

## ORIGINAL RESEARCH

**Pattern of deaths due to fall from height - a prospective study****Visnurajkumar. J<sup>1</sup>, Karthik. D<sup>2</sup>, Muralidharan. A<sup>3</sup>**

<sup>1</sup>Senior Assistant Professor, Department of Forensic Medicine & Toxicology, Government Kilpauk Medical College & Hospital, Chennai – 10, Tamil Nadu, India.

<sup>2</sup>Assistant Professor, Department of Forensic Medicine & Toxicology, Government Ooty Medical College & Hospital, Nilgiris – 643001, Tamil Nadu, India.

<sup>3</sup>Senior Assistant Professor, Department of Forensic Medicine & Toxicology, Government Kilpauk Medical College & Hospital, Chennai – 10, Tamil Nadu, India.

**ABSTRACT**

**Background:** Deaths due to fall from height are the second leading cause of injury-related deaths. The fatalities of the injuries depend not only on the height of fall but also on the landing position and impact surface<sup>2</sup>. Additionally, diversity of the injuries and the complexity of the patterns involved in these injuries, emphasizes the need for study in this area. A prospective autopsy study of deaths due to fall from heights was carried out in the Department of Forensic Medicine & Toxicology attached to Government Kilpauk Medical College & Hospital, Chennai – 10, Tamil Nadu for the year 2021 from 01-01-2021 to 31-12-2021. Among the total 2825 cases autopsied during the study period, 84 cases (2.97 %) were deaths due to fall from height. Maximum deaths were seen in males (77.38%). Maximum number of fall from height cases were seen in the age group of 31-40 Years (55.95%). Maximum case of fall from height was seen in construction workers (38.09%). Maximum cases of fall from height were seen in low socioeconomic status (73.80%). Maximum cases of death due to fall from height were married (73.80%). Maximum cases of fall from height were seen with a distance below 20 feet which constitutes (40.47%). The impact surface was maximum with fall over a hard surface (46.42%). The cause of death in maximum cases was attributed to Cranio Spinal Injuries (44.04%). The most common manner of death was accidental in nature (80.95). We concluded that fall from heights carry a significant morbidity and mortality and to decrease the incidence of these deaths, it is important to employ certain vital strategies. These include creating awareness amongst workers, increasing parental supervision of toddlers during their play at heights and psychological counselling for students.

**Keywords:** Impact, Fracture, Pattern of Injuries, Cranio Spinal Injuries

**INTRODUCTION**

Increasing urbanization and civilization has led to an increase in construction of high-rise buildings especially to gratify human needs. Additionally, factors like unsafe/ uneven surfaces, poor lighting and slippery surfaces, diminished eyesight and problems with gait and balance among elderly contribute immensely to greater incidence of fall from heights<sup>1</sup>. Globally, fall from height are a substantial public jeopardy and are among the important leading causes of serious and fatal injuries. It is the second leading cause of injury-related death worldwide. It is also a major cause of personal injuries disproportionately affecting the

very young and the very old and causing a significant impact on victim's families and the society<sup>2</sup>.

A fatal fall from height can result from accidents, suicides or homicides. In some cases, the manner of death becomes ambiguous. This is due to the fact that multiple injuries sustained due to fall pose a difficult task to autopsy surgeon to ascertain if the injuries were sustained due the fall or inflicted by other means before the fall. The severity of injury depends on many factors like the weight of the body and the manner in which the body impacts against the surface. Complexity of injuries increases with an increase in the height of the fall<sup>2</sup>.

Suicides and suicide attempts constitute a major concern for public health services, with implications for both families and society. Trauma incurred due to falls from height poses a great burden on health services due to its severity. This is particularly important if we take into account the fact that this is a largely preventable mechanism of injury<sup>3</sup>. Prior knowledge of the possible traumatic patterns incurred after a fall from height can prove helpful in the evaluation of survived individuals as well as reduced mortality. In this study we prospectively evaluated the demographic data, injury pattern of such cases and utilized this information for formulating the necessary preventive measures.

