

Research Article

Falls from flat roofed house in and around the city of Rewa, Madhya Pradesh: a study from central India

Manish Swarnkar*, Subham Lilhare

Department of General Surgery, Jawaharlal Nehru Medical College, Sawangi (M), Wardha, Maharashtra, India

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*Correspondence:

Dr. Manish Swarnkar,

E-mail: mwarnkar1971@gmail.com

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ABSTRACT

Background: High falls from flat-roofed houses are a common cause of death and disability in this part of central India; the aim of this study was to describe the experience of such falls seen over a 2-year period.

Methods: In this cross sectional study one hundred and twenty two patients (96 male and 26 female) who fell from flat roofed houses were entered and analysed.

Results: The Prevalence of fall from flat roofed house was 60.3% (122/202). The mean age of the whole group of patients was 16 years (range 1-75 years); majority of cases were of 11-30year age group (54.1%). Males, adolescent and rural population showed a greater tendency to fall from height. The mean height of these accidental falls was 3.65 ± 2.6 m. Head injury was the most common injury and most common cause of mortality and morbidity in these patients.

Conclusions: Death due to fall from height is an unforeseen and unfortunate occurrence. Cranio-cerebral trauma is the most common injury in fatal falls from flat roofs. Parental control, guidance and construction of parapet on roof tops can reduce this economic burden and protect vulnerable groups of people of our country from this type of incidents.

Keywords: Fall from height, Flat roof houses, Kite flying, Head injury

INTRODUCTION

Acute vertical deceleration is a major cause of significant morbidity and mortality in the urban trauma setting. Unlike other types of trauma, no age or social group is spared during falls, which constitute a remarkable problem.¹ According to the WHO Global Burden of Disease project for 2004, an estimated 424 000 people of all ages died from falls worldwide.

The risk of accidental fall from height is present in all age groups, but younger children are more prone to fall because of insufficient development of sensory systems, neural control mechanisms, cognitive ability in terms of hazard awareness and avoidance skills.² The severity of a fall-related injury is determined by the anatomy of the human body and the impact force to which the body is

subjected-in the absence of any special protection on the body or impact-absorbing materials in the landing or contact surfaces.³⁻⁷

Morbidity from falls is much more common and represents a significant burden on health-care facilities around the world. Among children under 15 years, non-fatal falls were the 13th leading cause of disability-adjusted life years (DALYs) lost.

In India, the mechanisms and causes of falls are not understood in detail since they are not routinely investigated nor documented clearly, requiring further research. flat-roofed are the major type of house owned by people on low incomes in the rural areas and Falls from flat-roofed houses remain an important cause of morbidity and mortality, and our rationale now is to

illustrate our experience of such patients over the last 2 years.

METHODS

A cross sectional study on 122 patients who sustained injuries after falling accidentally from flat roofed house was carried out during the period June 2000 and July 2001.

All the patients who were treated at S.S medical college and associated Hospital ED were analyzed prospectively, and such patients were entered consecutively into the study as a non-random sample. All were resuscitated according to advanced trauma life support program (ATLS) principles and underwent diagnostic and therapeutic procedures according to existing protocols.

Detailed information on the injuries (height of fall, collision surface, collision area of the body, reason for fall) was collected from the patients, paramedics and any witnesses.

The patient's age, height of the fall, presence of injuries to the extremities, abdomen, chest and pelvis, and the mortality rate were recorded, as were the initial Glasgow coma scale (GCS).

Patients who were dispatched to another trauma center, who died before admission to the ED, who had a doubtful history of fall from height, who did not want to be observed in the ED after their first treatment, and who rejected the treatment were not included in the study.

The patients were followed until discharge; data on the injuries, diagnostic and therapeutic interventions, hospital course and outcome were collected.

For the statistical analysis, SPSS 13.0 for Windows computer software was used. Student's t-test was used to compare the parameters and chi-square test was used to compare absolute numbers.

RESULTS

A total of 122 consecutive fall victims (26 females and 96 males) were entered into the study. All had suffered an apparently accidental fall from a flat-roofed house. The mean height of these accidental falls was 3.65 ± 2.6 m.

The mean age of the whole group of patients was 16 years (range 1-75 years); majority of cases were of 11-30 year age group (54.1%). Males, adolescent and rural population showed a greater tendency to fall from height.

Most of the patients had fallen in summer season (April - may) (59%) between 4:00pm to 12:00am (50%). Falls tend to cluster then because people are more likely to sleep on the flat roof when the temperature is high and

children are more likely to play there as there is summer vacation and also season of kite flying in central India.

Table 1: Demographic profile of fall injury cases (n=122).

