Characteristics and clinical predictors of minor head injury in children presenting to two Malaysian accident and emergency departments

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ABSTRACT

Introduction: Paediatric minor head injuries (MHI) are just as common in both bigger and smaller towns in Malaysia. Urban-based MHI are due more to motor vehicular injuries compared to rural-based MHI which are mainly due to non-motor vehicular injuries. The main objectives of this study were to compare incidence of admitted patients to accident and emergency departments of hospitals in two different settings in Malaysia, namely: Ipoh (urban-based) and Kota Bharu (rural-based); and to correlate to demographical characteristics, types of accident, clinical signs and symptoms, radiological and computed tomography (CT) findings, management; and finally, to determine clinical predictors of intracranial injury in MHI.

Methods: A cross-sectional study of 153 paediatric patients aged 2-18 years who were admitted to the Ipoh Hospital, Perak and 112 patients of the same age group admitted to Hospital Universiti Sains Malaysia, Kelantan were included in this study. The study period was between 1 January 1998 and 31 December 2001. Data collection was done prospectively. Chi-square and independent t-tests were applied to compare characteristics of patients admitted to these two hospitals. Backward stepwise multiple logistic regression was applied to determine clinical predictors of intracranial injury.

Results: There were significant differences of age, race, types of accidents, clinical signs and symptoms, Glasgow coma scale (GCS), skull fracture and CT findings between two hospitals. Significant clinical predictors were headache (OR 20.8, 95 percent CI 3.9-25.2, p-value is less than 0.001), unequal pupils (OR 8.4, 95 percent CI 4.3-17.9, p-value is equal to 0.0413) and GCS score of 13 (OR =3.8, 95 percent CI 1.9-6.8, p-value is equal to 0.005). Skull fractures and intracranial injuries were more common in Kota Bharu due to children riding motorcycles without helmets than in Ipoh (p-value is less than 0.001).

Conclusion: In the rural Malaysian community, both the police and physicians must be alerted to the fact that unhelmeted children riding motorcycles are more likely to sustain morbidity than those in urban areas. More aggressive traffic policing of the village roads should be done by the relevant authorities.

Keywords: childhood injury, craniocerebral trauma, emergency medicine, head injury, minor head injury

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INTRODUCTION

The American Academy of Paediatrics (AAP) defines children with minor head injury (MHI) as "those who have normal mental status at the initial examination, who have no abnormal or focal findings on neurological examination, and who have no physical evidence of skull fracture"[1]. MHI is usually taken as a Glasgow coma scale (GCS) of 13 to 15. Within this group, there is a heterogeneous pathophysiology ranging from a minimal intracranial pathology to an evolving intracranial bleed requiring neurosurgical intervention. Appropriate management of paediatric MHI in developing countries includes preparedness to recognise and to treat the neurological deterioration and potential complications. The objectives of this study were to compare characteristics of patients with MHI presenting to two different accident and emergency departments in two different states of Malaysia, and to determine clinical predictors that affect children who were admitted with MHI defined by the AAP.

METHODS

A cross sectional study was conducted from 1 January 1998 to 31 December 2001 on all paediatric patients with MHI following the criteria set by the AAP. The Department of Accident and Emergency (A&E) of Ipoh Hospital oversees nearly 100,000 cases per year with a breakdown of 70% medical- and 30% surgical-based patients, respectively. Of these, nearly 5% are neurotrauma cases. The other A&E department

Table I. A comparison of characteristics of patients with minor head injury between those who were admitted to two different hospitals.

