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Hospitalisation Rates and Radiological Findings in Infants with Head Trauma After a Fall

Düşme Sonrası Kafa Travması Geçiren Bebeklerde Hastaneye Yatış Oranları ve Radyolojik Bulgular

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ABSTRACT

Objective: The study aimed to determine the necessity of performing computed tomography (CT) scans in infants with head trauma because of falls because of concerns regarding radiation exposure by evaluating the hospitalisation rates.

Materials and Methods: The present study included 1060 patients who underwent cranial CT in the emergency department owing to a pediatric fall between 2018 and 2022. Two patients were excluded due to treatment refusal. Skull fractures, their characteristics, associated skin findings, and intracranial hemorrhage on CT scans and patients' demographic features (age & sex), medical history, and hospitalisation rates were investigated.

Results: Of the 1058 patients with head trauma who presented to the emergency department in the secondary care centre, fractures were detected in only 28 patients. Of these patients, 1.8% were treated as inpatients. Subdural hematomas and epidural hematomas were detected in 10.7% (n=3) and 7.1% (n=2) of patients with fractures, respectively. Furthermore, subdural hematomas and epidural hematomas were detected in 0.3% and 0.2% of trauma admissions, respectively.

Conclusion: In conclusion, positive CT findings and a low percentage of patients requiring hospitalisation stand out in the patients examined. Therefore, care should be taken when requesting tomography between the ages of 0-2.

Keywords: CT imaging, head trauma, hospitalisation rates, infant, skull fracture

ÖZ

Amaç: Bu çalışmada, düşme sonucu kafa travması geçiren bebeklerde radyasyona maruz kalma endişesi nedeniyle bilgisayarlı tomografi (BT) taraması yapılmasının gerekliliğinin hastaneye yatış oranları değerlendirilerek belirlenmesi amaçlanmıştır.

Materyal ve Metot: Bu çalışmaya 2018-2022 yılları arasında acil serviste pediatrik düşme nedeniyle kraniyal BT çekilen 1060 hasta dahil edildi. İki hasta tedavi reddi nedeniyle dışlandı. BT taramalarında kafatası kırıkları ve özellikleri ve ilişkili cilt bulguları ve intrakraniyal kanama, hastaların demografik özellikleri (yaş ve cinsiyet) ve tıbbi öyküleri, hastaneye yatış oranları araştırıldı.

Bulgular: İkinci basamak merkezinin acil servisine başvuran 1058 kafa travmalı hastadan sadece 28'inde kırık tespit edildi. Bu hastaların %1,8'i yatarak tedavi edildi. Kırığı olan hastaların sırasıyla %10,7'sinde (n=3) subdural hematom ve %7,1'inde (n=2) epidural hematom tespit edilmiştir. Ayrıca, travma başvurularının sırasıyla %0,3'ünde ve %0,2'sinde subdural hematom ve epidural hematom tespit edildi.

Sonuç: Sonuç olarak, incelenen hastalarda pozitif BT bulguları ve hastaneye yatış gerektiren hasta oranının düşüklüğü göze çarpmaktadır. Bu nedenle 0-2 yaş arasında tomografi istenirken dikkatli olunmalıdır.

Anahtar Kelimeler: Bebek, BT görüntüleme, hastaneye yatış oranları, kafatası kırığı, kafa travması

