Original Article

Clinical Analysis of Trauma Characteristics Among Preschool-Aged Children

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ABSTRACT

Purpose: This study aimed to independently analyze pediatric trauma characteristics from a single institution in Korea to gain a better understanding of pediatric injury.

Methods: A retrospective review was conducted at a single, non-regional trauma center using data from 303 children (< 8 years) who presented at the emergency department (March 2010 to December 2018), to determine the frequency and details of admissions. Demographic variables [sex, age, mechanism of injury, regions of trauma on the body, score of the injury (abbreviated injury scale)] location where the trauma occurred, injury severity score, history of surgery, mortality, and cumulative length of hospital stay], were used to evaluate the severity of the trauma.

Results: The frequency of admissions was typically high for all seasons except winter. The most common mechanism of injury was due to falls; however, this was not the case for 1-, 2-, and 4-year-olds. The most common location where trauma occurred was at home for the age group 1-3 years, and outside the home for children aged 4 years or older. The most common area of injury was the extremities (65.7%). The median injury severity score was 4 (range, 4-4), and the median hospital stay was 4 days (range, 2-6). The overall mortality rate was 0.3%.

Conclusion: Although mortality from trauma is low among pediatric patients, we must continue to improve treatment outcomes. Hospitals lack sufficient resources for pediatric trauma specialists, however to improve patient outcome, it is necessary to recognize age-specific trauma characteristics.

Keywords: child, falls, injury severity score, trauma

Introduction

Advances in medicine and improved hygiene have significantly reduced pediatric mortality rates associated with infections and malnutrition, whereas deaths from accidental trauma have increased, making trauma the leading cause of death among children worldwide [1,2]. According to statistics from the Korea National Statistical Office, trauma was a major cause of death among young people in Korea. Children require specific expertise that can be delivered by pediatric surgeons and trauma specialists to efficiently manage medical emergencies [3]. The importance of gaining a better understanding of pediatric injury patterns and the management of pediatric trauma patients is widely recognized

[2]. Pediatric patients are often unable to clearly convey information about their injuries making an accurate diagnosis difficult to ascertain. Doctors usually rely on caregivers' statements, physical examination, and imaging to help determine medical problems. For this reason, doctors often face difficulties in treating children, which can lead to ineffective delivery of medical emergency care, especially in preschool-aged children.

The number of surgeons in Korea has decreased in recent years [4], as has the number of pediatric trauma specialists, and this has resulted in many hospitals providing care with limited staff numbers. Both manpower and resources are required to address the limitations experienced in pediatric patient trauma management. Analysis of clinical features of pediatric

trauma patterns such as place of injury, mechanism of trauma, and distribution of admissions, may help form the decisions made for the appropriate allocation of available resources (manpower and equipment). This type of planning may aid in rapid decision-making when treating trauma patients.

The purpose of this study was to independently analyze pediatric trauma data including demographics, injury patterns, the associated mechanism of injury and outcomes at a single institution in Korea, to gain a better understanding of the current pediatric trauma trends in non-regional trauma centers.

Materials and Methods

This study was approved by the Research Ethics Board of Haeundae Paik Hospital (no.: 2019-09-019-001). The patients included in this study were under 8 years of age and had been hospitalized due to trauma between March 2010 and December 2018. A retrospective survey was conducted based on the patients' emergency room and hospitalization records to investigate demographic variables including age, sex, mechanism of injury, distribution of admission, duration of hospitalization, place of trauma, location of trauma, history of surgery, and mortality. Physical areas of injuries were recorded using the abbreviated injury scale (AIS), which is divided into six body parts (head and neck, face, thorax, abdomen, extremities, and external), and graded using the injury severity score (ISS) based on the AIS to evaluate the severity of the trauma.

