

## ORIGINAL ARTICLE

## The Study of Pattern of Injuries in Fatal Cases of fall from Height

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**Abstract:** *Objectives:* To study the various pattern of injuries from fall from height. *Background:* Deaths due to fall from height, form an important area of study due to diversity of the injuries sustained, complexity of the patterns involved and various phenomenon's associated there with. The medico-legal autopsy aims at deciding whether the death was attribute purely to the height. It also helps in ruling out the various contributing factors like drugs, alcohol and co-existing natural disease. *Methods:* The present study has been carried out in department of forensic medicine, M.S. Ramaiah medical college and hospital, Bangalore during the period October 2005 to May 2007, of all the cases of fall from height subjected for medico legal autopsy. *Results:* Fissure fracture of the skull and fracture of cervical spine was noticed when the fall occurred on to concrete from minimum height of 3 feet and on to hard soil from the height of 10 feet. Multiple rib fractures, fracture of clavicle and laceration of liver was noticed when the fall height was 7 feet on to concrete. Spleen and kidneys were damaged when height of fall was more than 20 feet on to hard surface. Fracture of upper limbs were seen in falls occurred on to concrete from height of 6 feet where as the fracture of lower limb was found when the fall height was more than 15 feet on to hard surface. *Conclusion:* The study of pattern of external and internal injury may together indicate the primary site of impact and height from which the fall has occurred. The determination of actual or probable anatomical site of primary impact may be useful in reconstruction of the events, which led to fatal falls. Presence of multiple blunt force injuries makes it hard to differentiate between falls induced injuries and those that have inflicted before the fall and often disagreement predominates regarding the height at which death results. Thus a careful study of total injury pattern is of vital importance in every case. In the difficult scenario of assessing the manner of death, meticulous autopsy in combination with visit to the scene of occurrence that includes observation of Ground nature and presence of any intervening object is of extreme help.

**Key words:** Fall, Height Site of Impact and Pattern of Injuries.

### Introduction

*"The higher you climb, the harder you fall."*-Chinese idiom [1]

It is noticed deaths due to fall from height is increasing yearly as the many work activities involve working at height. Many workers in maintenance, construction and many other people in a variety of jobs could be at risk of falling from height, examples include painters, decorators, window cleaners and those who undertake one off jobs without proper training, planning or equipment. Fall from height refers to fall from one higher level to another level involving ladder, stairs, roof, etc. [2].

Fall from height is defined in many ways, the international classification of diseases (ICD9) states that a fall from height is an event where a person falls to a Ground from upper level. Where as the frailty and injuries co-operative studies of intervention studies (FICSIT) define fall from height as unintentionally coming to rest on the Ground, floor or other lower level [3]. A more recent definition of fall from height to be a descent from upright, sitting or horizontal position, the descent height being less than or equal to 1metre [3].

Fall from height can be classified in several ways.

⇒ Depending on the height of fall which may vary from high rising building to ladder, chairs, tables or staircases, etc into:

- Low falls
- High falls

⇒ Depending on condition affecting, into:

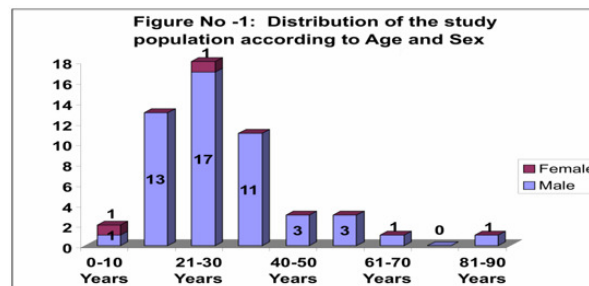
- Intrinsic (where some events or condition affects postural control)
- Extrinsic (where an environmental factor is the main contributing reason for the fall.) [3], during fall, the potential energy due to height is converted to kinetic energy under the influence of gravity. Fall from height, which results in injuries associated with rapid vertical deceleration; represent a unique form of blunt trauma. Victims of fall from height tend to sustain a unique pattern of injuries that depends on inertia of the body, movement of the body, rigidity of stationary objects and the nature of Ground nature against which body falls [4].

At the moment of impact, a falling body undergoes deceleration and amount of kinetic energy transferred to the Ground reacts with an equal amount against the body itself. The body in the form of injuries reabsorbs the energy lost [1]. Thus in the present situation study of deaths due to fall from height assumes a greater importance and it is absolutely essential to lay more emphasis on it.

