

## Patterns and Association of Pediatrics Head Injury Due to Fall in Accordance to Height

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### ABSTRACT

**Background and Purpose:** *The authors conducted a study to describe the patterns and association of fall related head injuries in pediatric population and also to compare it with the western world.*

**Methods:** *We performed a retrospective analysis of all patients less than 15 years of age treated for fall – related trauma between June, 2009 and September, 2011. Falls were classified as low (12 feet) and high level (more than 12 feet).*

**Results:** *Eight hundred and sixty cases were identified with a mortality rate of 6.7%. A fall of greater than 12 feet (high – level fall) was associated with a higher mortality rate than low – level falls 52 (5.7% Compared with 5 (1.0%), respectively). Two Hundred and twenty eight patients had sustained a skull fracture (150 children had a depressed skull fracture) and 80 patients had basal skull fracture, 46 patients had suffered a cerebral contusion, 25 subarachnoid hemorrhage, 42 subdural hematoma, and 82 had an epidural / extradural hematoma. One hundred twenty patients required surgery for traumatic injuries of these, 80 underwent craniotomy for evacuation of a blood clot. Height was not predictive of the Glasgow Coma Scale (GCS) score. In all 15 deaths resulting from a low – level fall there was an admission GCS score of 4/15, and abnormal findings were demonstrated on computerized tomography scanning. Death from high – level falls was attributable to either intracranial injuries (50%) or severe extra-cranial injuries (50%). Intracranial injury is the major source of fall – related death in children and, unlike extra-cranial insults, brain injuries are sustained with equal frequency from low – and high – level falls in this population. Height was not predictive of the Glasgow Coma Scale (GCS) score. In all 15 deaths resulting from a low – level fall there was an admission GCS score of 4/15, and abnormal findings were demonstrated on computerized tomography scanning.*

**Conclusion:** *The GCS scores obtained in patients who sustained a Low – level fall were a poor predictor of intracranial bleeding. In 47% of these patients with intracranial bleeding an Emergency room GCS score of 13 to 15 was determined. A high GCS score does not therefore; eliminate the need for performing head CT scanning, even after the patient suffers a low level fall. We found a high percentage of intracranial bleeding/cranial fractures in patients falling from low height. Physicians should obtain a brain CT scan in pediatric fall victims. A proper trauma protocol should be followed and made in accordance of our need and standards.*

**Key Words:** • LGH • Glasgow Coma Scale • Head Injury • Pediatric Trauma • Fall.

**Abbreviations:** *Used in this paper: LGH = Lahore General Hospital; CT = computerized tomography; GCS = Glasgow Coma Scale.*

### INTRODUCTION

Unintentional falls are a leading cause of morbidity and mortality in children and adolescents in the western world. Considering all pediatric trauma, falls

account for the most common reason for an emergency department visit and are the fourth leading cause of trauma – related death, ranking behind motor vehicle accidents, fires, and drowning in the developed coun-

tries.<sup>3,6,7,8</sup> Overall, falls accounted for 5.9% of childhood deaths.<sup>4</sup> The injury patterns following a fall differ between children and adults. The proportionally greater cephalic mass in children increases the likelihood of a fall – related head injury.<sup>4</sup> However, young children appear to suffer fewer extracranial injuries than adults when the fall occurs from the same height.<sup>5,9</sup> To elucidate factors associated with head injury in pediatric fall victims in this part of the world a developing country where access of medical facilities are difficult, we undertook an analysis of pediatric falls at our institution in which these injuries are particularly common.

Lahore general hospital (LGH), which is the largest tertiary care in the country for the diseases of nervous system and their treatment. We performed a retrospective analysis of all patients less than 15 years of age treated for fall – related trauma between June, 2009 and September, 2011. Falls were classified as low (12 feet) and high level (more than 12 feet). Eight hundred and sixty cases were identified with a mortality rate of 6.7%. A fall of greater than 12 feet (high-level fall) was associated with a higher mortality rate than low – level falls (5.7% Compared with 1.0%, respectively). Two Hundred and twenty eight patients had sustained a skull fracture (150 pts had a depressed skull fracture) and 80 experienced a basal skull fracture. Forty six patients had suffered a cerebral contusion, 25 subarachnoid hemorrhage, 42 subdural hematoma, and 82 had an epidural / extradural hema-

toma. One hundred twenty patients required surgery for traumatic injuries of these, 80 underwent craniotomy for evacuation of a blood clot. Height was not predictive of the Glasgow Coma Scale (GCS) score. In all 15 deaths resulting from a low – level fall there was an admission GCS score of 4/15, and abnormal findings were demonstrated on computerized tomography scanning. Death from high – level falls was attributable to either intracranial injuries (50%) or severe extracranial injuries (50%). Intracranial injury is the major source of fall – related death in children and, unlike extracranial insults, brain injuries are sustained with equal frequency from low – and high – level falls in this population.

