

## SUICIDAL INJURIES FROM HEIGHT FALLS

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### Abstract

According to the manner of death, falls from height can be accidental, homicidal and predominantly suicidal.

The type of injuries in suicidal falls from height depend to a large extent on the height of the fall, the part of the body that landed and suffered the first impact, the age and the body weight of the victim, clothes worn and body composition.

Although with prospect, the research is an average study of the Institute for Forensic Medicine in Skopje, conducted on 80 victims of fatal falls from different heights, through forensic-medical autopsy.

The data for all examined cases have been taken from the forensic-medical autopsy reports.

The study analyses the cases which appear to be suicides, according to the manner of death. The injuries inflicted from the falls are analysed according to the height in three groups: small height up to 7 meters, middle height from 7 to 10 meters and big heights above 20 meters.

Study results have shown that 25% of the analysed cases are suicides.

The analysis of the number and severity of the injuries in relation to the height of the fall prove that the fractures of the hipbone and legs were most frequent injuries found in the victims who have fallen from 7 to 20 meters.

In the victims of height falls up to 7 meters, most frequent injuries were the fractures of the ribs and the spine. In falls from height above 20 meters, all organs were equally damaged.

In suicides from falls from height, most frequent injuries of the skeleton were fractures of the ribs and spine, while the liver was the most affected organ among the internal organs.

However, the type of injuries determined with the autopsy is not a sufficient indicator for successful assessment of the manner of death in fatal falls from height.

**Key words:** fall from height, type of injury, suicide.

### Introduction

The basic medical and legal question in fall from height is the manner of death. The determination about the manner of death cannot always be simple, as the signs characteristic for homicide, such as neck injuries or limb injuries inflicted as a result of a defense, can also be found as a consequence of an accidental fall from height, but also in suicides. In these cases, it is necessary that the conclusions are brought not only on the basis of the autopsy findings, but also on the basis of as many as possible additional information.

Thorough examination of the place of the incident and toxicological analysis, as well as insight into the social and medical history of the victim is necessary [1-7].

A suicide is a conscious and purposeful taking of own's life [8]. For a person to commit a suicide there must be a suicidal predisposition and motive.

Suicidal predisposition is a cognitive lack of strive for living or increased psychological reaction of external and internal stimulus. Suicidal motive is the problem that forces the person to commit a suicide at a certain point of time.

These motives can be endogenous, such as somatic diseases (cancer or auto-immune diseases) or psychological and mental states (alcoholism, melancholy).

There can be numerous suicidal stimuluses, which boost the motive, but also conditions which ease the suicidal decision, such as puberty, menstrual cycle, climax and senility, in some authors also deficiency of drugs in drug addicts [8].

**The aim** of this study is to present the most frequent type of injuries which occur in suicidal falls from height.

### **Material and methods**

This is a retrospective study (cross-sectional study) carried out at the Institute for Forensic Medicine and Criminalistics in Skopje in 80 victims, casualties of falls from different heights, subjects of forensic-medical autopsy.

The selection of the victims was done in accordance with inclusive and exclusive criteria.

The analysis involved cases of falls from height (accidental or deliberate) in which the fall resulted with death, cases which demanded forensic-medical autopsy and have been determined that the cause of death was fall from height, victims for whom forensic-medical autopsy was requested, cases with victims of fall from height with diagnosed depression, bi-polar disorder, schizophrenia, etc, as well as cases with previously diagnosed malignant diseases of the internal organs.

The study involved victims who have been crushed (compressed) by a heavy object during the fall or right after (tree trunk, construction material, a machine, etc), victims of airplane accidents and victims of helicopter accidents. The data for all these cases have been taken from the forensic-medical autopsy reports.

The study analysed data related to the gender, age, body height, internal and external injuries, presence of alcohol and toxic substances in the bloodstream, as well as conclusions about the cause of death and information from the investigation which has concluded the manner of death (homicide, suicide or an accident).