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INTRODUCTION

Infants (0-2 years) have fundamentally different neurotrauma pathophysiology. During this age range, the skull, subarachnoid space, cerebrospinal fluid flow, and certain parts of the brain undergo growth and development. Cephalohematoma, subaponeurotic (sub-galeal) hematoma, diastatic skull fracture, growing skull fracture, depressed ("ping-pong") skull fracture, and extradural hematoma are the most frequent neurotraumatic events in infants 0 –2 years old.[1] Infants typically exhibit convulsions, pallor, and a sudden loss of consciousness. A brain computed tomography (CT) scan is usually the preferred test.[2] Infants have a more comprehensive and differentiated disease than adults; therefore, children who have suffered head injuries must be sent to a pediatric neurosurgery department or a pediatric critical care unit.[3] According to the Eastern Association for the Surgery of Trauma's guideline for evaluating blunt cerebrovascular injury (BCVI), pediatric trauma patients should be examined using the same criteria as adults. The risk factors for BCVI in pediatric trauma patients (Glasgow Coma Scale <8, skull base fracture, cervical spine fracture, complicated face fractures, and soft tissue damage to the neck) appear to be similar to those in adult patients.[4] Owing to the smaller body size of children, and therefore a larger area of exposure, scalp and head injuries in children are more prevalent and possibly more fatal than in adults. The initial diagnosis of pediatric skull fractures with CT may be delayed to reduce infant radiation exposure, making clinical follow-up essential. A small percentage of pediatric cranial fractures may progress to a developing skull fracture, manifesting as a widening skull fracture, pulsatile mass and neurological problems. To distinguish between cranial and cerebral damage when treating developing skull fractures, CT and magnetic resonance imaging are crucial techniques. Multidisciplinary surgical treatment benefits patients and necessitates extensive scalp exposure, craniotomy access, intracranial debridement, dural repair, and cranial reconstruction.[5]

The study aimed to determine the necessity of performing computed tomography (CT) scans in infants with head trauma due to falls because of concerns regarding radiation exposure by evaluating the hospitalisation rates.

MATERIALS AND METHODS

Ethics Committee Approval: This study was approved by the Kafkas University Clinical Research and Ethics Committee (Date: 26.05.2021, decision no: 06-20). All procedures for studies involving human participants were carried out in accordance with the 1964 Declaration of Helsinki.

Patient Selection: Patients who presented with fall trauma and underwent CT in the emergency department were included. Patients were evaluated retrospectively. In total, 1060 archived cranial CT scans of infants who presented to the emergency department between January 01, 2018, and May 01, 2022, were examined. Radiological pathology was observed in 30 patients; however, two patient was excluded because of treatment refusal. Therefore, a total of 28 patients were investigated.

Evaluation of CT Images: Cranial CT scans were performed with Toshiba Alexion 32 Multi-Slice, Canon Medical Systems Corporation (Tochigi, Japan). In the radiology clinic, the cranial CT images included 1 mm coronal/axial and sagittal sections, according to protocol. Patient characteristics such as fracture site, displacement status, skin findings, bleeding findings, and bleeding type were recorded and compared.

Statistical Analysis: Statistical Packages for Social Sciences (SPSS; Chicago, IL, USA) version 25 was used for data analysis. Demographic data were given as frequency in patients with positive CT findings and all patients.

The frequency of fracture characteristics was given both within and across all patients. All variables except age were categorical. Variables were evaluated by chi-square analysis. Fisher Exact Test and Continuity Correction Tests were applied in cross-tabulations. P value <0.05 was considered statistically significant.

RESULTS

Based on cranial CT images of the 1058 patients who presented to the emergency department in the secondary care center with head trauma, radiological pathology was detected in only 28 patients. Of those 1058 patients, 1.8% were treated as inpatients. Subdural hematomas and epidural hematomas were detected in 10.7% (n=3) and 7.1% (n=2) of patients with fractures. Moreover, subdural hematomas and epidural hematomas were detected in 0.3% and 0.2% of trauma admissions (Table 1).

In 28 patients with radiologic pathology, seventeen (60.7%) fractures were found on the left, and 11 (39.3%) were found on the right. The most common fracture location was the parietal bone (53.6%, n=15). Fractures were generally found to be non-displaced (71.4%, n=20), and typically not accompanied by skin findings (64%, n=18). Among patients with fractures, 25% showed thickening of the scalp, and in 10% of patients, the fractures were accompanied by a cephalohematoma. Cerebral hemorrhage was not detected in 82.1% (n=23) of the patients with fractures. Subdural hematomas and epidural hematomas were found in 10.7% (n=3) and 7.1%

Table 1. Demographic data of patients with radiologic pathology.