**MATERIALS AND METHODS**

Lahore General Hospital serves as the largest setup of neurotrauma tertiary care in Pakistan serving on average / month 250 children less than 15 years of age and receiving approximately 75% of all pediatric trauma patients in the region. Cases were identified through the hospital’s emergency database. All patients were under 15 years of age and suffered a fall as the primary mechanism of blunt injury (however, patients who suffered a fall, for example, after being ejected as a result of a motor vehicle accident were excluded). Nine hundred and sixty cases were randomized selected, and complete records were available for 860 patients. International Classification of Diseases – 9 codes (800 – 999), Injury Severity Score (ISS – Fig. 1), GCS score, neuroimaging results, hospital length of stay and outcome were considered all. The height of the fall was determined from attendant / witness and paramedic accounts.

**RESULTS**

**Sex Incidence**

Of the 860 patients, 490 were boys (male/female ratio 1.3:1).

**Age Incidence**

The age – specific incidence rose at age 2 years when mobility increases, and a second rise was demonstrated in adolescence as risk – taking and anti social behaviors increase.

**Mechanisms of Injury and Fall Characteristics**

Falls were classified as high level (12 feet or above) in

**Table 1:** An example of the ISS calculation is shown below:

Region	Injury Description	AIS	Square Top Three
Head and Neck	Cerebral Contusion	3	9
Face	No Injury	0	
Chest	Flail Chest	4	16
Abdomen	Minor Contusion of Liver Complex Rupture Spleen	2 5	25
Extremity	Fractured femur	3	
External	No Injury	0	
	<b>Injury Severity Score:</b>		<b>50</b>

396 (46%) or low level (less than 12 feet) in 464 (56%) of our patients as shown in Table 2. There was no correlation between the height of fall and admission GCS score, and the distribution of GCS scores was similar between patients who sustained low – and high – level falls (Table 3). The most common site of an accident was a fall from a Stair case 280 (32.5%), roof top 160 (18.6%), windows 90 (10.4%), furniture top 60 (6.9%), tripping 62 (7.2%), walkers 45 (5.2%), and play equipment 25 (2.9%). Sixty two (7.2%) falls were at ground level after tripping. Fifty seven percent of patients suffered injuries at home. At least 5.9% of patients sustained a fall while at school (Table 3).

**Table 2:** Height of Fall.

Height	Number	Percentage
Low Level	464	56%
High Level	396	40%

**Table 3:** Fall – Related Characteristic Obtained in 860 Patients with Head Injury.

Type of Fall	Number	Percentage
From stair case	280	32.5
Roof top	160	18.6
Windows	90	10.4
Furniture top	60	6.9
Walker	45	5.2
Play equipment	25	2.9
Dropped	19	2.2
Shopping cart	15	1.7
From vehicle	15	1.7
From tree	15	1.7
From wall	2	0.2
From fence	1	0.1
structures	65	7.5
“tripped	62	7.2
Seizure	6	0.69
<b>Total</b>	<b>860</b>	<b>100</b>

## Investigations

Eighty four percent of all patients underwent plain brain CT scanning. Abnormal findings were demonstrated in all patients who underwent brain CT scanning and later died. Abnormal findings were identified on 475 of 620 CT scans. One hundred fifty patients sustained a skull fracture and 80 a basal skull fracture. There were 46 patients with cerebral contusions, 35 with subarachnoid hemorrhage, 42 with a subdural hematoma, and 82 with an epidural hematoma.

**One hundred twenty** patients required a craniotomy for evacuation of a blood clot (extradural / fracture hematoma). Eight percent of patients died after undergoing a neurosurgical intervention. Falls from a height of greater than 12 feet were not associated with a higher incidence of intracranial bleeding (subdural, epidural, subarachnoid, or intracerebral hemorrhage) (Table 4) and most hemorrhages related to low level falls occurred at 6 feet or less (Table 5).

The GCS scores obtained in patients who sustained a Low – level fall were a poor predictor of intracranial bleeding. In 47% of these patients with intracranial bleeding an Emergency room GCS score of 13 to 15 was determined. A high GCS score does not therefore; eliminate the need for performing head CT scanning, even after the patient suffers a low level fall.

## Extracranial Injuries

Extracranial injuries were common in this study population (Table 6). Facial (33 cases), upper – extremity (56 Cases), and lower – extremity fractures (48 cases) were the most common orthopedic injuries. Thoracic (18 cases), Splenic (17 cases), and hepatic injuries (10 cases) were the Most common visceral injuries. Thirty – nine patients required extracranial surgery. Twenty – four operations were Performed to treat orthopedic injuries, and 11 operations were performed to treat thoracoabdominal injuries.

