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ORIGINAL ARTICLE

Pattern and Interpretation of Injuries Due to fall from Height in a Hilly State of North India: An Autopsy based Study

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ABSTRACT

Introduction: A fall from considerable height followed by landing on a surface can lead to multiple injuries which can be sustained during the fall or after landing on the ground. The injuries sustained after a fall from height can vary from an abrasion or contusions to more severe injuries like fractures, head injury, injury to the visceral organs or even death. This study was conducted to interpret the injuries caused due to fall from a considerable height and their medicolegal interpretation in cases brought for autopsy to a Tertiary Care Hospital of Northern India.

Aims and Objectives: To study the pattern of distribution of external and internal injuries in autopsy cases of deaths caused by a fall from height and to analyze their demographic characteristics.

Methodology: This cross-sectional study was conducted over a period of one and a half years from 1st January' 2020 to 30th December' 2020 in the Department of Forensic Medicine, Indira Gandhi Medical College, Shimla.

Results: During our study period, 125 (26%) cases were of fall, out of which, most of the cases were in the age group of 51-60 years (22.4%), 110 (88%) were males. The commonest region sustaining the primary impact was Head in 98 (78.4%)

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cases. The intracranial findings were present in 105 cases. The internal thoracic injury was present in 57 cases. The spinal fractures were found in 33 cases. The abdominal visceral injuries were found in 18 cases. 55 (44%) cases suffered fall from a height of 10-20 feet.

Conclusion: This study highlights that falls remain a significant cause of mortality, accounting for 26% of the total autopsy cases examined during the study period. The most affected demographic was middle-aged adults, particularly those between 51–60 years, with a notable male predominance (88%). the study underscores the urgent need for preventive strategies, especially in rural and occupational settings, as well as improvements in pre-hospital care and trauma management to reduce fall-related fatalities.

KEYWORDS

• Fall from height • Accidental • Head Injury • Intracranial • Hemothorax

INTRODUCTION

Himachal Pradesh is a hilly state and is composed of hills having variable altitudes, valleys, rivers, orchards and various crop fields.

A fall is defined as an injury sustained to a person that is caused after landing on the ground after a fall from a surface which is present at a height, such as a roof of a house.[1]

The factors identified as specific to Southeast Asian Region (SEAR) countries are falls from trees of workers, picking fruits, etc.[2] It is the second commonest cause of mortality associated with injury after road traffic accidents.[3]

A latest definition of fall from height describes it as "a descent from upright, sitting or horizontal position, the descent height being less than or equal to 1 meter".[4]

The victims of fall from height sustain injuries in a unique pattern which depends on the inertia of the body, motion of the body, nature of the objects encountered during the fall and the consistency of the ground on which body falls.[5]

The injuries sustained after a fall from height can vary from an abrasion or contusions to more severe injuries like fractures, head injury, injury to the visceral organs or even death.

A person can fall accidently or can be pushed from the height. In other instances, a person can jump from a height to commit suicide.

Not only the height from which a person falls can affect the injuries sustained. It also depends on the age of the victim, kinetic energy at the time of impact, duration of impact and the nature of the surface on which a person lands.[6]

In the context of insufficient detailed comprehensive study in the state of Himachal Pradesh, this study was conducted to interpret the injuries sustained due to fall from a considerable height and their medicolegal interpretation in cases brought for autopsy to a Tertiary Care Hospital of Northern India.

AIMS & OBJECTIVES

To study the pattern and distribution of external and internal injuries and to analyze the demographic characteristics in autopsy cases of deaths caused by a fall from height.

METHODOLOGY

This cross-sectional study was conducted over a period of one year from 1st January' 2020 to 30th December' 2020 in the Department of Forensic Medicine & Toxicology of a Tertiary Care Hospital of North India.

Inclusion Criteria:

1. Cases admitted with the history of fall from height and who died during the treatment.
2. Cases brought with the history of fall from height and were declared dead on arrival.
3. Cases referred from nearby institutions with the history of fall from height and death.

Exclusion Criteria: None.

Data Collection:

The data was collected on a self-designed proforma from the inquest papers, autopsy report and death summaries/hospital records. The data was also collected from the Police and attendants of the deceased.