Variable	Number (%)	Mortality (n=26) (%)
Sex*		
Male	96 (78.7)	22 (84.62)
Female	26 (21.3)	04 (15.38)
Residence*		
Rural	88 (72.1)	21 (80.8)
Urban	34 (27.9)	05 (19.2)
Age		
0-10	14 (11.47)	02 (7.7)
11-20*	30 (24.6)	09 (34.6)
21-30*	36 (29.5)	10 (38.5)
31-40	19 (15.6)	03 (11.5)
41-50	12 (9.84)	01 (3.85)
51-60	07 (5.74)	01 (3.85)
>60	04 (3.3)	02 (7.7)

*Statistically significant $P < 0.05$

Table 2: Diurnal and seasonal variation in incidence of fall cases.

Variable	Number (%)
Time of fall*	
8:00am-4:00pm	38 (31.15)
4:00pm-12:00am	61 (50)
12:00am-8:00am	23 (18.6)
Season of fall*	
Summer	72 (59)
Rainy	29 (23.8)
Winter	21 (17.2)

*Statistically significant $P < 0.05$

Table 3: Systemic involvement in cases of fall injury cases (n=143 injuries).

System	Number (%)
Head and neck	73 (51)
Thorax	19 (13.3)
Abdomen	08 (5.6)
Genito-urinary	03 (2.1)
Extremities	38 (26.6)
Spinal	08 (5.6)

The most common injuries overall were to the head (51%). linear fracture involving parietal bone was the most common injury (18.9%) Associated intracranial injuries were common, including epidural hematoma (11.9%), cerebral edema (5.6%) subdural hematoma (2.8%), cerebral contusion (2.1%), subarachnoid hemorrhage (2.1%) and diffuse axonal injury in 1.4%

cases. Fractures of the extremities occurred in 26.6% of patients; 52.5% of all patients suffered from fractures of the upper limbs. The incidence of extremity fractures was greater in falls from more than 3.6 m in children and 6.7 m in adults. The most common was a radius fracture (8.4%), followed by fracture of the ulna (3.5%), Multiple fractures were common, especially in falls from greater heights. Thoracic injuries occurred in 13.3% of cases, simple rib fracture was the commonest injury (5.6%).

Table 4: Distribution of injuries amongst the cases of fall (n=143 injuries).

Injuries	Number (%)
Head*	
Linear fracture	27 (18.9)
Depressed fracture	04 (2.8)
Pond fracture	02 (1.4)
Extradural hematoma	17 (11.9)
Subdural hematoma	04 (2.8)
Sub-arachnoid hemorrhage	03 (2.1)
Cerebral edema	08 (5.6)
Cerebral contusions	03 (2.1)
Diffuse axonal injury	02 (1.4)
Maxillary fracture	01 (0.7)
Nasal fracture	01 (0.7)
Orbital fracture	01 (0.7)
Thorax	
Simple rib fracture	08 (5.6)
Flail chest	03 (2.1)
Pneumothorax	05 (3.5)
Hemothorax	02 (1.4)
Clavicular fracture	01 (0.7)
Abdomen	
Splenic injury	04 (2.8)
Liver injury	01 (0.7)
Renal injury	01 (0.7)
Bowel rupture/mesenteric tear	02 (1.4)
Extremities	
Humerus fracture	04 (2.4)
Radius fracture	12 (8.4)
Ulna fracture	05 (3.5)
Femur fracture	03 (2.1)
Tibia fracture	01 (0.7)
Fibula fracture	01 (0.7)
Metacarpal/metatarsal fracture	02 (1.4)
Calcaneal fracture	02 (1.4)
Pelvic fracture	02 (1.4)
Spinal	
Cervical	01 (0.7)
Thoracic	02 (1.4)
Lumbar	05 (3.5)

Blunt Abdominal injuries were associated with fall from height more than 8 meters, of the eight cases 04 had splenic laceration and three were operated upon while one managed conservatively. All the cases of liver (01)

and renal injury (01) managed conservatively. Bowel rupture and mesenteric tear was seen 0.7% of cases. Around 5.6% of the patients had spinal injuries, the majority of which were around the thoracolumbar junction.

The most common was L1 compression fracture (3.5%), the neurological complications of injuries to the spine were correlated with increasing height of fall. Alcohol intoxication was present in 4% of cases and 54.2% of cases were brought within 04 hours of sustaining injury. 40.32% of the patients died on the first day after the fall. The most common reason for death was head injury (45.8%) with median GCS of 3.5. Overall mortality was 21.3%, mostly affecting male sex of 11-30year of age group and rural population.

