

Evaluation of brain computed tomography results in pediatric traumas

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ABSTRACT

Aims: The use of brain computed tomography (CT) in the management of childhood head traumas is increasing every day. However, due to the more prominent harmful effects of radiation caused by CT in children and the increase in health expenditures, rules have been settled to determine brain CT indications, especially in children with mild head trauma. The aim of this study is to contribute to the literature by sharing the demographic characteristics, clinical findings and Brain CT results of pediatric patients who admitted to the emergency department (ED) with head trauma.

Methods: The study was conducted retrospectively in children who admitted to Kırıkkale University Hospital ED with head trauma. The demographic characteristics of the patients, their complaints at admission, Glasgow coma score (GCS), examination findings, follow-up and treatment management in the ED, and brain CT results were recorded. Chi-square test was used to compare the data. A value of $p < 0.05$ was considered statistically significant.

Results: 234 children with head trauma were included in the study. Mean age of the study group was: 9.13 ± 6.36 /years and 57.3% (n=134) were males. While 7.2% of the children were < 2 years old, 92.8% of them were ≥ 2 years old. Mean GCS was 14.92 ± 0.79 . Falling from a height was the most common cause of head trauma with 30.8%, followed by falling from the same level with 21.8% and in-vehicle traffic accident with 18.4%. Headache (37.2%), nausea-vomiting (36.8%) and loss of consciousness (13.7%) were the three most common admission symptoms after head trauma. Headache was found to be significantly higher in the ≥ 2 age group and nausea-vomiting in the < 2 age group compared to the other group ($p = 0.006$; $p < 0.001$, respectively). While 97.9% of brain CT results were normal, the most common pathological finding was linear fracture (2.1%). In terms of brain CT results, no difference was found between children < 2 years and ≥ 2 years of age ($p = 0.527$).

Conclusion: Majority of the pediatric patients we evaluated in our study had minor head trauma, and most of the brain CT results were normal. Headache, nausea, vomiting, and loss of consciousness were the three most common symptoms after head trauma. Nausea-vomiting was observed more frequently in children aged < 2 years and headache was observed in children aged ≥ 2 years after head trauma, compared to other age groups.

Keywords: Computed tomography, child, head trauma

INTRODUCTION

Trauma is a major cause of death in childhood. The situation is especially prominent in children between 1-14 years of age.^{1,2} In the United States (USA), the number of pediatric patients admitted to the emergency department due to trauma is over half a million each year. 60 thousand of them are treated in the inpatient clinics and more than 7 thousand of them dies. Head

trauma was the primary cause of death in 50 % of children who lost their lives.³⁻⁶

The usage of brain computed tomography (CT) has led to a better understanding of cranial pathologies in patients with head trauma (such as intracranial hematoma, herniation, cerebral edema and skull base fractures) and a faster diagnosis. However, CT includes radiation and it is especially a risk factor for malignancy development in the pediatric population.^{7,8}

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Decision protocols like PECARN (Pediatric Emergency Care Applied Research Network), CATCH (Canadian Assessment of Tomography for Childhood Head Injury) and CHALICE (Children's Head Injury Algorithm for the Prediction of Important Clinical Events) have evolved to prevent irrelevant usage of CT in children with minor head injuries.⁸ Despite all these protocols, brain CT applications for children with head traumas are increasing in hospitals due to inexperience of the physician, workload of the ED, insistence of the patient's relatives and defensive medicine practices.

The aim of this study is to contribute to the literature by sharing the demographic characteristics, clinical findings and Brain CT results of children admitted to the ED due to head trauma.