In cases which have been determined to be suicides, the most frequent type of injuries was analysed. Analysis included victims of falls from 70 meter height. In the cases where the report did not include the height or the floor, for every floor 3 meters of height has been calculated. The victims were grouped according to the height of the fall:

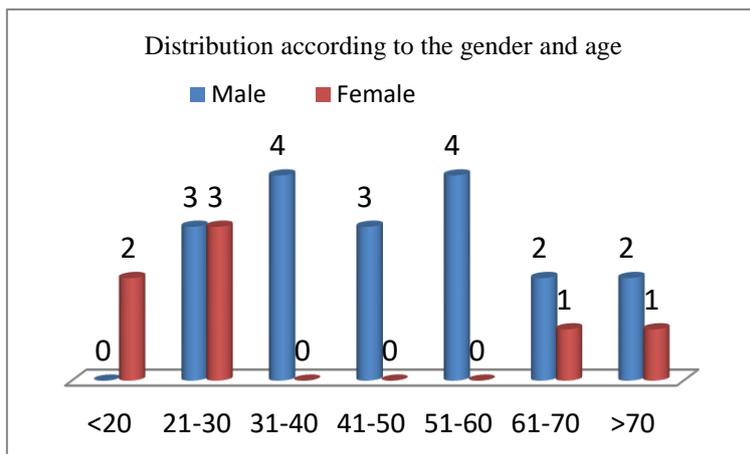
- group 1: victims of fall from height less than 7 meters (small height)
- group 2: victims of fall from 7 to 20 meters height (middle height)
- group 3: victims of fall above 20 meters (big height)

### **Results**

The results of the study shown that in the analysed 80 cases, 55 (68.5%) were an accident (accidental fall from height), while 25 (31.5%) are suicides with the following distribution:

- 4 victims of fall from less than 7 meters height (small height)
- 9 victims from 7 to 20 meters height (middle height)
- 12 victims of fall above 20 meters (big height)

Eighteen of the victims were men and seven (7) women in the age between 11 and 80 years (picture 1).



**Fig.1.** Distribution according to the gender and age of the cases of suicidal falls from height

Table 1 shows the distribution of the number of injuries according to the fall.

Most frequent injuries of the skeleton were rib and spine fractures, while in the internal organs, the liver was mostly affected (Table 2, picture 1-4). Most frequent cause of death was the traumatic shock, followed by brain injuries.

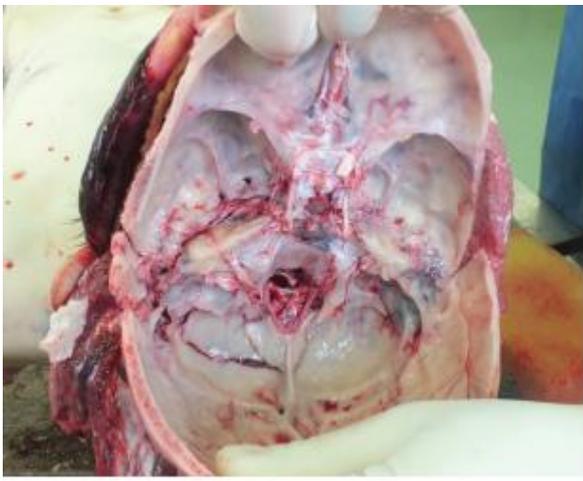
The distribution of the cases according to the presence of toxic substances is shown in picture 6. Majority of the suicides have been done in the period after midnight until 6 hrs in the morning (16 cases), a rarely from 18 hrs until midnight (5 cases). Nineteen (19) of the persons died immediately on place of the incident or in the period of 24 hours after admission in the hospital.

**Table 1.** Distribution of the number of injuries according to the height of the fall

Type of injury	Number of injuries in victims of falls below 7 m	Number of injuries in victims of falls between 7-20 m	Number of injuries in victims of falls above 20 m
Injury of brain	8	15	4
Injury of chest organs	10	27	8
Injury of stomach organs		18	8
Fracture of skull	6	9	6
Fracture of upper limbs	2	12	
Fracture of hipbone and lower limbs	8	30	4
Fracture of ribs and spine	20	30	8
Fracture of sternum, clavícula and scapula	6	21	6