DISCUSSION

Fall injuries from a height poses a great challenge to trauma services.^{8,9} They are mostly due to accidents in children, and to suicide, accident or crime in adults. direct impact and deceleration are the two most common type of injury result from such falls.^{10,11} Direct impact mostly result in fractures; the deceleration forces immediately after impact result primarily in visceral and internal injuries, including cranial injuries.¹²

Multisystem injuries result from physical forces in falls that are different from those seen in horizontal deceleration injuries such as from vehicular trauma. The extent and severity of impact injuries depend on many factors, including impact surface, tissue elasticity and viscosity, impact velocity, area and orientation of bodily impact, and duration of impact.¹³ In general, the duration of the impact force and body orientation play important roles in predicting the severity of injury and potential survival.¹⁴ Worldwide, an estimated 391000 people of all ages died of injuries related to falls in 2002. National Crime Records Bureau, Ministry of Home Affairs, Government of India in a published report in 2010 has mentioned that fall from height contributed 2.6% of all fatalities due to natural and unnatural causes.¹⁵

In our series, 122 (60.3%) of the 202 patients had fallen from flat-roofed houses, the majority (78.7%) of patients were men.^{9,11,16-18} The age group most commonly affected and with highest mortality rate with accidental falls were 11-30 years which is most productive population.^{16,19,20}

In present study majority of cases occurred during summer season between 4:00 pm to midnight because of vacation kite flying which is very common during this season and secondly absence of parapet in house in rural areas leading to increased number of fall cases in children and also adult group, another important factor for injury during kite flying was running for catching the broken or cut kite from one roof to another because houses in present setting were in close proximity to each other without any gap leading to serious injury from fall due

loss balance.^{16,19} Sleeping on roof during summer season to avoid heat of interiors is another reason for fall injuries from roof lacking protective barriers. Elderly people who get up in night for micturition, those sleeping near corner of roof and children who get up early in morning and start playing without any supervision likely to suffer from injury.^{11,16,19} The types of injuries we encountered were similar to those described in other studies of falls from height.^{2,9,11,21-25} The head injury was the most common injury (51%) involving parietal bone (linear fracture). Associated intracranial injuries were common, including epidural hematoma (11.9%), cerebral edema (5.6%) subdural hematoma (2.8%). injury to the extremities occurred in 26.6% of patients; 52.5% of all patients suffered from fractures of the upper limbs, radius fracture being most common bone involved. The incidence of extremity fractures was greater in falls from more than 3.6 m in children and 6.7m in adults.

The chest and abdominal injury were associated with greater height of fall (>8 meters). Overall mortality was 21.3%, out of which 40.32% of the patients died on the first day after the fall.¹¹ The most common cause of death was head injury (45.8%) mostly affecting male sex of 11-30year of age group and rural population.^{9,11,19}

The management of accidental injuries due to falls from height is nearly similar to any other trauma. Targeted swift multidisciplinary evaluation of patients attending the ED because of a fall might reduce the number of hospital admissions. Stabilization, of fractured extremity and spine with particular attention to airway maintenance and hemodynamic resuscitation, is the initial concern.¹¹ The high incidence of head injuries among our victims of accidental falls underscores the need for early evaluation for intra-abdominal trauma followed by cranial computerized tomography scanning and subsequent management of lesser injuries in this subset of patients.

Analyzing the mechanism of these accidents suggests that educating young children how to stay away from hazardous situations could play some part in prevention, in concert with parental information and education. The circumstances in which the accidents occur lead to the conclusion that active prevention could be by passive protection, ensured by the creation of a safer environment (compulsory building of pitch-roofed houses or parapet around flat roofs).

A number of strategies, some of which have documented effectiveness, have been suggested to prevent children falling from heights. This was the "Children Can't Fly" programme that was effective in reducing falls from high-rise buildings in a low-income community in New York City. While the materials used and the context may differ, more widespread use in developing countries of barriers and safety equipment is likely not only to be effective but also affordable, feasible and sustainable.²⁶ Parent counseling has been effective in preventing infant falls and other injuries, and should be part of any prevention

programme.^{27,28} A pilot programme combining education with the provision of a safe roof would reduce the incidence of falls and deaths.

CONCLUSION

Falls are the most common cause in many countries of injury-related hospital stays and emergency department visits. Head injuries and limb fractures are common and traumatic brain injuries are most likely to result in lifelong disability. The predisposing factors and the types of fall vary considerably across different settings. In our study fall from flat roof have a disproportionately high rate of fall-related injuries among adolescent and adults leading to loss of productive age group.

Recommendations

- Parental supervision is an important aspect of prevention, particularly when combined with other interventions.
- Acute care and rehabilitation should be available and devised appropriately for children, so as to minimize the long-term consequences of falls and prevent long-term disability.
- Construction of parapet on roof tops at homes and good safety measures can potentially lead to decrease in incidence of such cases.

Limitations

This study had definite drawback as estimated height of fall and other causative factors were intuitively assessed based on facts as told by patient's attendants. Also, the cases which required hospitalization were only recorded leaving out cases which were not brought to the hospital. Further study is required to determine whether the preventive measures based on observations of this study will lead to decrease in incidence of such falls or not.

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