Characteristics	Hospital		Test statistics	p-value[a]
	Ipoh (n=153)	HUSM (n=112)		
Age[b]	6.1 ± 3.4	15.7 ± 1.7	27.50	<0.001[c]
Sex[d]				
Male	54 (35.3)	32 (28.6)	1.33	0.248
Female	99 (64.7)	80 (71.4)		
Race[e]				
Malay	84 (54.9)	108 (96.4)	58.21	<0.001
Chinese	28 (18.3)	3 (2.7)		
Indian	40 (26.1)	0 (0.0)		
Others	1 (0.7)	1 (0.9)		
Type of accident[e]				
Fall	71 (46.4)	4 (3.6)	131.01	<0.001
Hit/assault	17 (11.1)	8 (7.1)		
Pedestrian	28 (18.3)	9 (8.0)		
Passenger	10 (6.5)	5 (4.5)		
Bicycle	17 (11.1)	6 (5.9)		
Motorcycle	10 (6.5)	80 (71.4)		

[a] level of significance _ = 0.05; [b] mean ± SD; [c] t-test for two independent samples; [d] frequency and percentage (in parenthesis); [e] chi-square test.

based in Hospital Universiti Sains Malaysia (HUSM) oversees 30,000 patients of which 89% are medical- and 11% surgical-based, respectively. 2.5% of these are neurotrauma patients.

Inclusion criteria included isolated closed paediatric head injury, a mechanism of injury witnessed by a second or third party and legally reported to the police, symptoms of head injury, initial GCS of 13 or higher on accident site which improved to 15 on admission at the A&E department or any healthcare professional facilities, normal mental status before incident, and no abnormal or focal finding on neurological examination seen acutely within 24 hours of injury in the A&E department by an accident and emergency physician or neurosurgeon. The exclusion criteria included patients aged younger than two years and older than 18 years, history of bleeding diatheses or neurological disorders potentially aggravated by trauma, multiple trauma, intentional head trauma, and speech disturbances.

Clinical parameters studied include progressive loss of consciousness and new neurological deficits after admission, seizures and headache. Radiological features assessed on computed tomography (CT) were: evidence of skull vault and base fractures as well as intracranial injury. Both clinical and radiological parameters were correlated to neurosurgical intervention. All paediatric MHI patients aged 2-18 years admitted to the A&E departments in Hospital Ipoh, Perak (n=153) and Hospital Universiti Sains Malaysia (HUSM), Kelantan (n=112) were selected for this study after parental consent and, for the latter group, approval of the Universiti Sains Malaysia ethical committee.

Chi-square test was applied to identify difference of proportions of parameters between two hospitals. The level of significance was set at 0.05. Backward stepwise multiple logistic regression was applied to determine clinical predictors of intracranial injury. Statistical Package for the Social Sciences (SPSS) software version 11.0 (Chicago. IL, USA) was used in the data analysis.

RESULTS

In the Ipoh study, there were 54 boys (35.3%) and 99 girls (64.7%) among the paediatric head injury patients. The majority of patients in this study were Malays (84; 54.9%), followed by Indians (40; 26.1%), and Chinese (28; 18.3%). The patients in HUSM hospital consisted of more Malays (p<0.001). The mean ages of patients admitted were 6.1 (± 3.4) years for Ipoh Hospital and 15.7 (± 1.7) years for HUSM (p <0.001). Sex distribution was similar for both hospitals (p=0.248). Motor vehicle accident was the most common cause of MHI for both hospitals,

Table II. A comparison of clinical new signs and symptoms occurring after admission, CT findings and management between children with minor head injury admitted to two different hospitals.

