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AUTOPSY STUDY OF FALL FROM HEIGHT

Forensic Medicine

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ABSTRACT

Falls are one of the leading causes of unintentional injury and death globally, only secondary to motor vehicle accident. This study aims at finding out pattern of injuries in fatal cases of fall from height and factors associated with such cases. A cross sectional study was conducted over a 2-year period from August 2015- July2017 in the department of forensic medicine LTMMC& GH Sion Mumbai. Total 3152 autopsies were conducted during study period. Out of which 102 were of fall from height. Males outnumbered (80.4%) the females, and maximum number of cases 39 (38.2%) was observed in the age group 21-30 years. Primary impact was most commonly seen on the head 40 (39.2%) followed by leg 21 (20.6%). Polytrauma was the most common cause of death in 48 (47.1%) cases followed by head injury in 32 (31.4%) cases. The manner of death was mostly accidental, i.e. 89 (87.3%) cases. Most of the incidents occurred between 12 pm to 6 pm involving 62 (60.8%) cases. Analysis of injury pattern in fall from height would help in knowing the height of fall, site of primary impact and ultimately aid in differentiating from other causes of trauma.

KEYWORDS

Fall, Height, Construction, Laborers, Primary Impact

INTRODUCTION

Falls are one of the leading causes of unintentional injury and death globally, only secondary to motor vehicle accident. A fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level. Motor vehicle accident produces injuries due to horizontal deceleration while fall produces injuries due to vertical deceleration. Vertical deceleration injuries characteristically affect weight bearing structures with forces transmitted through the foot, leg, pelvis and vertebral column[1]. Many factors such as height of fall, velocity of fall[2,3], rate of energy release[5,3], nature of the landing surface[4-7] and the body orientation at the time of landing determines the pattern of injuries sustained due to fall. Absorbed energy due to impact results in bodily damage in fall. This energy, i.e. the kinetic energy-E, of the moving body is explained by equation $E=1/2\ mV^2$ where m is the mass of body and V is the velocity. Fall from height is more common in metro cities like Mumbai due to multi storey buildings. In some cases, the mode of death is unclear at the time of body is found and the presence of multiple blunt force injuries make it hard to differentiate between fall induced injuries and those that have been inflicted before fall. The focus of this study is to analyze the co-relation between the height of fall and the frequency, type of injury of certain body region and organ as well as external injuries. It also aims to determine characteristic injuries of certain body region in relation to height of fall.

MATERIALS AND METHOD

The present cross sectional study was carried out over 2 year period from August 2015 to September 2017. The material for the present study included all fatal cases of fall from height brought for medico-legal post-mortem examination. Detail information including the height of fall was obtained from police inquest papers, by interview of the police officers, relatives and friends accompanying the case and visiting the site of fall. The resulting data was tabulated and analyzed. On the basis of analysis and observation, results were drawn, discussed and compared with other relevant literature.

OBSERVATIONS AND RESULTS

During the two year study period, a total of 3152 post mortems were conducted out of which 102 cases were fall from height. There was predominance of male with 82 (80.4%) cases and 20 (19.6%) cases were females and Male: female ratio was 4.1: 1**.** Maximum cases were observed in age group of 21-30 years comprising of 39 (38.2%), followed by 31-40 years 16 (15.7%) cases and least number of cases were observed in age above 60 years **(Table-1 and 2).**

Table No-1

Age Group	Number	Percentage
<=10 years	9	8.8
11-20 years	9	8.8
21-30 years	39	38.2
31-40 years	16	15.7
41-50 years	13	12.7
51-60 years	12	11.8
61-70 years	2	2
>70 years	2	2
Total	102	100

Table No-2

Sex	Number	Percentage
Female	20	19.6
Male	82	80.4
Total	102	100

Our study showed majority of the cases 89 (87.3%) had accidental fall, followed by suicide 13 (12.7%). No homicidal case of fall was noted. In our study, majority of the cases belongs to laborers comprising 53 (52.0%) engaged for work at construction site. In 15 (14.7%) cases housewives were involved and students in 13 (12.7%) cases **(Table-3)**

Table No-3

Occupation	Number	Percentage
Not working	13	12.7
Housewife	15	14.7
Labour	53	52
Service	8	7.8
Student	13	12.7
Total	102	100

Maximum number of cases 62 (60.8%) had fall during time period 12.00 pm to 06.00 pm, followed by 28 (27.5%) cases, during the 06.00 am to 12.00 pm and 12 (11.8%) cases during the time period 06.00 pm to 06.00 am**.**

We observed that majority of the cases 53 (52.0%) had a fall of height <=20 feet, 16 (15.7%) cases had a fall between 21-40 feet, 12 (11.8%) cases had a fall between 41-60 feet, 10 (9.8%) cases had a fall between 61-80 feet. 11 (10.8%) cases had fall more than 80 feet **(Table-4).**

Table No-4

Height of Fall	Number	Percentage
<=20 feet	53	52
21-40 feet	16	15.7

41-60 feet	12	11.8
61-80 feet	10	9.8
81-100 feet	5	4.9
>100 feet	6	5.9
Total	102	100

In the present study, fall from height observed most commonly in residential building 52 (51.0%) cases followed building construction sites in 34 (33.3%) and fall from tree 7 (6.9%) cases **(Table-5).**

Table No-5

Fall from	Number	Percentage
Residential Building	52	51
Under Construction Building	34	33.3
Tree	7	6.9
Others	9	8.8
Total	102	100

In 40 (39.2%) cases the head was the site of primary impact, followed by 21 (20.6%) cases leg as site of primary impact. 20 (19.6%) cases showed trunk as a site of primary impact and 13 (12.7%) it was buttock **(Table-6).** 69 cases show fall from height <= 40 feet out of which 39 cases had head impact.

