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CLINICAL RESEARCH / KLİNİK ARAŞTIRMA

What is the Diagnostic Value of Computed Tomography in Pre-school Children with Minor Head Injuries?

Minör Kafa Travması Geçiren Okul Öncesi Çocuklarda Bilgisayarlı Tomografinin Tanısal Değeri Nedir?

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Abstract

Objective: In this study, we evaluated whether computed tomography (CT) examination would be required or not, based on complaints and findings after minor head trauma in pre-school children.

Methods: In our retrospective study, the history of pre-school patients with minor head trauma, physical examination findings, Glasgow coma scale, cranial radiography, CT findings, and injury were evaluated retrospectively. The duration of unconsciousness and amnesia, presence of post-traumatic seizure, history of vomiting, and presence of scalp injury/hematoma were examined in the patient's records. Clinical and radiological information was obtained retrospectively, and patients were re-evaluated one year later by phone. The fractures, edema, contusion, pneumocephalus, epidural hematoma, subdural hematoma, intraparenchymal hematoma, and intraventricular hemorrhage were evaluated on CT examination.

Results: Between May 2014 and May 2018, 884 patients under 7 years of age with minor head injuries were evaluated in the emergency department. Among these, anterior-posterior and lateral cranial radiography and CT were performed in 262 patients. None of the patients had neurological deficits. Scalp laceration/hematoma was detected in 36 (16%) patients. Fifty-two (24%) patients vomited once, whereas 12 (5%) and 5 (2%) vomited twice and thrice, respectively. A loss of consciousness (LOC) duration of <5 min was observed in 25 (11%) patients. None of the patients had a history of LOC duration of more than 5 min. However, all three patients with skull fracture had a history of LOC.

Conclusion: We believe that clinical examination and other imaging methods may reduce the need for CT evaluation in pre-school childhood patients with minor head trauma.

Keywords: Head injury, pre-school childhood, computed tomography

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Öz

Amaç: Bu çalışmada, okul öncesi dönemdeki çocuklarda minör kafa travması sonrası şikayet ve bulgulara göre, bilgisayarlı tomografi (BT) incelemesinin gerektirip, gerektirmediğini değerlendirdik.

Yöntem: Retrospektif çalışmamızda, minör kafa travması geçiren okul öncesi dönemdeki hastalar öyküsü, fizik muayene bulguları, Glasgow koma skalası, kafa grafisi ve BT bulguları, yaralanmaları geriye dönük olarak değerlendirildi. Hastanın kayıtlarından bilinç kaybının ve amnezinin süresi, post-travmatik nöbetin varlığı, kusma öyküsü ve skalp yaralanması/hematomun varlığı incelendi. Klinik ve radyolojik bilgiler retrospektif olarak elde edildi, hastalar bir yıl sonar telefon ile tekrar değerlendirildi. Kırık, ödem, kontüzyo, pnömosefalus, epidural hematom, subdural hematom, intraparankimal hematom ve intraventriküler hematom BT ile değerlendirildi.

Bulgular: 2014 Mayıs ve 2018 Mayıs arasında acil servisde minor kafa travmalı 7 yaşından küçük 884 hasta değerlendirildi. Bunlar arasında, 262 hastaya aneterior-posterior ve lateral kafa grafisi ve BT çekildi. Hastaların hiçbirinde nörolojik sorun yok idi. Skalp yaralanması/hematom hastaların 36'sında (%16) tespit edildi. Elli iki (%24) hasta bir kes kusmuş, 12 (%5) hastanın iki kez kusarmuş, 5 (%2) hasta üç kez kusmuş. Hiçbir hastada beş dakikadan kısa süren şuur kaybı olmadı. Bununla birlikte kafa tası kırığı olan üç hastada şuur kaybı öyküsü vardı.

Sonuç: Biz minör kafa travması geçiren okul öncesi çocukluk çağındaki hastalarda, klinik muayene ve diğer görüntüleme yöntemlerinin BT değerlendirilmesine ihtiyacı azaltabileceğini düşündük.

Anahtar Kelimeler: Kafa travması, okul öncesi çocukluk, bilgisayarlı tomografi

Introduction

Traumatic brain injury (TBI) is the leading cause of death and disability in children worldwide. Mild head trauma (MHT) [Glasgow coma scale (GCS) score of 14-15, loss of consciousness (LOC) duration of <3 min and amnesia duration of <1 min] is the most frequent form of childhood head trauma. The appropriate evaluation of children in this age group is controversial[1-3]. Children with MHT have similar incidences of scalp lacerations, behavioral changes, LOC, vomiting or seizures as those with TBI[4,5]. Thus, there is no clinical consensus for neuroimaging after MHT in children[3,6]. Approximately 83% to 97% of computed tomography (CT) findings are negative in patients with MHT[3,7], and overall <0.5% of children in this age group require neurosurgical intervention[5,7].