Characteristics	Hospital		Test statistics[b]	p-value[c]
	Ipoh	HUSM		
New episode of				
– Loss of consciousness	92 (60.1)	107 (95.5)	35.44	<0.001
– Vomiting		63 (41.2)	28 (25.0)	
– Headache	10 (6.5)	34 (30.4)		
– Seizures	5 (33.3)	2 (1.8)		
– Neurological deficits	1 (0.7)	8 (7.1)		
– Unequal pupil	2 (1.3)	4 (3.6)		
– ENT bleeding	11 (7.2)	8 (7.1)		
GCS after admission with MHI				
15	35 (22.9)	73 (65.2)	52.51	<0.001
14	49 (32.0)	25 (22.3)		
13	69 (45.1)	14 (12.5)		
Skull fracture seen on CT				
Normal	58 (37.9)	96 (85.7)	78.26	<0.001
Linear	78 (51.0)	5 (4.5)		
Depressed	15 (9.8)	4 (3.6)		
Base of skull	2 (1.3)	7 (6.3)		
Intraparenchymal CT findings[d]				
Intracranial injury	31 (20.3)	22 (62.9)	25.53	<0.001
No intracranial injury	122 (79.7)	13 (37.1)		
Management				
Observation	145 (94.8)	104 (92.9)	0.42	0.518
Neurosurgical intervention	8 (5.2)	8 (7.1)		

[a] frequency and percentage (in parenthesis); [b] chi-square test applied; [d] patients who were not done for CT in HUSM were excluded from the analysis (n=77); [d] level of significance α=0.05

with falls and hit/assault producing MHI in some patients (p<0.001) (Table I).

Progressive loss of consciousness after admission was the major clinical symptom in patients admitted to HUSM, followed by headache, vomiting and seizures (p<0.001). More patients with MHI at HUSM had a GCS of 15 that did not deteriorate, compared to the hospital in Ipoh (p<0.001). More radiological skull fractures seen on CT were reported among patients in HUSM. More intracranial injuries were reported in these HUSM patients who proceeded to progressive decrease in GCS (p<0.001). These patients had more intracranial contusions (80%), intraventricular bleeds (10%), subarachnoid bleeds (5%) and extradural haematomas (5%). Management was similar in the two hospitals (p=0.518) (Table II). No clinical predictors could be determined for patients with MHI at HUSM, while headache, unequal pupils and decreasing GCS score were significant predictors of more serious MHI among patients admitted to Ipoh hospital.

Patients who had more serious MHI in the Ipoh hospital had almost 21 times higher probability of having headache (OR=20.8, 95% CI 3.9-25.2) (p<0.001). Patients with MHI and intracranial bleeds had 8 times higher probability of having unequal pupils than those who had normal CT findings (OR=8.4, 95% CI 4.3-12.9, p=0.043). Those with MHI and intracranial bleed had nearly 4 times higher probability of having GCS score of 13 after admission rather than 15, than those who had normal CT findings (OR=3.8, 95% CI 1.9-6.8, p=0.005) (Table III). There were no significant association between motorcycle accidents and skull fracture (OR=0.29, 95% CI 0.1-1.1, p=0.075) shown by Fisher's exact test. There was also

Table III. A comparison of new clinical predictors between children after admission with minor head injury admitted to two different hospitals.

Clinical predictors	Ipoh		HUSM	
	Adjusted OR[a] (95% CI)	p-value[b]	Adjusted OR[a] (95% CI)	p-value[b]
Progressive loss of consciousness				
Conscious	1[c]	0.576	1	0.949
Not conscious	1.3 (0.8-2.1)		1.9 (0.6-4.5)	
Vomiting				
No	1	0.361	1	0.613
Yes	1.4 (0.5-7.0)	0.58 (0.07-4.85)		
Headache				
No	1	<0.001	1	0.072
Yes	20.8 (3.9-25.2)	0.74 (0.09-5.69)		
Seizures				
No	1	0.988	1	0.952
Yes	0.9 (0.6-3.8)		0.1 (0.0-32.5)	
Focal neurological deficit				
No	1	0.056	1	0.213
Yes	2.5 (1.0-5.2)		0.1 (0.0-4.0)	
Unequal pupil				
Equal	1	0.043	1	0.967
Unequal	8.4 (4.3-12.9)		0.9 (0.0-22.9)	
ENT bleeding				
No	1	0.167	1	0.861
Yes	2.4 (0.6-5.6)		3.6 (0.8-18.2)	
GCS				
13	3.8 (1.9-6.8)	0.005	0.8 (0.1-7.7)	0.833
14	1.9 (0.8-5.1)	0.24	5.6 (0.3-21.2)	0.229
15	1	–		

[a] Multiple logistic regression (backward stepwise); [b] Wald's test; [c] Reference category

no significant association between motorcycle accidents and CT findings (OR=1.1, 95% CI 0.3-4.5, p=0.886).