Table No-6

Site of Primary Impact	Number	Percentage
Head	40	39.2
Leg	21	20.6
Trunk	20	19.6
Buttock	13	12.7
Unknown	8	7.8
Total	102	100

DISCUSSION

In the present study, Males (80.4%) were preponderated as compared to females (19.6%), the male to female ratio being 4.1:1. This is because more males are involved in work at high places. Maximum numbers of cases (68) were observed in the age group of 21-50 years as this age group is the most active phase of life - physically and socially. Similarly, maximum numbers of deaths in the active age group 21-40 years with male preponderance was observed by Venkatesh et al(2007)[8], J. V. Kiran Kumar & A. K. Srivastava (2013)[9], Vasudeva Murthy CR et al (2012)[10] and Mushtaq Ahmad et al (2014)[11]

In the present study, highest incidence of fall, 53 cases (52 %) occurred among labourer involved in variety of building construction / maintenance work. Eight victims (7.8%) were working in government/private service. 15 female victims (14.7%) were housewives, and rest of the victims (25.4%) were either students or very young or too old to work. Mushtaq Ahmad et al (2014)[11] and Cattledge GH et al (1996)[12] also observed maximum number of cases amongst construction workers/laborer.

In the present study majority of deaths were due to accidental falls, 89 cases (87.3%) and in 13 cases (12.7%) it was suicidal, none of the cases were homicidal. Similarly, majority of deaths were accidental and least were suicidal in studies done by Venkatesh et al (2007)[8] and J. V. Kiran Kumar and A. K. Srivastava (2013)[9], Memchoubi Ph et al (2016)[13], Li L, Smialek JE et al (1994)[14] and Cattledge GH et al (1996)[12]. While studies conducted in Germany by Elisabeth E, Turk and Michael Tsokos (2004)[15] observed 50% cases belongs to suicide and 35 % accidental. In general, suicides are done from a greater height to assure that death occurs. To commit suicide by jumping from building is easy as compared to other method of suicide as it requires little planning and no preparation.

In the present study, majority of the victims sustained injuries due to fall from residential building (51.0%) followed by 33.3% cases from under construction buildings, in 7 cases (6.9%) victim fell down from trees and in 9 cases from other places like stairs, ladders and attic. Similarly, in a study done in Delhi by **J**.V. Kiran Kumar & A. K. Srivastava (2013)[9] majority of the fall occurred from residential buildings, commonly from balcony/verandah or terrace due to lack of appropriate fencing barrier. In study done by Vasudeva Murthy CR et al (2012)[10] in Bangalore, majority of cases occurred at construction sites. In our study maximum cases of fall from height occurred due to fall from residential buildings. The reason might be much better safety precautions taken at construction site in Mumbai city comparatively.

We observed that the maximum number of falls, 53 cases (52%) were from height of 0-20 feet. In 16 cases (15.7%) the height of fall was 21-40 feet followed by 12 cases (11.8%) from 41-60 feet and in 6 cases (5.9%) the height of fall was more than 100 feet. Minimum height of fall was 5 feet from wooden board and maximum height of fall was19th floor from under construction building. Similar observations of maximum deaths from fall from less than 20 feet height were observed by Venkatesh et al(2007)[8], J. V. Kiran Kumar & A.K. Srivastava (2013)[9] and KohliA and Banerjee K K (2006)[16]. Majority of the fall from less than 20 feet indicates that falls were from 1st of 2nd floor of building.

Highest incidents took place between 12 pm – 6 pm, 62 (60.8%) cases followed by 28 (27.5%) cases between 6.00 am to 12.00 pm and during 6 pm - 6 am 12 (11.8%) cases occurred. Similar findings were noted by Guntheti BK, Singh UP et al (2015)[17] where maximum incidence occurred during 12.00 pm to 6.00 pm.Maximum fatalities occurring in day time is obvious as the construction work is mainly carried out during day time and as the fatalities were mainly accidental related to the work place.

Determination of site of primary impact was based on interpretation and evaluation of injuries. We noticed that serious injuries are sustained to the site of primary impact, but injuries of varying nature are seen on other parts of the body also. Head injuries were more common in falls of height <=40 feet, impact on leg and trunk was seen in nearly all heights of fall.

In the present study, the site of primary impact was head in majority of cases 40 (39.2%). It was also observed that person who falls from height less than 20 feet, head was commonly the site of primary impact. In 29 cases out of 40 cases of head impact were fell fall from less than 20 feet. Similar findings were revealed by V. Prathapan and B. Umadethan (2015)[18]and Guntheti BK, Singh UP et al (2015)[17] Buttock impacts was seen in 13 cases (12.7%) where maximum trauma occurred at buttock region and fracture of pelvis was present in all these cases.

SUMMERY AND CONCLUSION

Fall from height is one of the most common causes of accidental injuries. It is more common in urban setup where multi storey building or construction of such structure is ongoing. Most the cases occurred in day time during working hours. Primary impact to head indicates scope for improvement in safety measures to be worn by laborers at work site as well as improvement in safety measures at work sites. It also indicate need to increase safety measure in residential buildings to prevent such mishaps. The important steps required to implement are:

- Head protective gear to be worn by laborers.
- Strict use of safety harnesses at construction sites as well as while working in residential building.
- Multi-layered use of safety net to prevent fall and impact to ground.
- Windows and galleries to be fitted with grill and high railing.
- Periodic inspection by local authority for proper implementation of
- safety measures.

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