## Fatal Injuries

Fifty seven children died (overall mortality rate 6.7%). 52 Children fell from heights of greater than 12 feet (5.7%), and four patients fell less than 12 feet (1.0%). In these 57 children falls from staircase (53.3%) and Roof top (40%) were the most frequent mechanisms of lethal Injury. Of the children who died, four had undergone Surgery. Death from high – level falls was attributable to either intracranial injury (50%) or

multiple severe extracranial Injury / polytrauma (50%). In all 52 high fall – related deaths occurring from a height of 12 feet or above, there were emergency room GCS scores of 4/15 and abnormal findings on head CT scanning.

In 05 cases of low level lethal injuries there were no severe extracranial injuries, and the only source of mortality from low – level falls was cranial injury. Brain injuries included intracranial hemorrhage in 9 cases and subdural hematoma in 6 cases.

**DISCUSSION**

Falls are a common source of traumatic injuries in children, and fall injury patterns differ between adults and children and the modes differ from developed countries where medical facilities are adequate. Our experience with pediatric falls at the Lahore general hospital supports this contention. As expected, we found a higher mortality rate when comparing high – with Low – level falls (5.7% and 1.0%, respectively) with severe extra-cranial injuries more common in those falling greater Than 12 feet. The majority of fatalities in our study (6.7%) were attributable to a head injury. In our study we found a high incidence (33.7%) of intracranial hemorrhages in patients who fell less than 12 feet. Although there is a selection bias for Low – level falls, our sampling represents the patient population that neurosurgeons see at hospital emergency facility.

Furthermore, 47% of these patients received an emergency room GCS score of 13 to 15, thus limiting the utility of clinical criteria to predict the need for a brain CT scan. The outcome of pediatric falls from low heights has been somewhat controversial. In a study by Chadwick, et. al.<sup>1</sup> A 7% mortality rate was found in children who fell 8 feet or fewer. This led the authors to conclude that fatal injuries caused by low – level fall indicate an incorrect / false statement that is history until proven otherwise.<sup>1</sup> In another study the authors found no incidence of deaths in children who fell from heights of three stories or fewer.<sup>2</sup> Child abuse must clearly be excluded in pediatric deaths that occur after low-level falls; however, in our study none of the four deaths from a height of fewer than 12 feet had history of abuse. In all of these cases

**Table 4:** Comparison of Values Obtained in Patients Who Fell From Less Than 12 Feet and Equal to or Greater Than 12 Feet.

Intracranial Bleeding	12 Feet		Total
Subarachnoid hemorrhage	3.5%	2.4%	5.9%
subdural hemorrhage	2.5%	1.9%	4.4%
epidural hemorrhage	4.6%	1.6%	6.2%
Closed cerebral contusion	3.9%	1.8%	5.7%
open cerebral contusion	2.1%	2.5%	4.6%
Total	16.6%	10.2%	26.8%

**Table 5:** Incidence of Intracranial Hemorrhage in Patients who Suffered Low – Level Falls.

Height of fall (Feet)	Total No of Patients Who Fell	No of Patients with Intracranial Hemorrhages
1 – 3	240	55
4 – 6	215	92
7 – 9	125	70
9 – 12	160	42

**Table 6:** Other Fall – Related Injuries in the Patient Population\*.

Site of Injury Patients (Fractures)	No of Patients	Percentage	Expired
Facial	33	4.51	3
Rib	10	1.44	0
Pelvic	8	1.14	4
Upper Extremity	56	7.77	0
Lower Extremity	48	6.61	1
Pneumothorax	7	1.04	5
Cardiac	18	2.54	8
Thoracic	1	0.14	1
Abdominal	7	1.04	1
Hepatic	10	1.44	1
Splenic	17	2.34	0
Nephric	8	1.14	0
Urogenital	1	0.14	0
Vascular	2	0.34	2
Peripheral Nerve	2	0.34	0
Total			26

\*Values are based on the overall number of patients (860)

isolated head injury was the cause of death. Another very major factor that's differentiates the mortality and morbidity in our and international trauma setups is the following of Trauma Triage Protocols. The increasing reliance on trauma triage protocols to manage fall victims has resulted in specific height – related criteria intended to predict injuries.<sup>3</sup> Therefore, most trauma centers activate trauma response systems based on height – related criteria only when victims have fallen 15 to 20 feet or more.<sup>1,4</sup> In our study we found a high incidence (33.7%) of intracranial hemorrhages in patients who fell fewer than 12 feet. Although there is a selection bias for low – level falls, our sampling represents the patient population that neurosurgeons see here at hospital emergency which demonstrate an 8% mortality rate in patients who fell fewer than 20 feet.<sup>3</sup> One of the weaknesses / handicap of this study is that the height of the fall was obtained from recorded observation by the attendants and erroneous observations cannot be ruled out. A direct on – site measurement of the height of fall with confirmation by a second observer would be ideal to ensure accuracy and to rule out child abuse definitively.

## CONCLUSIONS

In this study we found a high percentage of intracranial bleeding / cranial fractures in patients falling from low height. Physicians should obtain a brain CT scan in pediatric fall victims. A proper trauma protocol should be followed and made in accordance of our need and standard.

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