### AIMS & OBJECTIVES

1. To know the predominant sex involved in fall from height.
2. To know the most common age group involved in fall from height.
3. To know about the prevalence in occupation involved their socio economic status and marital status.
4. To know about the fatal distance and type of surface increasing the death.
5. To know the most common cause of death encountered.
6. To know the most common manner of death.

### MATERIALS AND METHOD:

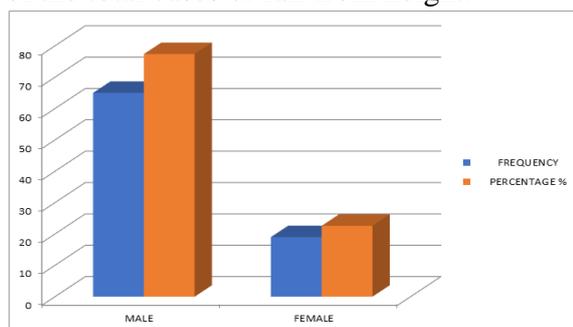
A prospective study of deaths due to fall from height for a period of (1) Year, from January 2021 to December 2021 was studied in the Department of Forensic Medicine & Toxicology, Government Kilpauk Medical College & Hospital, Chennai – 10. This study was conducted using a pre-tested structured proforma which fulfilled the inclusion and exclusion criteria, police inquest and perusal of hospital records.

### OBERVATIONS

**TABLE 1: GENDER WISE DISTRIBUTION:**

GENDER	FREQUENCY	PERCENTAGE %
MALE	65	77.38
FEMALE	19	22.61
TOTAL	84	100

Maximum cases of fall from height were observed in **males** which contributed to **(77.38%)** of the total cases of fall from height.

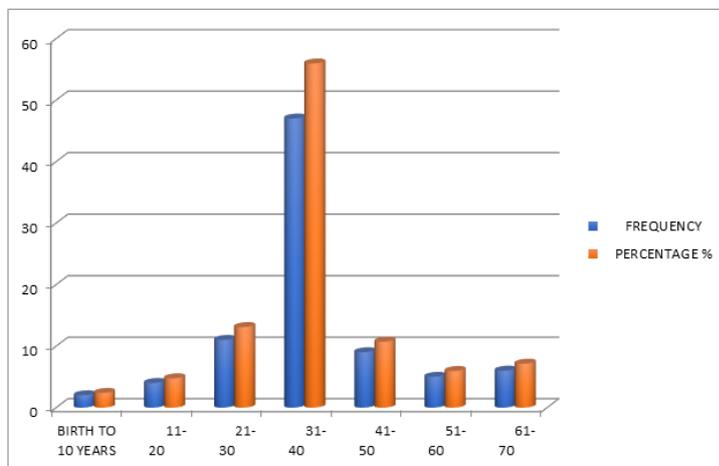


**FIGURE 1**

**TABLE 2: AGE WISE DISTRIBUTION:**

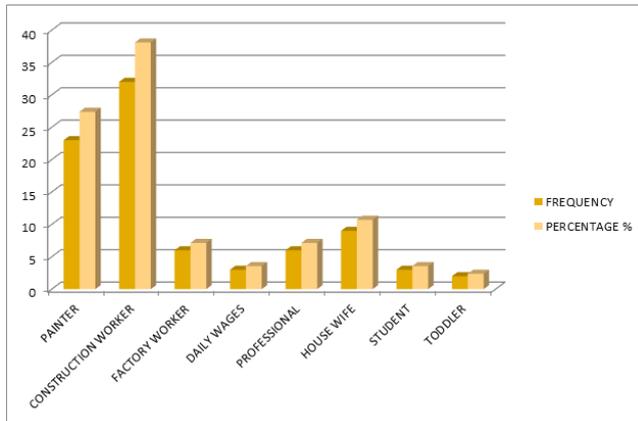
AGE IN YEARS	FREQUENCY	PERCENTAGE %
BIRTH TO 10 YEARS	02	2.38
11-20	04	4.76
21-30	11	13.09
<b>31-40</b>	<b>47</b>	<b>55.95</b>
41-50	09	10.71
51-60	05	5.95
61-70	06	7.14
TOTAL	84	100

Maximum number of fall from height cases were seen in the age group of **31-40 Years (55.95%)** followed by **21-30 Years (13.09%)**.