Patient Characteristics		n-28	%	n-1058 %
Gender	Female	15	53.6	1.4
	Male	13	46.4	1.2
Age	10.5±6.43 months (min 0- max23)			
Hospitalisation	Outpatients	9	32.1	0.9
	Inpatients	19	67.9	1.8
Days	1 day	12	42.9	1.1
	2 days	4	14.3	0.4
	3 days	3	10.7	0.3
Fall Story	No data	16	57.1	1.5
	Yes	12	42.9	1.1
Fall Type	Free altitude (0.5m-1.5m)	4	14.3	0.4
	From crib, sofa, seat	4	14.3	0.4
	Falling off the lap	3	10.7	0.3
	Falling down the stairs	1	3.6	0.1

(n=2) of the patients with fractures. Five patients with cerebral hemorrhage required hospitalisation (Table 2).

An analysis of factors affecting hospitalisation showed no significant correlation between the hospitalisation and the fracture site, displacement status and skin changes (Table 3, p>0.05). As seen in Table 3, 13 male patients out of 15 and six female patients out of 13 were hospitalised. So, hospitalisation rates significantly higher in male infants than female infants. (p=0.029, Cramer's V=0.433).

Table 2. Features of fractures.

Patient Characteristics		Number of patients	%	Rate in all patients (1058) screened (%)
Fracture Side	Right	11	39.3	1.1
	Left	17	60.7	1.6
Fracture Location	Parietal	15	53.5	1.4
	Frontal	6	21.4	0.6
	Occipital	5	17.9	0.5
	Temporal	1	3.6	0.1
	Maxillary	1	3.6	0.1
Fracture Type	Displaced	8	28.6	0.8
	nondisplaced	20	71.4	1.9
Accompanying skin finding	No	18	64.3	1.7
	Yes	10	35.7	0.9
	Cephalic hematoma	3	10.7	0.3
	Thickening of the scalp	7	25.0	0.7
Accompanying brain hemorrhage	No	23	82.1	2.2
	Yes	5	17.9	0.5
	Subdural Hematoma	3	10.7	0.3
	Epidural Hematoma	2	7.1	0.2

Table 3. Factors affecting hospitalisation in patients with positive imaging.

Patient Characteristics	No Hospitalised	Hospitalised	p-value
Male	2	13	**0.029**[a]
Female	7	6	
Right Fracture	3	8	0.493 [a]
Left Fracture	6	11	
Parietal Fracture	4	11	0.396 [a]
Other Location	5	8	
Displaced Fracture	2	6	0.949[b]
Non-Displaced Fracture	7	13	
Skin Finding	1	9	0.148[b]
No skin Finding	8	10	

a: Fisher Exact Test; b: Continuity Correction.

DISCUSSION AND CONCLUSION

We aimed to determine the frequency of radiologic imaging findings. Fractures were present in only 2.7% of patients. The most common finding was nondisplaced fractures in the parietal bone. Skin findings were usually not associated. The rate of positive CT findings was low, and the rate of cerebral hemorrhage was 0.5%. A skull fracture is a typical side effect of head trauma, a common cause of morbidity and death in children. Skull fractures in children differ from those in adults. Although the brain and craniofacial bones are still undergoing growth in children, they have a stronger ability to rebuild after a fracture.[6] In our study, traumatic brain hemorrhage was detected in 5 patients among 1058 trauma patients. Three traumatic brain hemorrhage was reported in 1574 trauma patients under one year of age admitted to the Pediatric Emergency Department in Scotland. The rate of cerebral hemorrhage was 0.2% in this study, and 0.5% in our study, and the results are correlated.[7]

One study suggested that children under two years of age can be examined without imaging. [8] Clinical decision criteria for diagnosing skull fractures in young children with head trauma but not requiring immediate head CT scan facilitated the identification of 90% of skull fractures in young children with moderate head trauma and not requiring immediate head CT scan. Using these criteria reduced radiologic evaluations by approximately 60%.[9]

A large prospective study of linear skull fractures due to mild head trauma in children under 18 included 43,904 children and 11,035 children under two. Fractures were found in 222 (%2) children under 2 years old, and 120 (%1) of these patients needed hospitalisation. Our study's results were similar, with a fracture rate of 2.7% and a hospitalisation rate of 1.8%.[10]

