

Clinical predictors of intracranial injuries in infants with minor head trauma

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Clinical Predictors of Intracranial Injuries in Infants with Minor Head Trauma

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■ **OBJECTIVE:** Minor head trauma is common in children. Although most cases are nonsignificant, minor head trauma can lead to preventable intracranial injuries. The aim of this study was to identify clinical predictors of intracranial injuries in infants with minor head trauma.

■ **METHODS:** Between 2006 and 2013, we retrospectively enrolled infants <11 months old with minor head trauma. Data recorded included age, sex, cause of trauma, fall height, vomiting, bad temper, size and location of scalp hematoma, fracture, and intracranial injuries on computed tomography.

■ **RESULTS:** Of 549 enrolled infants, 15 (3%) sustained traumatic intracranial injuries: epidural hematoma in 7, subarachnoid hemorrhage in 4, subdural hematoma in 3, and cerebral contusion in 1. Intracranial injuries were found in 8 of 98 infants who had fallen from a >60 cm height, 1 in 197 with fall height >30 cm, and none in 44 with fall height ≤30 cm ($P = 0.0001$); 1 of 2 with scalp hematomas >6 cm, 10 of 35 with hematomas >3 cm, and 2 of 121 with hematomas ≤3 cm ($P = 0.0001$); and 9 of 28 with temporal hematoma, 2 of 15 with parietal hematoma, 2 of 22 with occipital hematoma, and none of 98 with frontal hematoma ($P = 0.0001$). Logistic regression analysis showed that scalp hematoma was related to intracranial injuries (hazard ratio = 21.127, $P = 0.0001$), whereas age, sex, fall, vomiting, and bad temper were not.

■ **CONCLUSIONS:** Fall height and size and location of scalp hematoma were associated with intracranial injuries. These factors should be considered when making decisions on radiologic examinations of infants with minor head trauma.

INTRODUCTION

Minor head injury is defined as being present in individuals who have a normal mental status at the initial examination, no abnormal or focal findings on neurologic examination, and no physical evidence of skull fracture.¹ Minor head trauma is a common childhood injury and an important cause of morbidity. Minor head trauma has an estimated incidence of 250 per 100,000 per year. It accounts for >7000 deaths and 600,000 emergency department visits annually among children in the United States.^{2,3} The assessment of an infant's condition is very difficult. Although radiologic examination can effectively identify brain injuries, controversy and variability exist. The aims of this study were to identify clinical predictors of intracranial injuries in infants with minor head trauma and identify clinical factors using radiologic examination.

MATERIALS AND METHODS

This retrospective study was approved by the institutional ethical committee (No. 3574). All medical records of infants who had been hospitalized at Tokyo Women's Medical University Medical Center East for minor head trauma between January 1, 2006, and September 30, 2013, were reviewed. The study population comprised 549 infants ranging in age from birth to 11 months old. Data collected included sex, age, mechanism of head injury, fall height, vomiting, scalp hematoma size, scalp hematoma location, neurologic examination, and whether the intracranial injuries were epidural or subdural hematoma, subarachnoid hemorrhage, or contusion on computed tomography (CT).

Frequencies and descriptive statistics were used to characterize the study population. Either χ^2 test or Fisher exact test was used to determine differences between high and low heights and between large and small scalp hematomas. In multivariable logistic regression analysis, we assessed the association between intracranial injuries with minor head trauma and age, sex, vomiting, bad temper, and scalp hematomas.

Key words

- Infants
- Minor head trauma
- Scalp hematomas

Abbreviations and Acronyms

CT: Computed tomography

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Table 1. Characteristics of Patients with Minor Head Trauma

Characteristic	Intracranial Lesions		Total	P Value
	Yes	No		
Age (months)				
0–5	8	218	226	0.332
6–11	7	316	323	
Sex				
Female	4	243	247	0.148
Male	11	291	302	
Mechanism				
Fall	11	346	357	0.494
Fall from stairs	2	43	45	
Collapse	0	28	28	
Hit	0	112	112	
Abuse	2	1	3	
Vomiting	2	67	69	0.928
Bad temper	2	13	15	0.011
Scalp hematoma	13	150	163	0.0001
Hours after injury				
0–6	8	477	485	
7–12	3	21	24	
12–24	1	8	9	
>24	3	19	22	
X-ray	8	100	108	
CT	15	114	129	
Fracture	11	23	34	
Total	15	534	549	

CT, Computed tomography.