**FIGURE 2****TABLE 3: OCCUPATION WISE DISTRIBUTION:**

OCCUPATION	FREQUENCY	PERCENTAGE %
PAINTER	23	27.38
<b>CONSTRUCTION WORKER</b>	<b>32</b>	<b>38.09</b>
FACTORY WORKER	06	7.14
DAILY WAGES	03	3.57
PROFESSIONAL	06	7.14
HOUSE WIFE	09	10.71
STUDENT	03	3.57
TODDLER	02	2.38
TOTAL	84	100

Maximum case of fall from height was seen in construction workers (**38.09%**) followed by painters as their profession (**27.38%**) and house wife (**10.71%**).

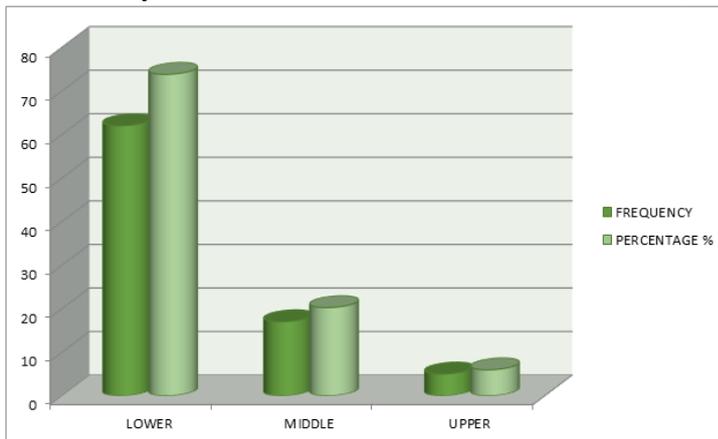


**FIGURE 3**

**TABLE 4: SOCIO ECONOMIC STATUS WISE DISTRIBUTION**

ECONOMIC STATUS	FREQUENCY	PERCENTAGE %
<b>LOWER</b>	<b>62</b>	<b>73.80</b>
MIDDLE	17	20.23
UPPER	05	5.95
<b>TOTAL</b>	<b>84</b>	<b>100</b>

Maximum cases of fall from height was seen in **low socio economic status (73.80%)** followed by **middle socio economic status (20.23%)**.

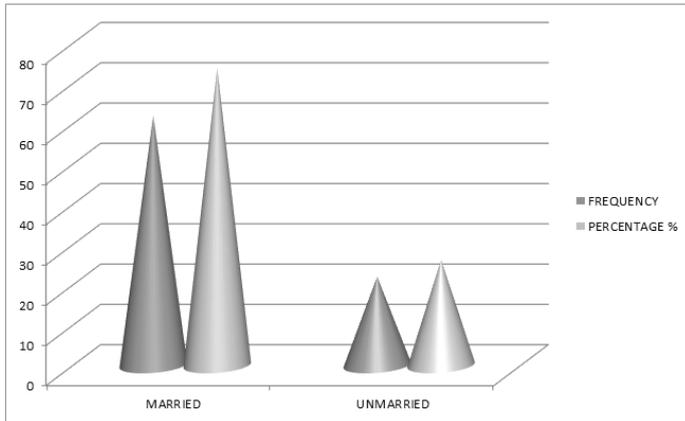


**FIGURE 4**

**TABLE 5: MARITAL STATUS WISE DISTRIBUTION:**

MARITAL STATUS	FREQUENCY	PERCENTAGE %
<b>MARRIED</b>	<b>62</b>	<b>73.80</b>
UNMARRIED	22	26.19
<b>TOTAL</b>	<b>84</b>	<b>100</b>