Young children are frequently injured due to falls. Mild head injury (MHI), also known as blunt head injury, is the most common head injury among falling children. To determine the cause and extent of injury, 595 children who fell from various heights were investigated. 10 (1.7%) patients had linear skull fractures, and five (0.8%) had a cerebral hemorrhage. The fracture and cerebral hemorrhage rates were similar to our study's results.[11] High-performance clinical decision rules (CDRs) have been developed to determine whether children with head injuries require a brain CT. The effectiveness of the Pediatric Emergency Care Applied Research Network (PECARN) CDRs, the Children's Head Injury Algorithm for the prediction of Important Clinical Events (CHALICE) CDRs and the Canadian Assessment of Tomography for Childhood Head Injury (CATCH) CDRs were assessed. The implementation of CDRs significantly increased the number of children exposed to CT: CATCH (20.1%), CHALICE (23.9%), PECARN high and intermediate risk (38.7%), and PECARN high risk (3.8%). Although direct implementation in regions with a low prevalence of serious TBI is expected to increase the number of unnecessary CT scans requested, CDRs have shown great accuracy in identifying children with positive CT results.[12]

Since the risk of intracranial hemorrhage in children with moderate traumatic brain injury (TBI) cannot be predicted by any clinical signs or symptoms, a wait-and-see strategy without initial imaging has been reported to be appropriate and safe in children with TBI without significant neurological symptoms.[13] Moreover, since the risk of complications of isolated skull fractures in children is low, these patients can be discharged without hospitalisation. It has been reported that this change in practice will lead to significant cost savings in healthcare services.[14,15] In our study, nine patients with isolated skull fractures were initially followed up with a wait-and-see strategy and discharged without hospitalisation since no significant clinical findings developed.

The most frequent cause of death and a substantial source of morbidity in children and young people worldwide is pediatric TBI. A retrospective assessment of all pediatric highly populated urban regions during two years showed that the most frequent cause of injury was pedestrian collisions, followed by falls from heights. The number of boys receiving injuries was five times higher than that of girls. Skull fractures and contusions were the most frequent intracranial injuries.[16] Children with mild TBI rarely exhibit clinically significant neurological impairment, even in the presence of intracranial bleeding. Additionally, there is ongoing debate concerning the value of routine surveillance imaging in the pediatric population, particularly in light of concerns about the risks of early radiation exposure. A level III epidemiological study demonstrated that clinical changes, rather than repeat imaging, help categorize all patients needing neurosurgical intervention. In most cases, clinical monitoring alone is safe and sufficient to avoid exposure to repeated radiographic imaging.[17] Children frequently experience skull fractures from unintentional falls. The establishment of biomechanical thresholds for newborn skull fractures has been hampered by the absence of comprehensive data from actual pediatric traumas. The parietal bone had the most fractures in this study and the literature. The likelihood of an infant suffering a parietal skull fracture from a 0.3 m fall has been low (0%–54%). For concrete and carpet impacts, the likelihood of head-on falls from 0.9 m resulting in fractures was high (86%–100%) and intermediate (34–81%), respectively. The impact surface affected the likelihood of fractures in 0.6 m falls. Occipital impacts from 0.9 m to concrete also had a 25%–70% likelihood of resulting in a parietal skull fracture.[18] A study that used 231 head CT 3D reconstructions showed that the impact surface played a significant role in the number of cracks present in a fracture, considering younger babies and higher fall heights, suture-to-suture spread, and biparietal involvement. Their findings showed that soft tissue edema occurred as a consequence of the position of the fracture rather than the location of impact.[19] In another study, a scoring system based on the initial CT imaging was developed to differentiate clinically significant TBI. Depressive skull fracture, pneumocephalus, epidural hematoma, subdural hematoma, and contusion were reported as independent variables. Thus, it has been reported that low- and high-risk TBI can be differentiated.[20]

In conclusion, there are some limitations in our study. This study is a cross-sectional research study in a single-centre secondary-level hospital. The fall history of some patients could not be determined. The absence of a pediatric trauma centre may have influenced the findings. The low number of positive CT findings and the low rate of patients requiring hospitalisation were noteworthy. Therefore, care should be taken when requesting tomography between the ages of 0-2.

Ethics Committee Approval: Our study was approved by the Kafkas University Ethics Committee (Date: 26.05.2021, decision no: 06-20). The study was carried out following the 1964 Helsinki Declaration.

Conflict of Interest: No conflict of interest was declared by the authors.

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