JF. Retinal hemorrhages: abusive head trauma or not?. Pediatr Emerg Care. 2018;34:665-70.

17. Blackwell CD, Gorelick M, Holmes JF, et al. Pediatric head trauma: changes in use of computed tomography in emergency departments in the United States over time. Ann Emerg Med. 2007;49:320-4.

18. Dolanbay T, Gül HF, Şimşek AT, Aras M. Severe traumatic brain injury cases among children younger than 24 months. Pediatr Neurosurg. 2020;55:12-6.

19. Karasu A, Sabanci PA, Cansever T, et al. Epidemiological study in head injury patients. Ulus Travma Acil Cerrahi Derg. 2009;15:159-63.

20. Schunk JE, Schutzman SA. Pediatric head injury. Pediatr Rev. 2012;33:398-411.

21. Tavor O, Boddu S, Kulkarni AV. Presenting characteristics of children who required neurosurgical intervention for head injury. Childs Nerv Syst. 2016;32:827-31.

22. Hung KL. Pediatric abusive head trauma. Biomed J. 2020;43:240-50.

23. Hamilton M, Mrazik M, Johnson DW. Incidence of delayed intracranial hemorrhage in children after uncomplicated minor head injuries. Pediatrics. 2010;126:e33-9.

24. Chen S, Liu Z. Effect of hyperglycemia on all-cause mortality from pediatric brain injury: a systematic review and meta-analysis. Medicine (Baltimore). 2020;99:e23307.

25. Bowman SM, Bird TM, Aitken ME, Tilford JM. Trends in hospitalizations associated with pediatric traumatic brain injuries. Pediatrics. 2008;122:988-93.

26. Scaife ER, Statler KD. Traumatic brain injury: preferred methods and targets for resuscitation. Curr Opin Pediatr. 2010;22:339-45.