Maximum cases of death due to fall from height were **married (73.80%)**

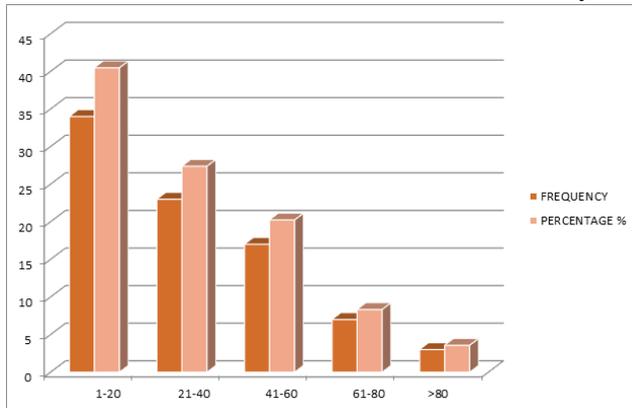


**FIGURE 5**

**TABLE 6: APPROXIMATE HEIGHT OF FALL**

APPROXIMATE HEIGHT OF FALL IN FEET	FREQUENCY	PERCENTAGE %
<b>1-20</b>	<b>34</b>	<b>40.47</b>
21-40	23	27.38
41-60	17	20.23
61-80	07	8.33
>80	03	3.57
<b>TOTAL</b>	<b>84</b>	<b>100</b>

Maximum cases of fall from height were seen with a distance **below 20 feet** which constitutes **(40.47%)** of the cases followed by **21-40 feet (27.38%)** and **41-60 feet (20.23%)**.



**FIGURE 6**

**TABLE 7: DISTRIBUTION OF CASES BASED ON IMPACT SURFACE:**

IMPACT SURFACE	FREQUENCY	PERCENTAGE %
MUD	07	8.33
SAND	14	16.66
CEMENT	16	19.04
STONE	06	7.14
<b>HARD SURFACE</b>	<b>39</b>	<b>46.42</b>
TILES / MOSAIC	02	2.38
<b>TOTAL</b>	<b>84</b>	<b>100</b>

The impact surface was maximum with fall **over a hard surface (46.42%)** followed by **fall over cement (19.04)** and **fall over sand (16.66%)**.

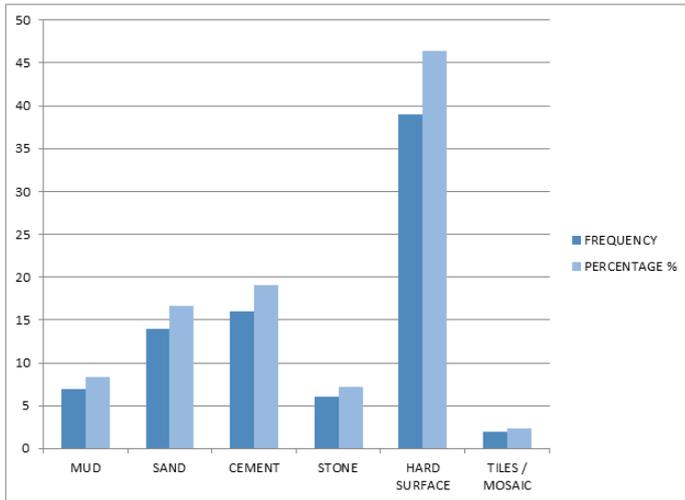


FIGURE 7

TABLE 8: CAUSE OF DEATH:

CAUSE OF DEATH	FREQUENCY	PERCENTAGE %
HEAD INJURY	21	25
<b>CRANIO SPINAL INJURIES</b>	<b>37</b>	<b>44.04</b>
BLUNT INJURY CHEST	09	10.71
BLUNT INJURY ABDOMEN	10	11.90
SHOCK AND HAEMORRHAGE DUE TO MULTIPLE INJURIES SUSTANED	03	3.57
SHOCK AND HAEMORRHAGE DUE TO INJURY TO VITAL ORGANS.	04	4.76
<b>TOTAL</b>	<b>84</b>	<b>100</b>

The cause of death in maximum cases was attributed to **Cranio Spinal Injuries (44.04%)** followed by **head injury (25%)** and **blunt injury to abdomen (11.90%)**.