### Material and Methods

The present study “the pattern of injuries in fatal cases of fall from height” has been carried out in department of forensic medicine, M.S. Ramaiah medical college and hospital, Bangalore during the period October 2005 to May 2007, of all the cases of fall from height subjected for medico legal autopsy. A total number of 52 cases were studied after the ethical clearance was obtained.

### Results and Discussion



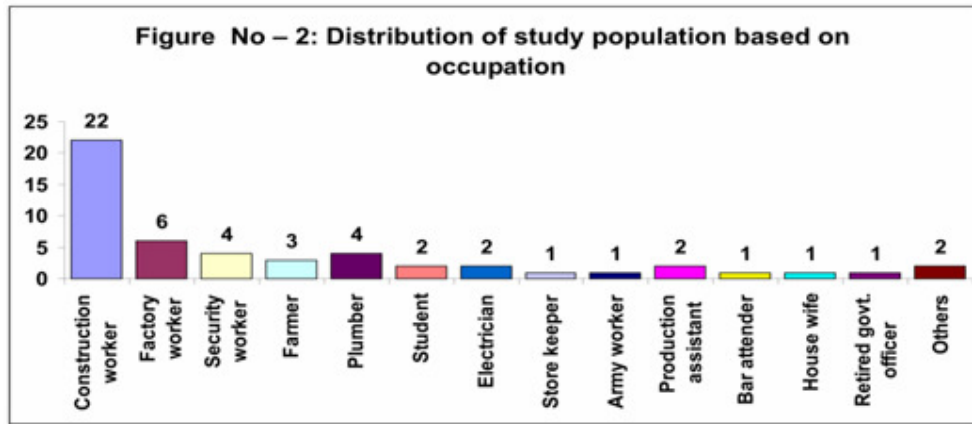
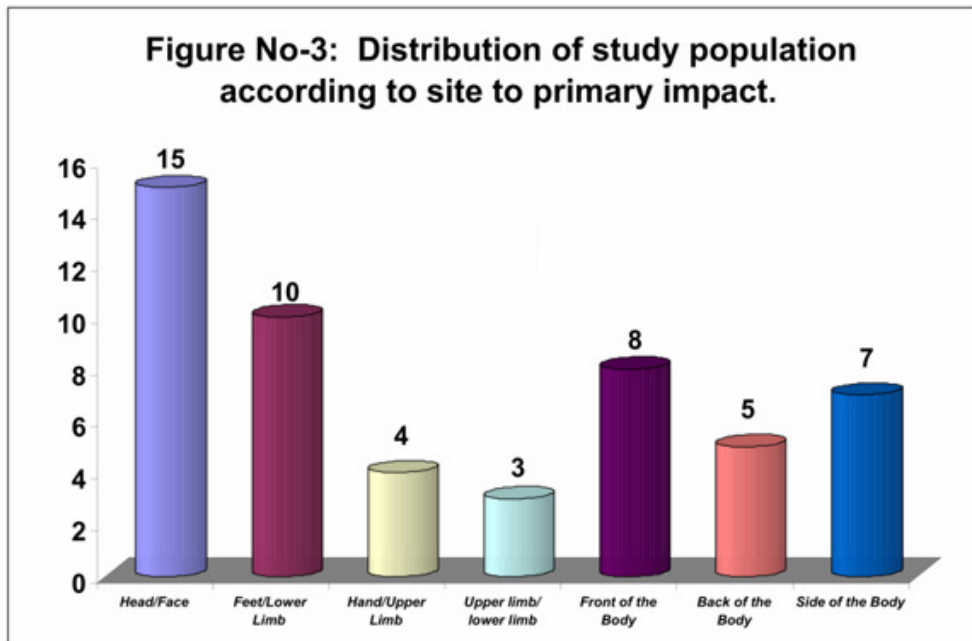


Table -1: Distribution of study population according to site to primary impact.