RESULTS

Between January 1, 2006, and September 30, 2013, 549 infants presented to Tokyo Women's Medical University Medical Center East with minor head trauma. Of infants, 302 were boys, and the

Table 2. Height of Falls and Intracranial Lesions ($P = 0.0001$)

Height (cm)	Intracranial Lesions		Total
	Yes	No	
≤30	0	44	44
≤60	1	196	197
>60	8	90	98
Total	9	330	339

Table 3. Size and Location of Scalp Hematoma and Intracranial Lesions

	Intracranial Lesions		Total
	Yes	No	
Size (cm) ($P = 0.0001$)			
≤3	2	124	126
≤6	10	25	35
>6	1	1	2
Location ($P = 0.0001$)			
Frontal	0	98	98
Temporal	9	19	28
Parietal	2	13	15
Occipital	2	20	22
Total	13	150	163

mean age was 6.25 months. Patient demographics are presented in **Table 1**. Among 549 infants with minor head trauma, 15 intracranial injuries occurred (3%). The most common mechanisms of injury were falls from a height ($n = 357$; 65%), being hit ($n = 112$; 20%), and falling down stairs ($n = 45$; 8%). Abuse was suspected to have occurred in 3 infants (0.5%). The most common accident sites were falling from a bed ($n = 110$); falling from a sofa, table, chair, or desk ($n = 105$); and falling from being held by a parent ($n = 58$). There was no correlation between age in months and number of incidents (**Table 1**). Fall heights were classified into 3 groups in 339 infants: high (>60 cm) in 98 (29%) infants, intermediate (>30, ≤60 cm) in 197 (58%) infants, and low (≤30 cm) in 44 (13%) infants (**Table 2**). Intracranial injuries were detected significantly more often in infants who had fallen from a greater height ($P = 0.0001$). The size of scalp hematomas was classified as large (>6 cm) in 2 (1%) infants, medium (>3, ≤6 cm) in 35 (22%) infants, and small (≤3 cm)

Table 4. Logistic Regression Analysis for Factors Independently Related to Intracranial Lesions

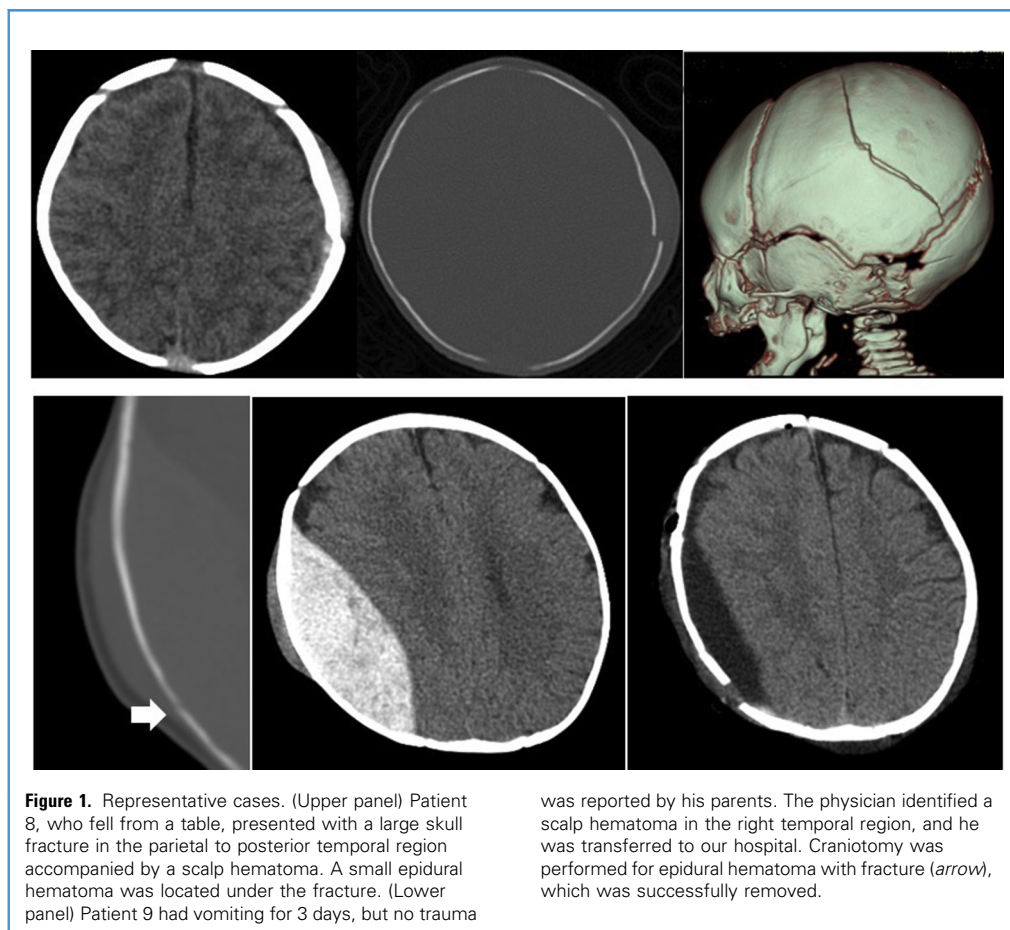
Factor	HR	95% CI	P Value
Age	2.383	0.776–7.315	0.129
Sex	2.2	0.666–7.272	0.196
Fall	1.776	0.511–6.175	0.366
Vomiting	1.127	0.231–5.488	0.882
Bad temper	3.819	0.670–21.785	0.131
Scalp hematoma	21.127	4.596–97.108	0.0001