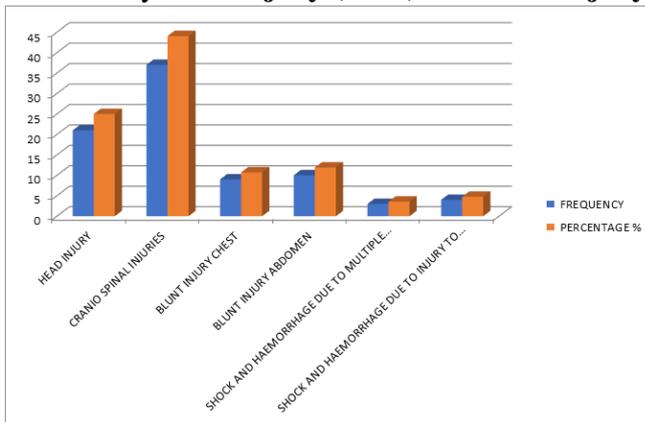
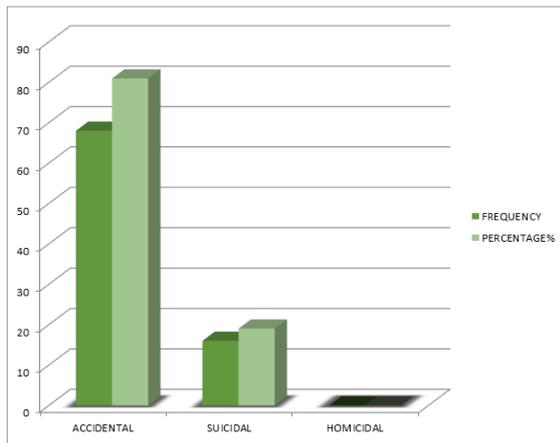


FIGURE 8

TABLE 9: MANNER OF DEATH:

MANNER OF DEATH	FREQUENCY	PERCENTAGE%
<b>ACCIDENTAL</b>	<b>68</b>	<b>80.95</b>
SUICIDAL	16	19.04
HOMICIDAL	0	0
<b>TOTAL</b>	<b>84</b>	<b>100</b>

The most common manner of death was **accidental in nature (80.95%)** followed by **suicidal (19.04%)** and **no cases of homicide** was reported.



**FIGURE 9**

## DISCUSSION

Deaths due to fall from height is the second cause of injuries related to death and are on rise. Maximum cases of fall from height were observed in **males** which contributed to **(77.38%)** of the total cases of fall from height. This is similar to the study conducted by Roopak SN, SR Jagannatha and VT Venkatesh MV Pradeep Kumar, SR Jagannatha<sup>3,9,12</sup>. This could be due to the fact that males being the breadwinner of the family and are more exposed to stress, strain and occupational hazards and a greater amount of zeal is involved in handling the work at heights compared to females.

Maximum number of fall from height cases were seen in the age group of **31-40 Years (55.95)** followed by **21-30 Years (13.09)**. This study is similar to the studies conducted by J.V.Kiran Kumar, A.K.Srivastava and Roopak SN, SR Jagannatha, VT Venkatesh MV Pradeep Kumar, SR Jagannatha. However our study was in contrast with the study conducted by V.Prathapan and B.Umadethan<sup>3,8</sup>. This could be due to the fact that the young age groups are more vulnerable to falls validating their stressful and ambiguous lifestyles.