Statistical analysis:

Data was recorded on a Microsoft excel spreadsheet. Statistical analysis was performed with SPSS student version 27.0 (SPSS Inc. Chicago, USA).

RESULTS

During our study period, the total of 486 autopsies were conducted in the department, out of which the cases attributable to fall were 125 (26%) cases.

In our study, the maximum cases were observed in the age group of 51-60 years (22.4%) followed by the age group of 41-50 years (20.8%). The distribution of cases on the basis of age are given in *Table* 1.

Table 1: Distribution of cases on the basis of age (n=125)

Age Group (Years)	Number of cases (%)
0-10	03 (2.4%)
11-20	04 (3.2%)
21-30	14 (11.2%)
31-40	23 (18.4%)
41-50	26 (20.8%)
51-60	28 (22.4%)
61-70	14 (11.2%)
71-80	07 (5.6%)
81-90	06 (4.8%)

In the study population, 110 (88%) were males and 15 (12%) were females.

In our study, 112 (89.6%) cases belonged to rural areas and 13 (10.4%) cases belonged to urban areas.

Majority of cases were farmer (44.8%) by profession, followed by labourer (24%). The distribution of cases on the basis of profession of the deceased is given in *Table* 2.

Table 2: Distribution of cases on the basis of profession (n=125)

Profession	Male (%)	Female (%)	Total (%)
Housewife	0 (0)	9 (7.2)	9 (7.2)
Labourer	28 (22.4)	2 (1.6)	30 (24)
Student	5 (4.0)	2 (1.6)	7 (5.6)
Govt. Employee	20 (16)	0 (0)	20 (16)
Farmer	55 (44)	1 (0.8)	56 (44.8)
Private Job	2 (1.6)	1 (0.8)	3 (2.4)

In the study population, 108 (86.4%) were married and 17 were unmarried.

In our study, the maximum number of cases were brought in the month of January (16%) followed by the month of July (15.2%). The month wise distribution of cases is given in *Figure 1*.

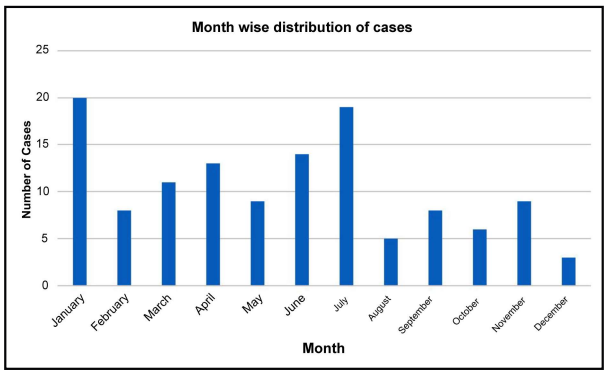

Figure 1: Month wise distribution of cases (n=125)

Among our study population, 63 (50.4%) cases received treatment at tertiary care hospital, 25 (20%) cases received treatment at primary or secondary care hospital and 37 (29.6 %) cases received no treatment and were brought dead to the hospital.

The manner of fall was Accidental in 70 (56%) cases, Suicidal in 2 (1.6%) cases, Homicidal in 1 (0.8%) case and unknown in 52 (41.6%) cases.

In our study, the commonest body region which sustained the primary impact was Head in 98 (78.4%) cases, followed by Trunk in 30 (24%) cases. The distribution of cases on the basis of region of the body which sustained the primary impact is given in *Figure* 2.

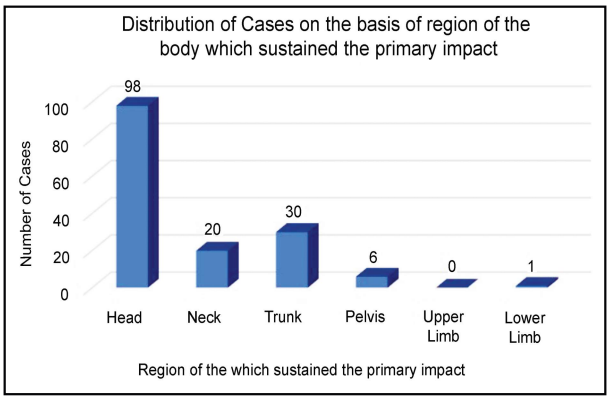

Figure 2: Distribution of cases on the basis of region of the body which sustained the primary impact (n=125)

The intracranial findings were present in 105 cases among which the most common intracranial finding was Sub-Dural

haemorrhage in 44 (41.9%) cases followed by Sub-arachnoid haemorrhage in 40 (38%) cases and Extra-Dural haemorrhage in 13 (12.3%) cases (*Figure 3*).