DISCUSSION

Head trauma is one of the most common childhood injuries. Annually, they account for more than 500,000 emergency visits, 95,000 hospital admissions, 7,000 deaths and 29,000 permanent disabilities. Hospital care costs alone exceed $1 billion annually[5]. Most patients have minor trauma[5,6], and while most of these injuries are significant, MHI paediatric patients can have underlying intracranial injuries[7-11]. The available research literature indicates that few paediatric patients with minor head trauma require surgical intervention. There are very few studies of MHI among children in Asian developing countries[12-18].

A study from Pakistan indicated that there were 52% patients out of a total of 260,000 who had MHI over a period of four years. Of these, 57.2% were children[12]. Other studies in developed North Asia revealed a high incidence of MHI associated with motorcyclists in adults[13] and children[14]. Most children were in the 15-17 years old age group, with a larger male ratio. Those in the younger age group (younger than 9 years) were pedestrians, and those older than 14 years were motorcyclists. Those between 10 and 14 years of age had MHI for

falls during sports, play, or from their bicycles. About 76% (n=624) of these patients had MHI. Another detailed study of injuries in Taiwan revealed that unhelmeted riders of motorbikes contributed to MHI, especially among children, compared to bicyclists or pedestrians[15]. One study found that MHI and their predictors were nonrandom and more likely to occur in certain types of younger individuals under certain circumstances[17].

Differences between a city study and a country study on head injuries revealed that more adolescents had motorcycle accidents in the country areas, whereas pedestrians were mainly children who fell victims to MHI in the city[16,18]. Even in the United States of America in 1996, only 18% of motorcyclists in general were helmeted, and more unhelmeted victims sustained head and spine injuries[19].

Our study was done to compare the type of accidents involving children in two cities, one in the mid-west (Ipoh) and the other in the north east (Kota Bharu) of Peninsular Malaysia. Ipoh, a more developed city with better roads and highways, was presumed to have more children involved in motor vehicle and pedestrian collisions on these roads. The Kota Bharu group was expected to have more accidents involving ungazetted roads in villages because of the poor development of larger highways and bigger trunk roads in this state. We also presumed that the more financially better-off Ipoh population would be driving their children to school in their own cars or using school buses. The less developed state of Kelantan and its capital city, Kota Bharu, with a larger low income population, would be using motorcycles instead of cars or school buses to transport their children to school or to travel.

Interestingly, a large number of children of early adolescence were illegally driving these motorcycles themselves, since the age allowed for obtaining a motorcycle or car license is 16 years and 17 years of age, respectively, in Malaysia. In our study, greater numbers of younger adolescents were involved in the HUSM group compared to the Ipoh group. Motorcycle accidents resulting in MHI among children aged 2-18 years comprised 13 out of 167 MHI (7.8%) in Ipoh Hospital, compared to 131 out of 215 MHI (60.9%) in HUSM ($p<0.001$).

In conclusion, our study data indicates that in rural areas of Malaysia, the road traffic council of that respective town or state may need to concentrate on village roads where accidents occur. Young adolescent children need specific education both in schools and colleges in order to prevent motorcycle accidents. Teachers and road traffic authorities play a big role to educate young adolescents in the right attitude of not riding motorcycles unless they have passed their licence. Control of road traffic accidents in both urban and rural towns are different, and it is thus the responsibility of all governmental and non-governmental organisations to prevent further accidents from occurring. Specific measures to educate the public at large and relevant institutions must be made a priority so as to decrease the rates of MHI associated with motorcycle accidents.