Maximum case of fall from height were seen in **construction workers (38.09%)** followed by those involved in **painting** as their profession (**27.38%**) and **house wife (10.71%)**. This is almost similar to the studies conducted by Roopak SN, SR Jagannatha and Jagannatha SR, Pradeep Kumar MV, Naveen Kumar et al and Lalwani S, Agnihotri AK, Talreja et al<sup>2,3</sup>. This could be due to lack of education, poor working skill's, worker's qualities like careless attitude, misjudgement and over confidence in doing the unusual work, lack of safety measures employed could be the reason causing fatal injuries. Chronic work pressure/ burnout, poor sleep deprivation, work depression due to increased workloads, rigorous physical activities and working at heights for long intervals causing over exertion are few other predisposing factors for fatigue causing fatal injuries.

Maximum cases of fall from height was seen in **low socio economic status (73.80%)** followed by **middle socio economic status (20.23%)**. This is similar to the studies conducted by the studies conducted by Lewis WS, Lee AB, Grantham SA and Mathis RD, Levine SH, Phifer.S<sup>4</sup>. This could be the reason that most of the people were daily wages and has to go to any type of work with risks involved for their livelihood.

Maximum cases of death due to fall from height were **married (73.80%)**. This type of study based on marital status were not done however this was done in my study because there was a case of suicide by a men after marriage because of extramarital affairs and he has chosen fall from height to commit suicide. In students, the reasons could be due to high amount of stress they are subjected to in their lives either due to personal affairs, poor academic performance, low self esteem and negative peers. The decreased incidence of falls among professionals can

be due to secure employment and the awareness and the privileges of the rights to live. In toddlers, evolving developmental stage, innate curiosity of their surroundings, inadequate supervision, and improper safety measures employed could be the reason behind their death. In senior citizens, ageing leading to variations in physical, sensory and cognitive functions, prevailing health issues, loneliness, depression, family pressure, and general debility could be the reasons behind their deaths.

Maximum cases of fall from height were seen with a distance **below 20 feet** which constitutes **(40.47%)** of the cases followed by **21-40 feet (27.38%)** and **41-60 feet (20.23%)**. This is similar to the studies conducted by Naveen Kumar T, Jagannaha S.R, V.T Venkatesha.<sup>3</sup> This indicates that most of the deaths due to fall from height were below 20 feet which can be prevented if proper safety measures were implemented during their profession.

The impact surface was maximum with fall **over a hard surface (46.42%)** followed by **fall over cement (19.04%)** and **fall over sand (16.66%)**. This is similar to the study conducted by C.R Vasudeva Murthy, S Harish, YPGirish Chandra<sup>9</sup>. The impacting surfaces, the unyielding surfaces like hard surface and tiles offered resistance and energy during impact caused grave injuries during impact, despite resistance being offered by the victims as a protective mechanism, head is still the most vulnerable organ to injury.

The cause of death in maximum cases was attributed to **Cranio Spinal Injuries (44.04%)** followed by **head injury (25%)** and **blunt injury to abdomen (11.90%)**. This is similar to the study conducted by Bharat Kumar Guntheti, Uday Pal Singh<sup>12</sup>. Head and spine is still the most vulnerable organ to injury due to presentation of these parts during a fall, this could be the reason behind head injury and cranio spinal injury being the most common injuries followed by blunt injury to the chest and abdomen.

The most common manner of death was **accidental in nature (80.95%)** followed by **suicidal (19.04%)** and **no cases of homicide** was reported. This is similar to all studies conducted by Roopak SN, SR Jagannatha and Jagannatha SR, Pradeep Kumar MV, Naveen Kumar et al and Lalwani S, Agnihotri AK, Talreja et al.<sup>3,7</sup> It is very difficult to differentiate a case of homicide in fall from height unless there are any transportation injuries, CCTV Footage which may give a clue on it.