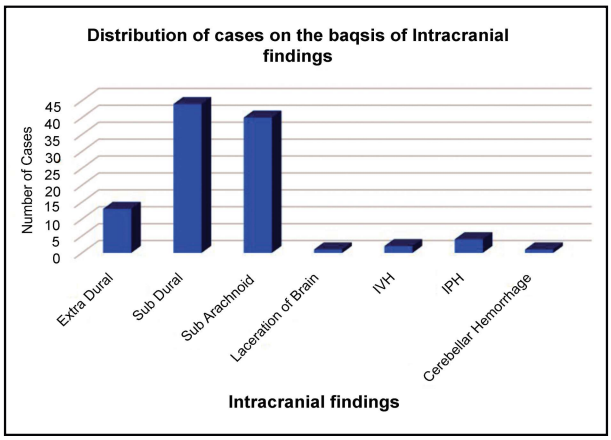

Figure 3: Distribution of Cases on the basis of Intracranial findings (n=105)

The internal thoracic injuries were found in 57 cases. The most common internal thoracic injury was lung contusions/lacerations in 28 (49.1%) cases, followed by rib fractures in 25 (43.8%) cases and fracture of sternum in 4 (7%) cases. Hem thorax was found in 30 cases, among which 22 (73.3%) were unilateral and 08 (26.7%) were bilateral.

The spinal fractures were found in 33 cases. The commonest spinal fracture was Cervical spine fractures in 20 (60.6%) cases. The distribution of cases on the basis of type of spinal fracture is given in *Figure 4*.

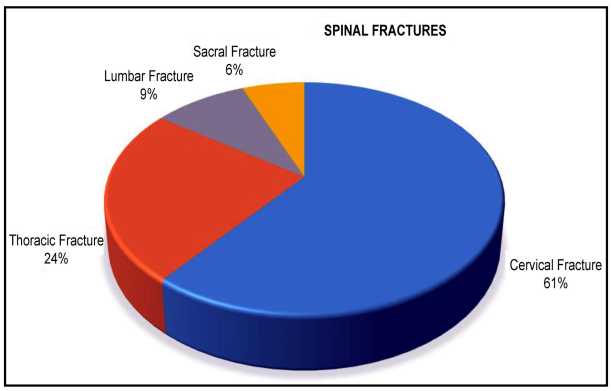

Figure 4: Distribution of cases on the basis of type of spinal fractures (n=33)

In our study population, the abdominal visceral injuries were found in 18 cases. The most common abdominal visceral injury was liver lacerations which were present in 7 (38.8%) cases followed by the spleen lacerations in 6 (33.3%) cases (*Figure* 5).

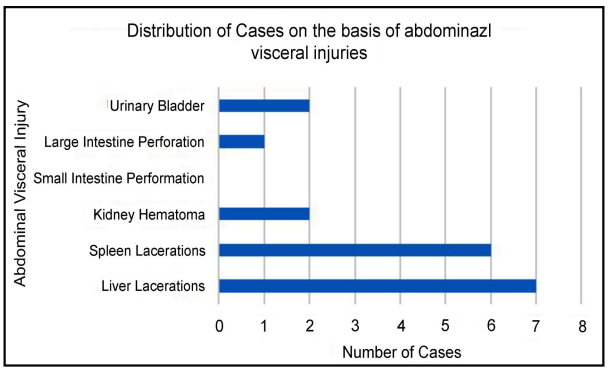

Figure 5: Distribution of Cases on the basis of abdominal visceral injuries (n=18)

The distribution of cases on the basis of Height of Fall is given in *Table* 3.