Non-normally distributed variables are expressed as median and interquartile range (IQR) for continuous variables. Categorical data are described as count and percentage. The Shapiro-Wilk test was performed to verify the assumption of normality. After descriptive analyses were performed, chi-square test or Fisher's exact was used to compare categorical variables between the groups. Inter-group differences in non-parametric variables were compared using the Kruskal-Wallis test with Tukey corrected post-hoc tests. A difference was considered significant if the two-tailed p -value was <0.05 . Data analysis was performed using SPSS v25 (IBM Inc., Armonk, NY, USA).

Results

Data were evaluated from 303 pediatric patients under the age of 8 years who visited the emergency department after experiencing a trauma and were admitted into the hospital during the study period.

The cumulative admission time for each calendar month

during this study period is shown in Figure 1. The number of patients admitted from January to April was lower than the other months. The highest number of admissions was in September ($n = 34$) followed by October ($n = 33$), whereas January ($n = 10$) had the lowest number of admissions followed by April ($n = 14$). The median patient age was 4 years (range, 3-5), and 62% were boys ($n = 188$). The most common mechanism of injury was due to a fall ($n = 113$, 37.3%), followed by slip down ($n = 65$, 21.5%), and other blunt traumas ($n = 42$, 13.9%; Table 1).

Analysis of the frequencies of different mechanisms of injury between different age groups showed that the most common cause was slip down ($n = 2$, 50%) at age 1 year, slip down ($n = 6$, 24%) and crush injuries ($n = 6$, 24%) at age 2 years, slip down ($n = 14$, 32.6%) at age 4 years, and falls at other ages ($n = 21$, 24%; $n = 19$, 37.3%; $n = 28$, 37.3%; $n = 29$, 45.3% at ages 3, 5, 6, and 7 years, respectively; $p = 0.012$).

A total of 285 (94.1%) patients experienced an injury in a single region, whereas 18 (5.9%) patients had injuries in 2 or more regions. The most common injury classified according to the AIS, was to the extremities, followed by the face and head and neck (76.7%, 31.0%, and 6.9%, respectively; Table 1). Comparisons of the AIS region for each age group, showed that head injuries occurred more often at 6 years ($n = 4$, 19%) and 7 years ($n = 6$, 28.6%) than other ages ($p < 0.001$). The most common place where traumas occurred for ages 1-3 years was at home, and for ages 4 years or older, it was outside the home ($p = 0.001$; Table 2).

The median ISS was 4 (range, 4-4), and 3.6% ($n = 11$) of the study population had an ISS > 15 . The difference in ISS by age was statistically significant ($p = 0.001$). Post hoc testing showed that the ISS of children aged 1 year was statistically significantly different from those of children aged 2, 3, 5, and 6 years ($p = 0.006$, 0.018, 0.024, and 0.020, respectively), but there was no statistically significant difference between children aged 1 year, and children aged 4 and 7 years ($p = 0.069$ and 0.189).

Surgical treatment was performed in 80.2% of patients ($n = 243$; Table 1), and 72.4% of patients ($n = 176$) underwent

Figure 1. Distribution of pediatric trauma admissions by month.

Table 1. Demographics of the pediatric trauma patients (n = 303).

	All patients (n = 303)
Males	188 (62)
Age (y), median (IQR, 25-75)	4 (3-5)
Mechanism of injury	
A fall	113 (37.3)
A slip	65 (21.5)
Other blunt trauma	42 (13.9)
Vehicle related incident	28 (9.2)
Crush	19 (6.3)
A stabbing	13 (4.3)
Bicycle	12 (4.0)
Unknown and not specified	9 (3.0)
Violence	2 (0.7)
AIS body region of primary diagnosis	
Head or neck	21 (6.9)
Face	94 (31.0)
Chest	5 (1.7)
Abdomen	9 (3.0)
Extremities	199 (65.7)
Combined injuries	18 (5.9)
Location of incident	
Home	85 (28)
Not at home	165 (54.5)
Road traffic	41 (13.5)
Unknown	12 (4)
ISS, median (IQR, 25-75)	4 (4-4)
ISS > 15	11 (3.6)
Surgery performed	243 (80.2)
Length of hospital stay (d), median (IQR, 25-75)	4 (2-6)

AIS = abbreviated injury scale; ISS = injury severity score; IQR = interquartile range.