HR, hazard ratio; CI, confidence interval.

Table 5. Characteristics of Patients with Minor Head Trauma and Intracranial Lesions

Patient	Age (months)/Sex	Mechanism	Fall Type/Height (cm)	Vomiting	Scalp Hematoma	Hematoma Size (cm)/Location	X-ray	Fracture	Intracranial Lesion (CT)	Hours After Head Injury	Treatment	Outcome
1	0/F	Fall	Carry/40	Yes	Yes	2/Occipital	Yes	No	SAH	45	Observation	Good
2	1/M	Fall	Carry/100	No	Yes	5/Temporal	Yes	Yes	SDH	2	Observation	Good
3	2/F	Fall	Carry/80	No	No		No	No	SAH	1	Observation	Good
4	2/M	Fall	Carry/100	No	Yes	4/Occipital	Yes	Yes	Contusion	10	Observation	Good
5	2/M	Fall	Carry/120	No	Yes	5/Temporal	Yes	Yes	EDH	1	Observation	Good
6	2/F	Fall	Carry/100	No	No		No	No	SAH SDH	1	Aspiration	Good
7	2/M	Fall	Carry/120	No	Yes	5/Temporal	Yes	Yes	SDH	1	Observation	Good
8	4/M	Fall	Table/100	No	Yes	6/Temporal	Yes	Yes	EDH	24	Observation	Good
9	6/M	Abuse		Yes	Yes	5/Temporal	No	Yes	EDH	36	Craniotomy	Good
10	6/M	Fall	Carry/100	No	Yes	3/Parietal	No	Yes	SDH	48	Observation	Good
11	6/M	Fall	Stairs (15 steps)	No	Yes	5/Temporal	No	Yes	EDH	10	Observation	Good
12	7/M	Fall	Carry/70	No	Yes	5/Parietal	Yes	Yes	EDH	3	Observation	Good
13	9/M	Abuse		No	Yes	10/Temporal	No	No	SAH	1.5	Observation	Good
14	10/M	Fall	Bicycle/80	No	Yes	4/Temporal	No	Yes	EDH	12	Observation	Good
15	11/F	Fall	Stairs (12 steps)	No	Yes	5/Temporal	Yes	Yes	EDH	1.5	Observation	Good

CT, computed tomography; F, female; M, male; SAH, subarachnoid hemorrhage; SDH, subdural hematoma; EDH, epidural hematoma.



was reported by his parents. The physician identified a scalp hematoma in the right temporal region, and he was transferred to our hospital. Craniotomy was performed for epidural hematoma with fracture (arrow), which was successfully removed.

in 121 (77%) infants (Table 3). Intracranial injuries were significantly correlated with a larger scalp hematoma ($P = 0.0001$). We assessed intracranial injuries according to the location of the scalp hematoma (frontal, temporal, parietal, occipital). There was a significant difference among the scalp hematoma locations ($P = 0.0001$) (Table 4). The risk of intracranial injuries with temporal hematomas was high. Multivariate logistic regression analysis revealed that an independent predictor of intracranial injuries was scalp hematomas, whereas age, sex, fall, vomiting, and bad temper were not (hazard ratio = 21.127, $P = 0.0001$) (Table 4). Of the 15 infants with intracranial injuries, 7 had epidural hematoma, 4 had subarachnoid hemorrhage, 3 had subdural hematoma, and 1 had cerebral contusion; 11 were boys; 11 were from falls; 10 involved falls from >60 cm; 13 had scalp hematomas; 11 scalp hematomas were >3 cm; and 9 scalp hematomas were located at temporal sites. Although the most common site of falls was from a bed in our entire series, 9 of the 15 infants with intracranial injuries had sustained falls from being held by parents. Craniotomy was performed in 1 infant, and aspiration was performed in 1 infant. The prognosis of all patients was good (Table 5). Representative cases are shown in Figure 1.