The ionizing radiation from CT scans can cause lethal malignancies[2,6,8]. The estimated rate of lethal malignancies due to CT is between 1 in 1000 and 1 in 5000, and the risk increases with decreasing age[2,6,8].

This study aimed to determine whether clinical signs, symptoms, direct X-ray, and other findings are useful predictive parameters for deciding the necessity of performing CT scans in young children with MHT.

Materials and Methods

We reviewed the medical records of previously healthy children aged ≤7 years who visited our clinic and who were diagnosed with MHT and treated in the emergency department (ED) between May 2014 and May 2018. Patient history, physical findings, GCS score, X-ray and CT findings, the cause of injury, and outcomes were recorded. The history and duration of LOC and amnesia, presence of post-traumatic seizures, history of vomiting, and presence of scalp lacerations/hematomas were also noted.

In our study, we classified the mechanism of injury as falling, playground accidents, home accidents, in-vehicle traffic accidents, and out-of-vehicle traffic accidents. The patient's symptoms of nausea, vomiting, LOC, and duration were classified in this study. Based on the findings of physical examinations, we performed adult GCS on children older than 2 years. The findings of skull base fractures (raccoon eyes, battle sign hemotympanum, otorrhea, rhinorrhea), scalp hematomas, cranial nerve anomalies, motor and sensory examinations, deep tendon reflexes, and meningeal irritation were reviewed.

We examined whether there were abrasions, ecchymosis, incisions, or tissue defects in the head. Direct head radiography according to linear fracture and compression fracture was distinguished. The fractures, edema, contusion, pneumocephalus, epidural hematoma, subdural hematoma, intraparenchymal hematoma, and intraventricular hemorrhage were analyzed by CT.

Children with a history of previous head trauma, coagulation disorders, and a ventricular shunt were excluded. A GCS score of 14-15, LOC duration of <5 min, amnesia duration of <1 min, and absence of focal neurological deficits indicated MHT. The children were followed up by interviewing their parents through telephone.

Statistical Analysis

All data were evaluated using SPSS 21.0 (Statistical Package for Social Science; IBM, Chicago, IL, USA). Kolmogorov-Smirnov test was used to reveal whether the data were suitable for normal distribution. Since most of the data showed normal distribution, independent t-test and paired-samples t-test were used in the data analysis. The mean values, standard deviations, maximum and minimum values and percentages were determined. The 95% confidence intervals were calculated and a p<0.05 5 was considered statistically significant.

Results

Between May 2014 and May 2018, 884 children (<7 years) who were diagnosed with MHT visited our ED. Among them, 262 had undergone skull X-ray imaging (anteroposterior and lateral) and head CT. Clinical and radiological data were recorded, and these patients were re-evaluated after one year through telephone interviews. Because 44 patients were lost to follow-up, 218 were included.

The causes of head injury are summarized in Table 1. The most common cause of head injury is falls (Figure 1). The study included 124 boys (56.8%) and 94 girls (43.2%). The mean age of the patients was 26.2±17.5 months (range, 0-80 months), with 48% and 51.9% belonging to the pediatric nonverbal and verbal age groups, respectively.

The time to admission was 0-4 h after the incident in 67.8% of the patients, with 3.5% admitted 24 h after the incident (Figure 2). Upon admission, 84% and 16% of the children had GCS scores of 15 and 14, respectively.

None of the patients had neurological deficits. Scalp laceration/hematoma was detected in 36 (16%) patients. Fifty-two (24%) patients vomited once, whereas 12 (5%) and 5 (2%) vomited twice and thrice, respectively. A LOC duration of <5 min was observed in 25 (11%) patients (Figure 3). None of the patients had a history of LOC duration of more than 5 min. However, all three patients with skull fracture had a history of LOC.

Table 1. Causes of MHT in this study

	n	%
Fall	128	58.7
Sports	34	15.6
Home accident	26	11.9
Occupant in MVA	18	8.2
Pedestrian struck by vehicle	12	5.6
Total	218	100.0

MHT: Mild head trauma

Discussion

Head trauma and resultant TBI are the leading causes of death and disability during childhood[1,2]. CT is a routine