Table 2. A Comparison of the location where the trauma occurred according to age ($p = 0.001$).

Location	No. of patients						
	Age (y)						
	1	2	3	4	5	6	7
Home	2 (50)	13 (52)	20 (49)	14 (33)	16 (31)	11 (15)	9 (14)
Not at home	2 (50)	8 (32)	18 (44)	22 (51)	30 (59)	43 (57)	42 (66)
Road traffic	0 (0)	2 (8)	1 (2)	7 (16)	4 (8)	17 (23)	10 (15)
Unknown	0 (0)	2 (8)	2 (5)	0 (0)	1 (2)	4 (5)	3 (5)

Data are presented as n (%).

extremity-related surgery. The median hospital length of stay was 4 days (range, 2-6; Table 1). The difference in hospital length of stay by age was statistically significant ($p = 0.036$); however, there were no significant differences observed during post-hoc analysis. The overall mortality rate was 0.3% ($n = 1$); a 1-year-old child with liver injury (due to a car accident) died from persistent bleeding.

Discussion

The frequency of admissions was high throughout the year, except winter. In this study, falls were the most common mechanism of injury in all ages except for 1, 2, and 4-year-olds, according to comparative analysis by age and mechanism. The most common place where trauma occurred for children aged 1-3 years was at home, and for 4-year-olds or older the trauma occurred more frequently outside the home.

Trauma is significantly associated with child mortality and morbidity worldwide. Approximately 830,000 children die each year from unintentional injuries. Road traffic collisions, falls, and drowning are among the most common causes of deaths [1] and as a major cause of mortality in children, trauma should be treated appropriately through accurate rapid diagnosis and treatment to reduce the risk of mortality.

Children under 8 years of age were selected for evaluation in this study because children of this age often lack the ability to convey information about their symptoms and may be uncooperative during physical examinations. As there are difficulties in medical diagnosis and treatment of young patients, understanding age-specific trauma characteristics may be helpful [5].

A study has reported that boys tend to experience trauma more often than girls because boys typically participate in riskier activities and are considered less careful than girls [6]. In the present study, 62% of the patients were boys, concordant with the results of other studies [6-9].

Regarding the distribution of admission, Masterson et al in 1993[10] showed that admission followed a pattern of increased frequency in the spring and summer months. In 2017, Naqvi et al[9], reported that, when comparing the four quarters of the year, the third quarter (July to September) had the highest proportion of admissions. In this current study a similarly high distribution over all seasons except winter was observed. This is presumably due to a decrease in outdoor activities in the winter.

Tracy et al [7] reported in 2013 that falls were the leading mechanism of injury in children aged 0-9 years in their study using data from the National Trauma Database in the USA. In a cohort study using Japan's Trauma Data Bank data from 2004 to 2015 of 15,441 children aged 15 years and under, Aoki et al

[6], reported that falls were the most common mechanism of injury in children up to 5 years old. In 2014, Snyder et al [11] reported an 11-year review of the Alaska Trauma Registry that showed falls were the most common mechanism of injury in all age groups of children, especially those younger than adolescents. In this current study, it was observed that falls were the most common mechanism of injury, accounting for 37.3% of injuries.

Injuries caused by trauma were classified according to AIS body regions. You et al [12] reported that the most frequently injured body part in children under 7 years was the face, followed by the extremities or pelvis, and the head and neck. These results reflect the age and development of children, for example, the age at which first steps are taken and the head size which is relatively large compared to the body [12]. This characteristic continues to be predominant during preschool ages. Naqvi et al [4] reported that from the ages of 1 to 5 years, the most commonly injured body region was the head, followed by the extremities. A study of 1,138 severely injured pediatric trauma patients (ISS > 15) who were assessed for 6 years by Mitchell et al [8], reported that the most frequently injured region was the head and neck region, followed by the abdomen, extremities, pelvic girdle, and pelvic area. Aoki et al [6], reported that the head was the most frequently injured body part in 44% of the children aged 15 years and under and the most frequent cause of trauma was traffic accidents (44%). In this study, the extremities were the most commonly injured region (65.7%), followed by the face (31%). However, the most frequent cause of trauma was not by a vehicle (9.2%), but by falls (37.3%) and slips (21.5%). In addition, the mean ISS was 5 ± 4.3 including 3.6% of patients with an ISS > 15.