Table 3: Height of Fall (n=125)

Height of Fall	No. of cases (%)
10-20 ft.	55 (44)
21-30 ft.	41 (32.8)
31-40 ft.	17 (13.6)
41-50 ft.	01 (0.8)
51-100 ft.	07 (13.6)
101-150 ft.	00 (00)
More than 150 ft.	04 (3.2)

The most common injury present over the extremities was red grazed abraded contusions 91 (72.8%) (*Figure* 6).

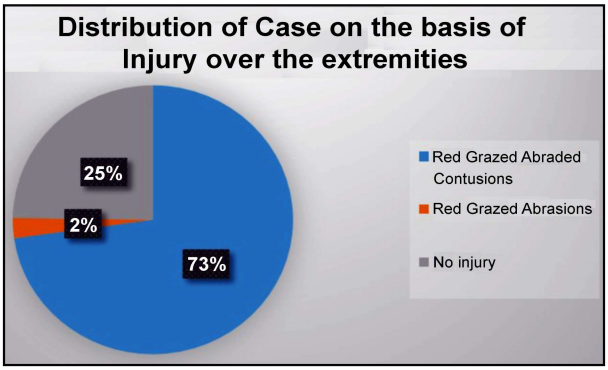

Figure 6: Distribution of cases on the basis of injury present over the extremities (n=125)

DISCUSSION

In our cross-sectional study, the total autopsy cases with the history of of fall from height were 125 cases which were 25.72 % of the total cases.

In our study, the commonest age group involved was 51-60 years which included 28 (22.4%) cases. The findings in our study are

consistent with a similar study conducted by Icer *et. al.*[7] and they found the maximum victims of deaths due to fall from height were ≥55 years old. In a study conducted by Turgut K. *et. al.*, in maximum cases of fall, the mean age of all deaths was 55.27±26.46 years.[8] The reason for high rate of morbidity and mortality due to fall from height in old individuals can be attributed to the decreased balance and coordination, muscle weakness, vision problems and chronic health problems like osteoporosis etc.

The numbers of females in our study population were 15 (12%) and males were 110 (88%) which is in accordance with the findings of Somasundaran Y. *et.al.*[9] in which the number of females constituted 10% of all cases and males constituted 90% of total cases. Turgut K. *et.al.* concluded that men are more prone to fall from height than women.[8] The reason for this can be that the males are more involved in occupations which involve working at heights, they are more likely to be involved in riskier activities or ignoring safety protocols than females.

In our study the incidence of fall was maximum amongst Farmers which constituted 56% of cases followed by Laborers (24%). These findings are in slight contrast to the study conducted by Somasundaran Y. et al in whose study, labourers constituted 34% of cases followed by Construction site workers (22%).[9] Our state is an agriculture dominated and has hilly terrain. This is the reason for the higher incidences of fall from height among farmers.

In our study population, 86.4% of the study population were married and 13.6% were unmarried.

In our study, the maximum number of cases were found in the winters (16%) followed by the monsoons (15.2%). The findings are in contrast with the study conducted by Turgut K. *et. al.* who concluded that 45.9% of the falls and 30.8% of the deaths due to fall from height were seen in summer season.[8] Our region's seasonal variations contribute to an increased risk of falls, with snowy winters heightening the likelihood of slips and falls, while monsoon seasons bring a surge in landslides and slippery surfaces, further exacerbating the risk of falls from heights.

In our study, 50.4% of cases received treatment at a tertiary care institute. Turgut K. *et. al.*[8] concluded on similar lines and said that the patients in their study received treatment in the emergency, neurosurgery, orthopaedics, and general surgery departments which is consistent with tertiary level of treatment. Similar findings were also noted by Ersoy S. *et.al.* and Yavuz M. *et.al.* in their respective studies.[10,11]

In our study, the number of deaths attributable to accidental falls were 56% followed by suicidal falls in 1.6% of cases. Eren A *et. al.* in their study concluded that the common causes of falls from height were suicide and accidents at the workplace.[12]