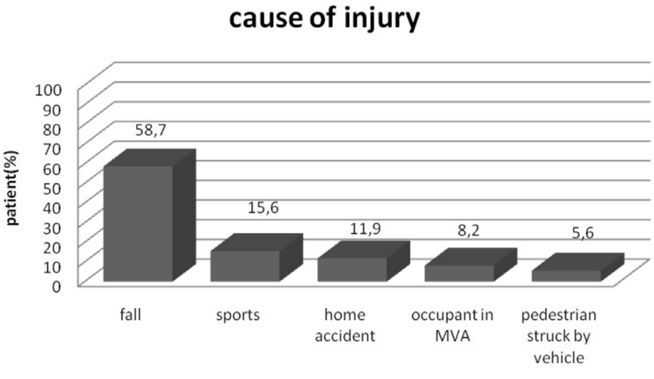

Figure 1. Bar graph demonstrating the percentages of causes of injury

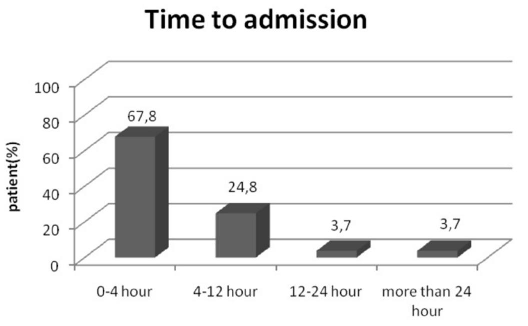

Figure 2. Patient time to admission to the emergency department

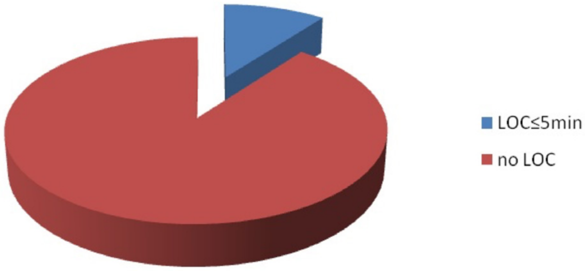

Figure 3. Patient distribution based on loss of consciousness duration

LOC: Loss of consciousness

diagnostic imaging modality that assesses children with TBI in the ER setting. However, several studies have reported that the diagnostic value of CT in children with head trauma is <10%[3,7,9,10]. Furthermore, children with MHT rarely have TBI, and the need for neurosurgical intervention in this subset of patients is even rarer. Considering the harmful effects of ionizing radiation on the developing brain and additional problems encountered in the ER setting during the procedure, the decision for performing head CT scans in children with head trauma must be carefully made[1,8,11-13].

The GCS stratification in the pediatric age group differs in the literature[10]. In some reports, patients with GCS scores of 14 and 15 were included in the minor head injury group, whereas other studies included patients with a GCS score of 13 in this group[7,14]. In patients with a GCS score of 13, focal neurological deficits accompany the clinical picture, and thus, the decision for performing an emergency CT scan is easier to make. However, in the patient group with GCS scores of 14-15 without additional signs or symptoms, deciding whether CT should be indicated is difficult. Furthermore, considering that the effects of ionizing radiation are more harmful in younger patients, dealing with MHT in the nonverbal age group (between 0 and 2 years) becomes more difficult. Grouping and evaluating different components contributing to the full clinical picture of TBI are necessary. The age and GCS scores of patients on admission, cause of injury, physical signs and symptoms, presence of LOC, and duration and X-ray findings if LOC is present need to be evaluated in a certain group of patients to obtain useful conclusions.

This study was retrospectively conducted in trauma patients in the pre-school age group (range, 0-6 years). TBI in this age group represents the early brain injury group, and clinical signs and symptoms together with X-ray findings have a higher correlation with brain injury and the consequent need for neurosurgical intervention. The need for performing CT is expected to be lower in this age group with MHT but without major clinical signs and symptoms than in older age groups. Our findings are similar to this suggestion. None of the patients with MHT without LOC or scalp hematoma had any abnormal findings on performing CT.

In our study, trauma causes were grouped into falls, sports accidents, home accidents, passengers in motor vehicle accidents, or pedestrian accidents. Falls have been reported as the most common cause of head trauma in children[4,5,14-17]. It was also the most common cause of injury in our study, and all three patients with cranial fractures had a history of falls. Literature reports suggested a higher risk of TBI in patients who fell from a distance of >3 m.

In the USA, less than 4-8% of brain CTs taken for children with minor head trauma show evidence of TBI[1,2,7]. Homer and Kleinman[3] reported that the prevalence of MHT varied between 0% and 7% in children. In our study, a ratio of 1.4% constitutes an evidence of TBI in CBT.

Dunning et al.[13] found the rate of detecting fracture in CT or direct radiography in a series consisting of 22,772 cases as 1.9%. Of the skull fractures, the ratio of linear skull fracture alone was found to be 1%[13]. In our study, we determined this ratio to be 1.4%. In our study, we found this rate to be 3%.