This study has several limitations. Firstly, data were retrospectively collated from medical records and randomization was not applied. Secondly, the study included a small number of patients admitted to a single institution. In addition, the hospital where the patients were treated was not a Regional Level 1 Trauma Center and thus the severity of patients admitted may be lower than that in other hospitals, which may have influenced the results of this study. To resolve these study limitations, prospective, large-scale, multicenter studies are required.

To conclude, many preschool-aged patients presented with extremity or facial injuries caused by falls sustained not at home. Although mortality from trauma is low in pediatric patients, treatment outcomes for children must continue to be improved. It is unlikely for a hospital to have a pediatric trauma specialist, such as a pediatric orthopedic surgeon or plastic surgeon, because of manpower constraints. To further improve the outcome of treatment with insufficient resources, it is necessary to recognize age-specific trauma characteristics to appropriately allocate the available resources (manpower

and equipment) to potentially aid in rapid decision-making in emergency departments.

Conflicts of Interest

The authors have no conflicts of interest to declare.

Ethical Approval

This study was approved by the Research Ethics Board of Haeundae Paik Hospital (no.: 2019-09-019-001).

References

- [1] Peden M, Oyegbite K, Ozanne-Smith J, Hyder AA, Branche C, Rahman AF, et al. World report on child injury prevention. Geneva (Switzerland): World Health Organization; 2008.
- [2] Upperman JS, Burd R, Cox C, Ehrlich P, Mooney D, Groner JI. Pediatric applied trauma research network: A call to action. *J Trauma* 2010;69(11):1304-7.
- [3] Hulka F. Pediatric trauma systems: Critical distinctions. *J Trauma* 1999;47(3 Suppl):S85-9.
- [4] Lee RA. Crisis in recruit of competent surgeon in Korea. *Korean J Med Educ* 2014;26(4):253-6.
- [5] Kim JW, Cho JP. Emergency department clinical evaluation of child hand injuries. *J Korean Soc Emerg Med* 2001;12(4):502-10.
- [6] Aoki M, Abe T, Saitoh D, Oshima K. Epidemiology, Patterns of Treatment, and Mortality of Pediatric Trauma Patients in Japan. *Sci Rep* 2019;9(1):917.
- [7] Tracy ET, Englum BR, Barbas AS, Foley C, Rice HF, Shapiro ML. Pediatric injury patterns by year of age. *J Pediatr Surg* 2013;48(6):1384-8.
- [8] Mitchell RJ, Curtis K, Chong S, Holland AJA, Soundappan SVS, Wilson KL, et al. Comparative analysis of trends in paediatric trauma outcomes in New South Wales, Australia. *Injury* 2013;44(1):97-103.
- [9] Naqvi G, Johansson G, Yip G, Rehm A, Carrothers A, Stöhr K. Mechanisms, patterns, and outcomes of paediatric polytrauma in a UK major trauma centre. *Ann R Coll Surg Engl* 2017;99(1):39-45.
- [10] Masterson E, Borton D, O'Brien T. Victims of our climate. *Injury* 1993;24(4):247-8.
- [11] Snyder CW, Muensterer OJ, Sacco F, Safford SD. Paediatric trauma on the Last Frontier: An 11-year review of injury mechanisms, high-risk injury patterns and outcomes in Alaskan Children. *Int J Circumpolar Health* 2014;73:25066.
- [12] You JY, Lee JI, Ryu JY. A comparison of characteristics in Pediatric Trauma patients under 7 years. *J Korean Soc Traumatol* 2004;17:197-205.