Sl. No.	Primary Impact	Number of cases	Percentage
01	Head/Face	15	28.84
02	Feet/Lower Limb	10	19.23
03	Hand/Upper Limb	04	07.69
04	Upper limb/ lower limb	03	05.76
05	Front of the Body	08	15.38
06	Back of the Body	05	09.61
07	Side of the Body	07	25.00
	Total	52	100



**Table-2: Distribution of study population according to injuries to Thorax**

Sl. No.	Injuries	No. of Cases	Percentage
01	External Injuries	09	17.30
02	Fracture of ribs	29	55.76
03	Fracture of sternum	02	03.84
04	Lungs	12	23.07
05	Heart	01	01.92
06	Diaphragm	01	01.92

**Table No.3: Distribution of study population according to injuries to Abdomen and Pelvis**

Sl. No.	Injuries	No. of Cases	Percentage
01	External Injuries	06	11.53
02	Liver	18	34.61
03	Kidney	08	15.38
04	Spleen	15	28.84
05	Intestine	02	03.84
06	Thoraco-Lumbar vertebrae	04	07.69
07	Mesentery	05	09.61
08	Posterior abdominal wall	08	15.38
09	Fracture of pelvic bone	02	03.84

**Table No-4: Distribution of study population according to Height of fall and body region involved.**

Sl. No.	Height of Fall	Head	Neck	Thorax	Abdomen/pelvis	Upper /Lower Limb
01	0-20 Feet	18	06	12	10	03
02	21-40 Feet	15	00	16	16	09
03	41-60 Feet	01	00	01	01	02
04	61-80Feet	00	00	00	00	00
05	81-100 Feet	00	00	00	00	00
06	101-120Feet	02	01	03	03	02
07	121-140 Feet	00	00	01	01	01
	Total	36	07	32	31	17

**Table No-5: Distribution of study population according to nature of the Ground, Height of fall and injuries sustained**

Height of fall	Hard surface					Soft surface		Total
	Hard soil	Cement / concrete	Stone	Tiles / Marble	Tar	Mud	Sand	
0-20 feet	13	04	02	02	02	02		25
21-40 feet	07	11	02	-	-	-	01	21
41-60 feet	-	01	-	-	-	-	01	02
61- 80 feet	-	-	-	-	-	-		-
81-100 feet	-	-	-	-	-	-		-
101- 120 feet	-	02	-	-	-	-		02
121- 140 feet	02	-	-	-	-	-		02
Total	22	20	04	02	02	02		52



Plate No-1: Scene photograph-The victim a construction worker who died on the spot, due to head injuries. Showing lacerated scalp, drained out brain matter and cement, paint stains on the body and clothing. Nature of Ground: Cement Surface and Height of Fall: 40 feet.



Plate No-2: Scene photographs

A) The victim was a “PLUMBER” Nature of Ground: Sand Height of fall: 13 feet.

B) The victim was a “Construction Worker” fell accidentally when the scaffolding gave away though he was secured with a snap hook. Nature of Ground: Hard Soil Height of Fall: 130 feet.

Out of total 1319 cases of Post mortem, fall from height constituted 52 cases amounting to 3.94 %. It is observed that maximum number of fall from height cases was seen in the age group 21-30 years (34.61%). The least number of fall from height cases occurred in age group of 61-70 years and 81-90 years, accounting to 1.9% in each group. None of the cases found in the age group 71-80 years. The youngest age was 2 ½ years and eldest was 82 years. The highest incidence of fall from height occurred at construction site followed by fall from public buildings. Fall from height is the most common cause of fatal injuries and single biggest cause of work place deaths. On an average majority of fall related deaths happens in construction industry with remaining spread across other industries.

The highest incidence of fall from height occurred among construction workers followed by factory workers. It was observed that in dizziness was the precipitating factor in 04 cases (07.69%) and Presence of alcohol was confirmed in 02 cases. Past history of hypertension and intake of anti-hypertensive drugs was found in 02 cases (03.84%). It was found that in 25 numbers of cases falls occurred from 0-20 feet (48.07%) followed by from 21-40 feet height (40.38%). Wide range of injuries varying from soft tissue injuries to fracture of vault, base of skull along with intra cranial hemorrhages was found in majority of the cases. The fracture of vault, base of skull was seen in 31 cases. (59.61%) Among skull fractures, fissured fracture was more frequently found (26.92%) followed by Comminuted Fracture (23.07%) and subdural, Subarachnoid Hemorrhages were found in 29 cases and Extradural Hemorrhage was seen in 02 cases along with, subdural, Subarachnoid Hemorrhages. Among injuries to neck, fracture of cervical spine was more frequently noticed (13.46%). Fracture of facial bones (nasal, maxilla and mandible) was seen in 03 cases (05.76%). Fracture and dislocation of teeth was observed in 03 cases (05.76%). It is observed that majority of the cases falls were onto hard surface like cement/concrete, stone, hard soil and marble followed by falls on to soft surface like sand and mud. On a relatively yielding surface, the energy is given up slowly, but on a relatively unyielding surface such as hard soil, concrete, time of deceleration is shorter and hence the forces on the body are much great [5]. Multi organ involvement was noticed where the nature of Ground was hard surface and isolated fatal injuries were hall mark of falls over the soft surface.