METHODS

The study was carried out retrospectively in children who applied to Kırıkkale University Hospital ED between 01.01.2016 and 01.01.2017 due to head trauma. The study was approved by the Kırıkkale University Clinical Researches Ethics Committee (Date: 20.06.2017, Decision No: 16/02). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki

Patient data were obtained from hospital information system. The demographic data of the patients, their complaints, physical examination findings and brain CT results were recorded. Patients > 18 years, or without head traumas or without CT results even with a head trauma and patients with insufficient data were excluded from the study. Internationally valid guidelines were used in the evaluation of head trauma in children.^{7,8}

Statistical Analysis

All data were analyzed with SPSS 21.0 (IBM SPSS Statistics 21.0, IBM Corporation, Armonk, NY, USA) programme. Variables were expressed as number (n), percentage (%), mean and standard deviation (SD). Normality tests were done with Kolmogorov-Smirnov test. Chi-square test was used for comparison of groups. $p < 0.05$ was accepted as statistically significant.

RESULTS

A total of 234 children who admitted to ED with head trauma and who had brain CT were included in the study. Mean age was 9.13 ± 6.36 (range:1-18) /years and 57.3% (n=134) were males. The age of 7.2% (n=17) of the children with head trauma was <2 years, while the age of 92.8% (n=217) was ≥ 2 years. The mean Glasgow coma score (GCS) of all children with head trauma was 14.92 ± 0.79 (range 6-15), calculated at the time of admission, and the median value was 15. According to GCS; the number of patients with severe (GCS: 3-8) head trauma was only 0.9% (n=2), while the remaining patients (n=232) were patients with minor (GCS: 13-15) head trauma. The mean GCS was 15.0 ± 0.0 (median: 15) in children aged <2 years and 14.91 ± 0.82 (median: 15) in children aged ≥ 2 years ($p=0.956$).

Falling from a height was the most common cause of head trauma with 30.8%, followed by falling from the same level with 21.8% and in-vehicle traffic accident (IVTA) with 18.4%. While it was determined that 73.3% of the patients who admitted with IVTA were not wearing seat belts, the most common mechanism causing IVTA injury was "overturning of the vehicle" (48.9%). While 91.5% of the patients applied

to the emergency department between 0-2 hours after head trauma, the first three most common symptoms were headache (37.2%), nausea-vomiting (36.8%) and loss of consciousness (13.7%) (Table 1).

Table 1. Causes of trauma in pediatric patients and results of emergency evaluation	
Mechanism of trauma, (n=234)	n (%)
• Falling from a height	72 (30.8)
• Falling from the same level	51 (21.8)
• In vehicle traffic accident, (n=45)	45 (18.4)
• Collision with another vehicle or object	17 (37.8)
• Accidents with death	3 (6.7)
• Ejection from vehicle	10 (22.2)
• Vehicle roll over	22 (48.9)
• Jamming within the vehicle	9 (20.0)
• More than one cause/mechanism	8 (17.7)
• Non-Vehicle Traffic Accident	15 (6.4)
• Bicycle accidents	7 (30.0)
• Hit by a hard object on the head	25 (10.7)
• Minting	13 (5.6)
• Sharp-drilling tool injury	1 (0.4)
• Shot by a firegun	6 (26.0)
Emergency department admission after trauma	n (%)
• 0-2 hours	214 (91.5)
• 2-4 hours	12 (5.1)
• 4-8 hours	2 (0.9)
• >8 hours	6 (2.5)
Symptoms at admission	n (%)
• Loss of consciousness	32 (13.7)
• Headache	87 (37.2)
• Nausea-vomiting	86 (36.8)
• Amnesia	9 (3.8)
• Auras	3 (1.3)
• Rhinorrhea/Otorrhea	-
• Maxillofacial Trauma	14 (6.0)
• Scalp injury (incision/hematoma)	17 (7.3)
Localisation of head trauma	n (%)
• Frontal	160 (68.6)
• Temporal	6 (2.6)
• Parietal	27 (11.5)
• Occipital	21 (9.0)
• Maxillofacial Trauma	20 (8.5)
Concomitant other system injury	n (%)
• Servical injury	8 (3.4)
• Thoracal injury	7 (3.0)
• Abdominal injury	2 (0.9)
• Ekstremitte injury	4 (1.7)
• No concomitant injury (isolated head injury)	213 (96.0)
• Multiple system injuries	21 (8.8)

While the brain CT result of 97.9% of the children who admitted due to head trauma was normal, the most common pathological finding was "linear fracture" (2.1%). The most common supporting imaging technique together with brain CT was PAN CT. The most frequently requested clinical consultation after trauma was Neurosurgery consultation with 4.7%. When the emergency service follow-up times of the patients were examined, it was found that 82.9% were discharged after 0-2 hours of follow-up. While 97.9% of all

patients were discharged, the most patients were hospitalized in Neurosurgery Clinics (2.1%). When children aged <2 years and ≥ 2 years with head trauma were compared in terms of brain CT results; no significant difference was found between the two groups ($p=0.527$) (Table 2).