In our study, the site of primary impact was head in 78.4% cases, followed by the trunk, which was involved in 24%. In their study, Somasundaran Y. *et.al.* concluded that the commonest site of primary impact in their study population was Head (50%).[9] Turgut K. *et. al.* found that the injuries sustained to the skin and subcutaneous tissue (37.4%) and head (25.4%) were the commonest.[8] Kohli A. *et. al.* in their study had similar conclusions as our study and stated that in deaths due to fall from height, 73.1% cases had head injuries and 50% cases had subarachnoid haemorrhages.[13] Prathapan V. *et. al.* in their study concluded that the head was the most common site of primary impact which was found in 53% cases.[14]

In this study, subdural haemorrhage was found in 41.9 % cases followed by subarachnoid haemorrhage in 38%. Turgut K. *et. al.* in their study also found that in fatal cases 50% had subarachnoid haemorrhages.[8]

In our study, the internal findings in the thoracic region were found in 45.6% of total cases, among which, lung contusions/ lacerations were found in 49.1% cases. Hem thorax was found in 30 cases, among which 22 (73.3%) were unilateral and 08 (26.7%) were bilateral. In a similar study by Prathapan V. *et. al.*, lung injuries were noted in 28% of cases.[14]

In our study, the vertebral column fracture was seen in 26.4% of cases, out of which, cervical vertebral fractures was seen in 60.6% of cases followed by thoracic vertebral fractures in 24.2% of cases. In a study conducted by Prathapan V. *et. al.,* cervical spine was the most commonly affected region, which is consistent with our study. Fracture of the vertebrae was commonly caused by indirect forces. The reason could be to the jack knifing of the torso

resulting in flexion/extension of the spine at multiple sites. Fracture of the spine due to direct trauma has also been reported which was associated with the presence of external injuries.[14]

In our study, injury to abdominal visceral organs was seen in 14.4% of total cases. The maximum trauma was seen in liver in the form of lacerations/sub capsular hematoma which constituted 38.8% of total abdominal visceral injuries. Kumar P. *et. al*. in their study said that liver injuries are the commonest abdominal injury seen in most of the studies. This can be explained by the fact that the liver is a solid organ, covering most of the area in the abdominal cavity.[15]

In our study, the maximum number of fall cases were from a height between 10-20 ft. who constituted 44% of all cases, followed by 32.8% of cases falling from a height between 21 to 30 ft. These findings are consistent with those found in a study conducted by Prathapan V. *et. al.* and Vasudeva Murthy CR *et. al.*[16]

In our study, abraded contusions were found in 73% of cases followed by grazed abrasions, contusions and lacerations followed by no visible external injuries. These findings are consistent with the general pattern seen in a case of fall and documented in various studies conducted by Prathapan V. *et. al.* and Jagannatha SR *et. al.*[79, 84]

CONCLUSION

This study highlights that falls remain a significant cause of mortality, accounting for 26% of the total autopsy cases examined during the study period. The most affected demographic was middle-aged adults, particularly those between 51–60 years, with a notable male predominance (88%). The majority of victims were from rural areas (89.6%) and engaged in physically demanding occupations such as farming and labour, indicating occupational and environmental risk factors. Head injuries emerged as the most common and severe form of trauma. Thoracic and spinal injuries were also frequent, with cervical spine fractures and lung lacerations being the predominant findings. Although abdominal visceral injuries were less common, liver and spleen lacerations were the most frequently observed. A considerable proportion of cases (29.6%) were brought dead, having received no prior medical treatment, indicating the need for improved emergency response and trauma care access, especially in rural settings. Most falls were accidental (56%), but a significant number (41.6%) had an undetermined manner, suggesting the need for more thorough investigations into the circumstances surrounding these events. Falls from moderate heights (10–30 ft) were the most common, comprising over 75% of cases, underscoring the lethality even of relatively short-height falls when proper safety measures are lacking. In conclusion, the study underscores the urgent need for preventive strategies, especially in rural and occupational settings, as well as improvements in pre-hospital care and trauma management to reduce fall-related fatalities.

Ethical consideration

The ethical permission was obtained from the Institutional Ethical Committee, Indira Gandhi Medical College Shimla in December 2020 and the identity of the deceased persons has not been disclosed anywhere.

Conflict of interests: None

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