In another study investigating 3,866 cases of minor head trauma involving GCS 13-14-15, the proportion of cases with an initial GCS score of 14 (282/3,866) was 7.3%, whereas the proportion of cases with an initial GCS score of 15 (3,489/3,866) was 90.2%[18]. In our study, the proportion of cases with an initial GCS score of 14 (34/218) was 16%, whereas the proportion of cases with an initial GCS score of 15 (184/218) was 84%. Other demographic data were consistent between the two studies. In that study, the rate of CT in all cases was 52.8%[18]. In our study, it was 29.6%. While a series of 42,412 cases by Kuppermann et al.[7] revealed a CT rate of 35.3%, Palchak et al.[1] reported a CT rate of 62% in their study.

Radiation exposure during CT is 200 times greater than PA lung radiography[19]. Cranial radiographs have significant advantages because they do not require sedation and expose children to radiation 100 times less than brain CT. However, TBI may also occur in the absence of skull fracture. Cranial radiographs do not provide information about intracranial anatomy. In a meta-analysis of 16 studies covering 22,420 cases of minor head trauma, Dunning et al.[20] defined the individual risk factors associated with TBI. In this study, skull fracture, focal neurological findings, LOC, and GCS score less than 15 were statistically associated with TBI. We detected linear fractures in three cases via CT. In these cases, we did not find any lesion that suggested TBI in CT. We also detected fractures in direct head radiography images of the same cases.

Schnadower et al.[21] found that acute skull fracture in cranial radiography of children younger than 2 years of age significantly increased the emergence of TBI in the presence of skull fracture. In our study, among all pre-school age groups, 2 out of 3 patients in whom skull fracture was detected were between 0 and2 years old, and 3 patients were 3 years old. Although we did not detect any TBI in these cases, we recommend CT to be performed based on other accompanying findings (LOC, scalp hematoma, meningeal irritation, GCS score below 15). Another study argues that although the absence of skull fracture does not eliminate TBI, its presence increases the possibility of TBI by almost four times[16].

In the meta-analysis by Gruskin and Schutzman[22], some other publications, it has been reported that clinical worsening is not observed in isolated direct radiography. In the study by Ozsarac et al.[15], no significant correlation was found between TBI and other clinical parameters except for LOC (vomiting, post-traumatic seizure, somnolence, scalp hematoma). In our study, we found the frequency of LOC duration to be 11.4%. In their study, Palchak et al.[1] found this ratio as 36%. However, all head traumas were included in this study.

Radiation exposure is significantly higher in CT compared with conventional radiography[6,8]. Major epidemiological studies have not yet been conducted in clinical trials on cancer risk related to CT[11]. When we review the studies conducted, we see that there are two main conclusions. First, a correlation has been found between radiation and all solid cancers, with cancer risk increasing as radiation dose increases. Second, children are more severely affected by radiation than adults[8,12].

Children are more susceptible to radiation than adults because their cells are dividing more rapidly. Since children are expected to have a longer life expectancy, they are more likely to be exposed to radiation damage, especially cancer[21].

It is necessary to reduce the use of CT because it has been shown in many studies that ionizing radiation exposure resulting from CT causes lethal malignancies[7,8,23-26]. Estimated lifetime cancer mortality risks attributable to radiation exposure from a CT in a one-year-old are %0.18 (abdominal) and 0.07 (head), although these figures still represent a small increase in cancer mortality over the natural background rate[26]. Based on these data, it becomes evident that serious considerations should be made before performing CT. The use of CT is debated in blunt abdominal trauma, epilepsy, chronic headache, and even acute appendicitis. In Turkey, similar to the USA, CT is performed at a very high rate[8]. It was revealed that a third of the CBTs taken was unnecessary[21]. There is a growing consensus on ensuring that patients receive minimal radiation doses during CT to protect their medical welfare[8].

Based on this information, new technical studies have begun to address the issue of high radiation exposure even when there is an indication of performing CT, and it has been shown that CT radiation can be reduced by almost 50% without altering the accuracy of existing findings[27].

Study Limitations

The fact that our study is in patients with pre-school children with minor head injury may pose a problem in terms of its effects in early pediatric periods and advanced ages, so it will of course be useful to evaluate our results with more patients, more centers and more parameters.

Conclusion

Due to increasing medicolegal problems, the number of patients, media, politics, and many other issues, CT examination -as it is in general medical applications, is also performed on children with minor head trauma due to the influence of defensive medicine. CT should be approached with great caution and concern in the diagnosis and follow-up of children with minor head trauma due to the risk of radiation exposure. Before deciding to utilize CT, the benefit-loss ratio should be considered in detail. With a good clinical approach and other imaging modalities, we believe that unnecessary CT evaluations in children can be prevented.

Ethics

Ethics Committee Approval: Ethics committee was not taken because the study was conducted before 2020 and was retrospective.

Informed Consent: Retrospective study.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: N.Ü., Concept: E.Ö., Design: N.T., Data Collection or Processing: R.F., Analysis or Interpretation: N.Ü., Literature Search: E.Ö., Writing: N.T., R.F.

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