Additional imaging together with brain CT	n (%)
• PAN CT	15 (6.4)
• Servical CT	7 (3.0)
• Extremity CT	2 (0.9)
Brain CT results	n (%)
• Normal	229 (97.9)
• EDH	2 (0.9)
• SAH	2 (0.9)
• Linear fracture	5 (2.1)
Unit for consultation	
• Neurosurgery	11 (4.7)
• Pediatric surgery	3 (1.3)
• Orthopedics	2 (0.8)
• Plastic surgery	2 (0.8)
Clinical outcome	
• Discharge	229 (97.9)
• Hospitalization (service or intensive care)	5 (2.1)
• Neurosurgery	4 (1.7)
• Pediatric surgery	1 (0.4)
Post-traumatic follow-up time in the ER	n (%)
• 0-2 hours	194 (82.9)
• 2-4 hours	36 (15.4)
• 4-8 hours	4 (1.7)

When the <2 age group and the ≥ 2 age group of children with head trauma were compared in terms of presentation symptoms; headache was found to be significantly higher in the ≥ 2 age group and nausea-vomiting in the <2 age group ($p=0.006$; <0.001 , respectively). No significant difference was found between two groups in terms of loss of consciousness, amnesia, maxillofacial trauma and scalp injury (Table 3).

Admission complaint	age <2, (n=17)	age ≥ 2 , (n=217)	p
	n (%)	n (%)	
• Loss of consciousness	1 (5.9)	31 (14.3)	0.331
• Headache	1 (5.9)	86 (39.6)	0.006
• Nausea-vomiting	14 (82.4)	72 (33.2)	<0.001
• Amnesia	0 (0.0)	9 (41.5)	0.392
• Maxillofacial trauma	0 (0.0)	14 (64.5)	0.280
• Scalp injury (incision/hematoma)	1 (5.9)	16 (7.4)	0.816

DISCUSSION

Management of minor head trauma in pediatric patients admitted to the emergency department is an issue that is gaining more importance everyday. The majority of the pediatric patients we evaluated in our study had minor head trauma, and cranial pathology was detected in only a small percent of the brain CT scans performed on them. This situation supports the results of the previous studies, which emphasize that the probability of detecting pathological findings in brain CT in children with minor head trauma is very low, and that certain criteria and algorithms should be followed for the indication

of brain CT in these children.⁸⁻¹⁰ In addition, in our study, headache, nausea-vomiting and loss of consciousness were the three most common symptoms in children who admitted to emergency department after head trauma; and among these, the incidence of nausea-vomiting was found to be the dominant symptom in children <2 years of age, and headache in children aged ≥ 2 years.