## CONCLUSION

Deaths due to fall from height is on the rise. Most of the deaths due to fall from heights could be averted by using protective equipment's, personal fall arrest systems, on-site precautionary measures, short safety training courses for the workers, adequate rest among workers, to employ ergonomics to derive a holistic approach to deal with risks involved from fall from height. Psychological counselling for students and elders and safety measures and strict supervision among toddlers would be few other mechanisms to avert fall from heights. This approach could reduce the morbidity and mortality of deaths due to fall from heights and decrease the burden on the health care system.

## RECOMMENDATIONS

Stringent action should be taken by the government against the companies / work place areas where they are not following standard operating procedures pertained to life safety and organizations / companies which fail to provide proper protective covers during work.

An awareness demo can be given by an individual about the risk involved in the appropriate professions with do's and don'ts prior to commencement of work which can reduce accidental deaths of fall from height.

Climatic situation also plays a vital role like working during rainy seasons over a slippery area where there are higher chances of accidents can be prevented by using appropriate preventive measures at that material time.

**REFERENCES**

1. Rajesh Bardale Principles of Forensic Medicine & Toxicology, Jaypee Brothers Medical Publishers (P) Limited. First Edition 2011.
2. Naveen Kumar T, Jagannatha S.R, V.T.Venkatesha "Rise in Deaths Due to Fall from Height" A 3 year Retrospective Study, Medicolegal update July – December 2019, Volume 19. NO 2. Page No: 113-116
3. Roopak SN, SR Jagannatha."Deaths due to fall from Height"-A Autopsy Study. IJFMT. Jan-June 2015; 9(1): 123-125.
4. Lewis WS, Lee AB, Grantham SA. "Jumpers syndrome": The trauma of high free fall as seen at Harlem hospital. The Journal of Trauma. 1965; 5(6):812-818
5. Mathis RD, Levine SH, Phifer S. An analysis of accidental free falls from a height: The "spring break" syndrome. The Journal of Trauma. 1993; 34(1):123-126
6. Steedman DJ. Severity of free-fall injury. Injury. 1989;20:259-261
7. JagannathaSR, Pradeep Kumar MV, Naveen Kumar T, Ananda K, VenkateshaVT. Injuries due to fall from Height-A Retrospective Study. Journal of Forensic medicine & Toxicology. Jan-June 2010; 27(1): 47-50.
8. VT Venkatesh, MV Pradeepkumar, SR Jagannatha, RH Radhika, K Pushpalatha. Pattern of Skeletal injuries in cases of fall from a height. Med.Sci. Law.2007; 47(4): 330-334.
9. C.R Vasudeva Murthy, S Harish, YP GirishChandra. The Study of Pattern of Injuries in Fatal Cases of fall from Height. AlAmeen J Med Sci.2012; 5(1): 45-52.
10. J.V.KiranKumar, A K Srivastava. Pattern of Injuries in fall from height. JIAFM. Jan-March 2013; 35(1): 47-50.
11. V.Prathapan and B.Umadethan. Fall from Heights-Pattern of injuries. International journal of Biomedical Research.2015; 6(01): 8-13.
12. Bharath Kumar Guntheti, Uday Pal Singh. A Study of pattern of Injuries in fall from Height. Journal of Karnataka Medico legal society .Jan-Jun 2016; 25(1): 26-34.
13. Lalwani S, Agnihotri AK, Talreja, murthy OP. Pattern of injuries in fatal falls from height. .A retrospective review. Journal of forensic Medicine and Toxicology 1999; 16(2):38-46.
14. Demetriades D, Murray J, Brown C, et al. High-level falls: Type and severity of injuries and survival outcome according to age. The Journal of Trauma. 2005;58:342-345
15. Guyomarc'h P, Campagna-Vaillancourt M, Chaltchi A, Sauvageau A. Skull fracture with brain expulsion in a one-level jumping-fall. Journal of Forensic Sciences. 2009;54(6):1463-1465
16. Dickinson A, Roberts M, Kumar A, Weaver A, Lockey DJ. Falls from height: Injury and mortality. Journal of the Royal Army Medical Corps. 2012;158(2):123-127.