Fissure fracture of the skull and fracture of cervical spine was noticed when the fall occurred on to concrete from minimum height of 3 feet and on to hard soil from the height of 10 feet. Multiple rib fractures, fracture of clavicle and laceration of liver was noticed when the fall height was 7 feet on to concrete. Spleen and kidneys were damaged when height of fall was more than 20 feet on to hard surface. Fracture of upper limbs were seen in falls occurred on to concrete from height of 6 feet where as the fracture of lower limb was found when the fall height was more than 15 feet on to hard surface.

### Conclusion

A study of pattern of injuries in fatal cases of fall from height subjected to medico legal autopsy at M.S.Ramaiah medical college hospital, Bangalore from October 2005 to May 2007 concludes as follows

- Fall from height subjected for medico legal autopsy contributed for 3.94% of total autopsies conducted.
- Most cases of falls from height were accidental in nature. (88.46%)
- In Five cases there was allegation of homicide.
- Males (96.16%) out numbered females (3.84%)
- Falls were more commonly in afternoon.
- 21-40 years age group contributed the highest number (34.61%).
- Most cases of falls from height were due to accidental in nature. (88.46%)
- Abdomen (Liver Lacerations) injuries are very common followed by head and chest injuries (rib fractures and lung laceration).
- Liver is the most common solid organ to be damaged, followed by spleen.
- Head injury is the most common cause of death among victims of fall. But hemorrhagic shock due to multiple injuries is common in adults though head injuries may be contributory.
- In 48.07% of cases the height of fall was 0-20 feet followed by 21-40 feet.
- Head and cervical spine injury was common when the fall occurred from 0-20 feet height
- Abdomen and thoracic injuries were common when the height of fall was 21-40 feet and With increasing in height, the limb injuries were commonly noticed
- Study revealed that in more than 80% of cases more than one body region was injured.
- In 57.69% cases, deaths occurred on the spot.
- Among occupation, fall from height most frequently seen among construction workers (42.3%)
- Multi organ trauma was seen when fall was on to hard surface.

*The common risk factors and etiology observed were [6- 7]*

- Lack of safety measures at work place/ residence
- Alcoholic intoxication.
- Chronic illness with long-term treatment, psychiatric disorders, poor vision, arthritis, and dizziness.
- Lack of parental supervision of children while playing

**Recommendations: [8-9]**

Lot of human life can be prevented if proper safety precautions are followed.

- Awareness campaigns stressing on the need for safety practices and screening of people working at heights, to emphasize on supervision /restriction of people on the roof top of public buildings.
- Active and effective management of cases of falls from heights at centers well equipped with modern diagnostic facilities and advanced techniques so that precious human lives can be saved
- Ensure safety of residence like- high parapet wall for the roof/ building.
- Sensitization of architects, builders and masons for safer designs of stairs, balconies and rooftops with appropriate railing, grab bars and landings.
- Publicizing safety standards for grills on windows.
- Encouragement / evolution of safer working techniques and harnesses for construction workers and window cleaners who work at heights and tree climbers.

*Prevention of fall at the construction/ work place as suggested by health safety regulations [10]*

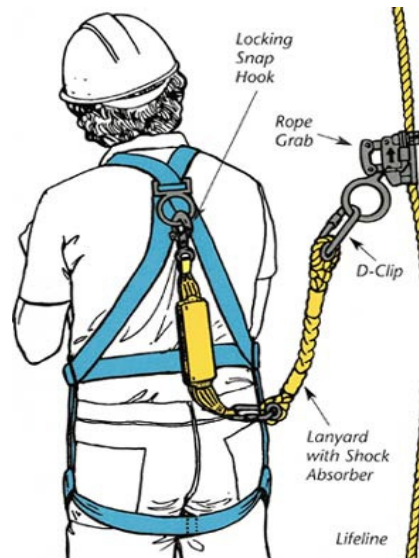


Plate No-3: In the above photograph shows how safety measures being incorporated after a case of fall occurred at that place

Loss of human life can be prevented if safety measures like [11]

- Self-retracting life lines (SRLs)
- Locking snap hooks
- Head gear
- Rope grab
- Life line anchor
- Lanyard and shock absorber.

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