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Use of Cranial Computed Tomography in Minor Head Trauma Cases Under Two Years of Age

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Abstract

Objectives: There is a controversy about whether to use cranial computed tomography (CT) for children with minor head trauma (MHT) under two years of age. In this study, it was aimed to determine the parameters that can be useful at decision-making stage.

Materials and Methods: Patients under two years of age who were admitted Emergency Department (ED) within three months due to MHT and who underwent cranial CT scan were included in the study. Trauma mechanisms, Glasgow Coma Scale (GCS) scores, symptoms (crying/unrest, vomiting, to refuse eating, drowsiness, loss of consciousness) and clinical signs (hyperemia/ecchymosis, abrasion, skin laceration, cephalohematoma, fontanel bulging) were retrospectively screened.

Results: Of the 486 patients with MHT, 156 (32%) who underwent cranial CT examination were evaluated. Their average age was 10.4 (SD ± 6.3) months and 50.6% of them were male. In 8.3% of cases clinically important cranial CT findings were detected; however, surgical intervention was not needed for any of them. Cephalohematoma and drowsiness were associated with positive CT results ($p<0.05$).

Conclusion: The observation of cephalohematoma and drowsiness in children younger than two years of age may indicate significant trauma-related injuries and may be helpful in deciding whether to use cranial CT.

Keywords: computed tomography; pediatric; head trauma; emergency department

Introduction

Minor head trauma (MHT) is an important part of childhood injuries [1]. Although trauma mechanisms are variable, falling from low height under the age of two years is often observed [2]. Management of these patients is still a controversial issue [3]. The Glasgow Coma Scale (GKS) or its derivative for preverbal infants and toddlers is often used to determine the severity of head injury. Head injuries resulting in a GCS score of ≤8 are severe, those with scores of 9 to 13 are moderate, and those with scores of 14 or 15 are mild [2]. GKS for adults and infants is shown in Table 1. In this group of patients undergoing CT scan, sedation may be necessary, which brings along many additional risks such as hypoxia, apnea, changes in the level of consciousness, aspiration risk and even endotracheal intubation [4,5]. In addition, exposure to CT-induced radiation can lead to an increase in the risk of malignancies [6]. The ED management of children with MHT remains uncertain. Limited studies have been made especially on patients under two years of age. The aim of the study is to draw attention to the fact that these patients often have unnecessary cranial CT scanning and to determine the parameters that may be useful to reduce it.

Materials and Methods

This study was conducted within three months in an educational and research hospital attaining approximately 170 000 ED applications annually. Information about the cases was scanned retrospectively from patient's files and the electronic medical record system. The study was carried out by emergency physicians. They had at least two years of experience in the emergency trauma department. All examinations were accompanied by an emergency medicine specialist to improve inter-rater reliability. The study included patients aged 0-24 months, with a GCS value of 14 or 15, who fell from <1 meter height, presented to the ED within the first 24 hours and underwent a cranial CT scan. Patients who have inaccessible data, whose trauma mechanism was uncertain, with

Response	Adults	Infants	Score
Eye opening	Spontaneous To voice To pain No response	Spontaneous To voice To pain No response	4 3 2 1
Verbal response	Oriented Disoriented Inappropriate words Incomprehensible No response	Coos, babbles Irritable Cries to pain Moans to pain No response	5 4 3 2 1
Motor response	Obeys commands Localizes pain Withdraws to pain Decorticate posture Decerebrate posture No response	Makes normal spontaneous movements Withdraws to touch Withdraws to pain Decorticate posture Decerebrate posture No response	6 5 4 3 2 1

Table 1: Glasgow Coma Scale Score for Adults and Infants

GCS score of 13 or lower and with coagulopathy history were excluded from the study. Age, gender, trauma mechanism, GCS score (14 or 15), symptoms (crying/unrest [unusually by parents], vomiting [several times or hours later], to refuse eating [no eating or eat less than usual], drowsiness [unusually by parents] and loss of consciousness [<5 seconds]), physical examination signs (hyperemia/ecchymosis, abrasion, skin laceration, cephalohematoma and fontanel bulging) and outcomes of the cases were recorded. At the end of the study, the obtained data were analyzed. A positive CT result was defined as the presence of one or more of the following: intracranial hemorrhage, contusion, cerebral edema, pneumocephalus or skull fracture.

Statistical Analysis

All statistical analyses were performed using the IBM® SPSS 22.0 statistical software package. Categorical variables were expressed as the number of observations and percentages. Qualitative data were analyzed by chi-square test. Relationship between clinical signs and symptoms with cranial CT results was evaluated by Single Logistic Regression Analysis. For each parameter, odds ratio (OR) was calculated with 95% confidence interval (95% CI). In all analyses, the level of significance was accepted as $p<0.05$.

Results

Within the period of the study, 156 (32%) patients who had cranial CT examination from 486 patients meeting MHT criteria were included in the study. The mean age of the patients was 10.4 (Standard Deviation [SD] ± 6.3) months and out of them 50.6% were male. After the initial evaluation, 17 patients were excluded from the study because of inaccessible data (n=12), uncertain trauma mechanism (n=4) and history of coagulopathy (n=1).

GCS values were calculated as 14 in 13 cases and 15 in 143 cases. There was no statistically significant correlation between GCS values and CT results ($p>0.05$). The relevant analysis is shown in Table 2.