REFERENCES

1. The management of minor closed head injury in children. Committee on Quality Improvement, American Academy of Pediatrics. Commission on Clinical Policies and Research, American Academy of Family Physicians. Pediatrics 1999; 104:1407-15.
2. Bailey PL, Pace NL, Ashburn MA. Frequent hypoxemia and apnea after sedation with midazolam and fentanyl. Anesthesiology 1990; 73:826-30.
3. Vade A, Sukhani R, Dolenga M. Chloral hydrate sedation of children undergoing CT and MR imaging: safety as judged by American Academy of Pediatrics guidelines. Am J Roentgenol 1995; 165:905-9.
4. Woolard DJ, Terndrup TE. Sedative-analgesic agent administration in children: Analysis of use and complications in the emergency department. J Emerg Med 1994; 12:453-61.
5. Kraus JF, Rock A, Hemyari P. Brain injuries among infants, children, adolescents and young adults. Am J Dis Child 1990; 144:684-91.
6. Tepas JJ 3rd, DiScala C, Ramenofsky ML, Barlow B. Mortality and head injury: the pediatric perspective. J Pediatr Surg 1990; 25:92-5; discussion 96.
7. Chan KH, Yue CP, Mann KS. The risk of intracranial complications in head injury. Results of multivariate analysis. Child Nerv System 1990; 6:27-9.
8. Davis RL, Mullen N, Maleela M. Cranial computer tomography scans in children after minimal head injury with loss of consciousness. Ann Emerg Med 1994; 2:640-5.
9. Quayle KS, Jaffe DM, Kuppermann N, Kaufman BA, Lee BC, Park TS, et al. Diagnostic testing for acute head injury in children: when are head computed tomography and skull radiographs indicated? Pediatrics 1997; 99: E11.
10. Greenes DS. Infants with isolated skull fracture: What are their clinical characteristics, and do they require hospitalization? Ann Emerg Med 1997; 30:253-9.
11. Wang MY, Griffith P, Sterling J, McComb JG, Levy ML. A prospective population-based study of pediatric trauma patients with mild alterations in consciousness (Glasgow Coma Scale Score 13-14). Neurosurgery 2000; 46:1093-9.
12. Raja IA, Vohra AH, Ahmed M. Neurotrauma in Pakistan. World J Surg 2001; 25:1230-7.
13. Chiu WT, Yeh KH, Li YC, Gan YH, Chen HY, Hung CC. Traumatic brain injury registry in Taiwan. Neurol Res 1997; 19:261-4.
14. Chen CL, Wong MK, See LC, Chong CK. [Head injuries in children and adolescents: causes and natures.] Changgeng Yi Xue Za Zhi 1995; 18:353-60. Chinese.
15. Lee MC, Chiu WT, Chang LT, Liu SC, Lin SH. Craniofacial injuries in unhelmeted riders of motorbikes. Injury 1995; 26:467-70.
16. Chen CL, Howng SL. [The incidence and mortality rates of head injuries in Kaohsiung City, Taiwan (1991-1992)]. Gaoxiong Yi Xue Ke Xue Za Zhi 1995; 11:537-45. Chinese.
17. Lee LS, Shih YH, Chiu WT, Lin LS, Wu CM, Wang YC, et al. [Epidemiologic study of head injuries in Taipei City, Taiwan.] Zhonghua Yi Xue Za Zhi (Taipei) 1992; 50:219-25. Chinese.
18. Hung CC, Chiu WT, Tsai JC, Laporte RE, Shih CJ. [An epidemiological study of head injury in Hualien County, Taiwan.] J Formos Med Assoc 1991; 90:1227-33. Chinese.
19. Orsay E, Holden JA, Williams J, Lumpkin JR. Motorcycle trauma in the state of Illinois: analysis of the Illinois Department of Public Health Trauma Registry. Ann Emerg Med 1995; 26:455-60.