DISCUSSION

Minor head trauma is a common problem throughout childhood and has been reported in many studies^{1,2,4}; there are also reports concerning trauma in infants ≤ 2 years old.^{5,7} However, there are almost no reports concerning infants ≤ 1 year old. Infancy is a period during which the body experiences marked growth, and walking ability is not yet acquired; thus, it is necessary to divide the period into subdivisions. A comparison of head trauma in infants and toddlers may reveal a difference. Thus, in the present study, we focused on minor head trauma and intracranial injuries in infants ranging in age from birth to 11 months.

Ibrahim et al.⁸ reported that subcutaneous hematomas tend to be more common in infants compared with toddlers. Subcutaneous hematomas were observed in 28.7% of children <24 months old, and a correlation with traumatic brain injury was noted.⁹ In the present study, subcutaneous hematomas were observed in 29.6% of patients.

We found that the size and location of scalp hematomas are useful predictors of intracranial injuries in infants with minor head trauma. Scalp hematomas >3 cm in size were determined to be a risk factor for intracranial injuries. We also found a close relationship between the location of the scalp hematoma and intracranial injuries. A temporal location is associated with a very

high risk of intracranial injuries. Although frontal hematomas were the most common, lesions were not commonly associated. To date, several reports of similar findings have been published.^{6,9,10} In our study, among 11 patients with intracranial injuries caused by fracture, 8 were temporal, probably because of the thinner cranium in infants. Compared with infants, frontal and parietal regions are the most common for skull fracture in children and young adults 0.1–21.7 years old.²

Falls are a common cause of traumatic injuries in children, and we have shown that fall injury patterns differ between infants and older children. The most common mechanism of intracranial injuries in infants with minor head trauma was a fall, especially from being held by parents. Previous studies including children <15 years old and <5 years old reported the highest number of falls from a window, balcony, stairs, and furniture.^{11,12} Kim et al.¹¹ reported that intracranial injury is a major cause of fall-related deaths in children, and, in contrast to extracranial insults, brain injuries are sustained with an equal frequency from low-level (<15 feet) and high-level (≥15 feet) falls. Our results suggest that parents should always be careful when holding their infants.

It has typically been considered to be more difficult to detect clinical signs of intracranial lesions in children <2 years old.¹ The multivariate logistic regression analysis in our study also revealed that vomiting and bad temper were not independent predictors of intracranial injuries. Our results are in accordance with the report by Dayan et al.,¹³ which stated that clinically important traumatic brain injury is rare in children with minor head trauma when vomiting is their only sign or symptom.

The available research literature indicates that few pediatric patients with minor head trauma require surgical intervention (0–1%).¹ In our series, 2 of 549 infants (0.4%) needed surgical intervention, and all infants had a good outcome. Although CT can identify intracranial injuries with high-level sensitivity, we

should carefully select candidates for CT; otherwise, unnecessary tests with high costs and wasted time and resources would result. The effects of radiation exposure must also be considered. According to previous studies, infants <2 years old undergoing cranial CT had a higher risk of developing cancer compared with older children.¹⁴ The results of the present study are useful in determining whether to perform CT for infants with minor head trauma.

According to the National Institute for Health and Care Excellence (<https://www.nice.org.uk/about>), most of the criteria for performing CT in children are for nonminor head injuries. The criteria for minor head injury include suspicion of nonaccidental injury; age <1 year; presence of bruising, swelling, or laceration >5 cm on the head; and ≥3 discrete episodes of vomiting. Nonaccidental injury warrants emphasis. Although there were only 3 abuse cases in our series, 2 had intracranial hematomas. The only infant who underwent craniotomy had an injury caused by abuse. When abuse is suspected, CT must be done.

The present study has some limitations. First, imaging was not performed in all patients. Because there were problems related to patient age and radiation, cranial CT could not be performed in all patients. Second, this study was conducted retrospectively.

CONCLUSIONS

We found that fall height and size and location of scalp hematomas were correlated with intracranial injuries in infants with minor head trauma. These factors should be considered as indications for radiologic examination. As 9 of the 15 infants had intracranial injuries caused by falls from being held by parents, parents should always be careful when holding infants. Most infants with intracranial injuries caused by minor head trauma had good outcomes.

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