		CT (+)		CT (-)		Total		p
		n	%	n	%	n	%	
GKS	14	3	23,1	10	7,0	13	8,3	0,079
	15	10	76,9	133	93,0	143	91,7	
Total		13	8,3	143	91,7	156	100,0	
GKS: Glasgow Coma Scale, CT: Computed Tomography								

Table 2: Relationship between GCS scores and CT results

The most frequent symptom was crying/unrest (44.2%) and the second was vomiting (26.3%). Among physical examination signs the most frequently seen was hyperemia/chemosis (39.1%) and the second was cephalohematoma (30.1%). Distribution of symptoms and signs are shown in Table 3. In 13 (8.3%) of the cases positive findings were detected in the cranial CT scan. It was observed that 9 of them have non-displaced linear fractures (occipital [n=3], parietal [n=2], frontal [n=1], temporo-parietal [n=1], parieto-frontal [n=1] and temporal [n=1]. Most important injuries were a minimal displaced right parietal fracture, a left occipital linear fracture with right parieto-frontal subarachnoid hemorrhage, occipital and temporo-parietal linear fractures with minimal epidural hematoma. All of these patients were admitted to the hospital and none of them needed surgical intervention. They were discharged after 24-48 hours of clinical follow-up. All patients without CT imaging or positive CT findings were discharged from ED after 4-6 hours of observation. The clinical follow-up of these patients did not deteriorate and none of them had been brought back to the ED with the same complaints. The relation between symptoms and positive cranial CT results is shown in Table 4. In the single logistic regression analysis statistically significant relevance between drowsiness and CT results is found ($p<0.05$; OR:8.49;

%98 CI:1.28 to 56.25). The relation between physical examination signs and positive CT results is shown in Table 5. In the single logistic regression analysis statistically significant relevance between cephalohematoma and CT results is found ($p<0.05$; OR:4.27; %95 CI:1.32 to 13.84).

Symptoms	**n**	**(%)**
None	10	6,4
Crying/Unrest (unusually by parents)	69	44,2
Vomiting (several times or hours later)	41	26,3
To refuse eating	15	9,6
Drowsiness	12	7,7
Loss of consciousness (< 5 seconds)	9	5,8
Total	156	100
Clinical Signs	**n**	**(%)**
None	8	5,1
Hyperemia/Ecchymosis	61	39,1
Abrasion	28	18,0
Skin Laceration	10	6,4
Cephalohematoma	47	30,1
Fontanel bulging	2	1,3
Total	156	100

Table 3: Distribution of clinical signs and symptoms

Symptoms	**B**	**Wald**	**Sig.(p)**	**OR**	**95% CI**	
Crying/Unrest	0.42	0.53	0.47	152	0.49	4.76
Vomiting	-1.54	2.12	0.15	0.22	0.03	1.71
To refuse eating	0.60	0.53	0.47	1.82	0.36	9.10
Drowsiness	2.14	4.91	**0.03**	**8.49**	1.28	56.25
Loss of consciousness	-18.87	0.00	0.99	0.00	0.00	.
CT: Computed Tomography, OR: Odds Ratio, CI: Confidence Interval						

Table 4: Single logistic regression analysis for the relationship between symptoms and positive cranial CT results

Clinical signs	**B**	**Wald**	**Sig.(p)**	**OR**	**95% CI**	
Hyperemia/Ecchymosis	-2.16	4.20	0.04	**0.12**	0.02	0.91
Abrasion	-1.03	0.94	0.33	0.36	0.05	2.87
Skin Laceration	0.22	0.04	0.84	1.24	0.15	10.64
Cephalohematoma	1.45	5.84	**0.07**	**4.27**	1.32	13.84
Fontanel Bulging	23.77	0.00	0.99	0.00	0.00	.
CT: Computed Tomography, OR: Odds Ratio, CI: Confidence Interval						

Table 5: Single logistic regression analysis for the relationship between clinical signs and positive cranial CT results

Discussion

The use of CT is important in the early diagnosis of cranial injuries [7]. However, the issue of which head traumas require CT scan remains controversial. Fear of missing clinically significant injuries causes the unnecessary use of CT. The rate of CT scanning of children with MHT varies between 35% and 52% [7,8]. In our study, this rate was 32% in children under 2 years of age. Serious injury rate in children with MHT is less than 10% and this is not usually require surgical intervention [3,7,8]. Consistent with these results, in our study this rate was 8.3% and surgical intervention was not required for any of them. A number of studies have been conducted to determine clinical parameters to reduce the CT scan rate. Pediatric Emergency Research Canada (PERC) Head Injury Study Group (CATCH), Pediatric Emergency Care Applied Research Network (PECARN) and Children's Head Injury Algorithm for the Prediction of Important Clinical Events (CHALICE) are key works in this area [7-9]. Among them, PECARN differs in terms of the separate evaluation of cases under two years of age [8].

In the literature, many indicators have been described for clinically significant cranial injuries in children with MHT. Dangerous mechanism of injury, cephalohematoma, acting abnormally according to the parents, altered mental status, vomiting, worsening headache, post-traumatic seizures, amnesia, loss of consciousness, GCS less than 15, signs of skull fracture, drowsiness and irritability [2,7-11]. It is difficult to decide whether to use cranial CT in children with MHT under two years of age. Since cranial sutures have not yet closed in this patient group, early signs of intracranial pressure increase are not seen. In addition, their physical examination is not effective because of limited communication [2]. Therefore, different decision-making rules are proposed in similar studies. In addition to this rules, clinicians often perform CT imaging based on their clinical experience. This situation leads to an increase in cranial CT rates.

Limitations

The limitations of the study include the fact that it was retrospective, included limited number of cases and included patients from one single center. In addition, inter-rater reliability may have affected outcomes when all examinations were accompanied by an emergency medicine specialist.

Conclusions

Due to their anatomical differences and clinical assessment difficulties, the issue of whether to use CT in children with MHT under two years of age remains uncertain. In this special patient group cephalohematoma and drowsiness may indicate trauma related injuries and may be helpful in deciding whether to use cranial CT.

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