Thinner skull bones in children, the condition of fontanelles, anatomical differences and susceptibility of children to the secondary effects of head trauma make childhood head trauma special and distinguish it from adult head trauma.^{3,11,12} Childhood head traumas may vary according to age, geographical conditions, seasons or different time zones of the day. These traumas are also more common in males than females.¹³⁻¹⁹ Considering the trauma mechanisms, traffic accidents (Passenger, pedestrian or bicycle-motorcycle driver etc.) are the common causes of head trauma in every period of childhood; Child abuse under the age of 1, falls during the play age, and sports or traffic accidents in adolescence are seen to come to the fore.^{12,13} Studies have reported that "falling" is one of the most common causes of head trauma in childhood. Fall-related trauma can occur as a result of falling from a height and falling from the same level.¹⁷⁻²¹ In a retrospective study by Lallier et al.²⁰ in Canada, it was reported that the mean age of children who applied to the emergency department after falling was 7.4/year (range, 1-18), and fall-related injuries were more common in males. In another study, Melo et al.²¹ reported that head traumas caused by falling were mostly caused by falling from a window and were more common in males. When we look at the studies in our country, it is seen that the cause of head trauma in different geographical regions are caused by different types of falls. In a study conducted in Samsun (Black Sea region), it was emphasized that while head traumas due to simple falls inside and outside the home were at the forefront, injuries due to falling from the roof or rooftops were more common in the Southeast Anatolia region.¹⁷⁻¹⁹ In our study, the most common cause of trauma in children admitted to the emergency department due to head trauma was falling from a height, followed by falling from the same level and traffic accidents. In addition, 57.3% of our patients were male, and our data on trauma mechanism and gender were consistent with previous studies.

Head traumas are evaluated in three different groups according to GCS as pain, moderate and mild (minor).^{12,22,23} "2 years" of age is accepted as the cut-off value for a better clinical understanding of especially childhood minor head traumas.^{22,23} This can be explained by the fact that clinical evaluation in children under 2 years of age is more difficult compared to elder children, and that no clinical findings are observed in infants even in the case of intracranial injury. In addition, the response of children under 2 years of age to alerting situations such as sounds and tactile stimuli is different from that of older children.^{22,23} All these factors have emerged the question that when and with which symptoms in clinical evaluation should indicate a brain CT to be performed in children with minor head trauma, and caused the creation of algorithms like PECARN, CATCH, CHALICE, etc. PECARN is the most successful among these algorithms in terms of usefulness, and it is also one of the algorithms in which childhood is categorized as under 2 years old and above.^{8,9,12,23,24} The PECARN algorithm enables the decision to take a Brain CT scan in children after head trauma, by evaluating the admission complaints such as scalp

hematoma, loss of consciousness, nausea-vomiting, headache, abnormal behavior, as well as factors such as the mechanism of injury, the experience of the physician and the preference of the family (25). In previous studies, the most common symptoms after minor head trauma were defined as loss of consciousness, headache and vomiting.^{23,26-29} The most common three symptoms of patients in our study were headache, nausea-vomiting and loss of consciousness, respectively. Together with this, we also found that the rate of nausea-vomiting in children <2 years of age and headache rate in children aged ≥ 2 years was significantly higher than in other age groups. These data we obtained support the results of previous studies. 'Headache' is included as a criterion in all internationally accepted scoring systems such as PECARN, CHALICE, CATCH in children presenting to the emergency department due to head trauma. However, almost all of the children under the age of 2 cannot describe the headache complaint because they cannot speak properly or their expressive abilities are not fully developed. Therefore, in our study, it was thought that the statistical difference in headache symptoms between both age groups was actually related to the children's ability to speak and express.

Limitations

Our study has some limitations, the most important of which is that being retrospective. For this reason, information about the complaints of patients included in the study, physical or neurological examination findings, follow-up and treatment management in the emergency department were limited to file records only. In addition, although the majority of the patients included in the study had minor head trauma, brain CT was performed in all patients; however The reason for the CT performance (such as the clinical condition of the patient, the experience of the physician or the family preference) is not clearly known. But in any case, this situation should not be interpreted as unnecessary brain CT scan.

CONCLUSION

In most of the children evaluated in our study, minor head trauma was observed after trauma, and acute surgical pathology was not observed in a very small part of the brain CT performed on these patients. Headache, nausea-vomiting and Loss of consciousness were detected as the three most common symptoms after head trauma. These symptoms also form the basis of many internationally accepted scoring systems. Considering these symptoms, the number of CT scans can be reduced, especially in pediatric patients with minor head trauma.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was approved by the Kırıkkale University Clinical Researches Ethics Committee (Date: 20.06.2017, Decision No: 16/02).

Informed Consent: Written informed consent was obtained from the patient participating in this study.

Referee Evaluation Process: Externally peer-reviewed.

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

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