**Table 2.** Distribution of victims according to the height of the fall and the type of injuries.

	Number of victims of falls below 7 m	Number of victims of falls between 7-20 m	Number of victims of falls above 20 m
<b>Bones</b>			
Fracture of skull	2	3	9
Fracture of upper limbs	2	1	11
Fracture of lower limbs	3	1	12
Fracture of ribs and spine	3	9	12
Fracture sternum, clavícula and scapula	3	5	12
Fracture of hip bones	1	7	12
<b>Organs</b>			
Brain	3	4	7
Lungs	4	6	12
Heart	0	4	12
Liver	1	6	10
Spleen	0	1	9
Kidney	0	1	5
Intestines	0	1	4



*Suicidal injuries fro.*

**Picture 3.** Round fracture of the skull basis



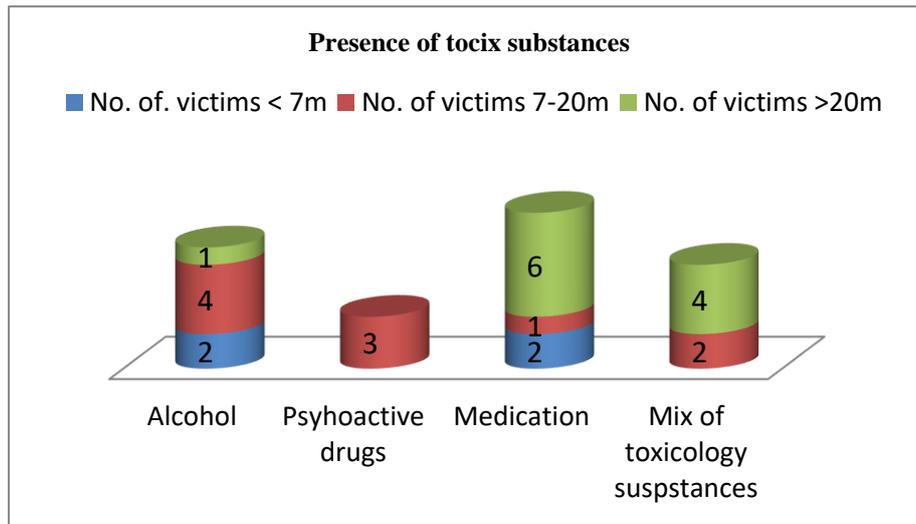
**Picture 5.** Multiple liver lacerations



**Picture 2.** Opened fracture of the fibula



**Picture 4.** Fracture of the thoracic part of the spine



**Picture 6.** Distribution of the suicidal cases of fall from height according to the presence of psychoactive substances

### Discussion

In the cases of death caused by fall from height, the forensic doctor besides the determination about the cause of death and the inflicted injuries, it is necessary to also direct the investigation towards determining of the way death occurred (manner of death) and determine whether it is a homicide, suicide or an accident.

The forensic doctor should collect all data which can be gathered individually, but also in collaboration with the prosecution, police and family of the victims. Every successful case closure requires a detailed analysis of the place of death, psychiatrically history of the victim, analysis of the type of injuries, determination of the cause of death and toxicological analysis.

Fall from height according to the manner of death can be accidents, homicides or suicides [1-7]. Compared with the other methods of suicides, suicidal falls from height are relatively rare and usually practiced by elderly [1, 6, 9].

The forensic medicine has little practical research about the determination of the manner of death according to the distribution and type of injuries.

The biggest number of analyses, cite the type and characteristics of the injuries, the infliction mechanism, cause of death, while the final conclusion about the manner of death has been left at the authority of the investigative organs – the prosecution to determine whether the respective case is a homicide, suicide or an accident, according to the collected evidence and results of the investigative measures.

Through forensic-medical analysis, the forensic pathologist may contribute to a large extent in the determination of the manner of death and case reconstruction.

In the assessment of the most important fact – is it a homicide, a suicide or an accident, the analysis and the data examination of the facts about the place of death, psychiatry history and type of injuries may give significant contribution.

The place and the ground of the fall may give crucial information about determining the manner of death and the body position before the fall. The suspicions about a suicide would be present in the cases when the falls are done from places where people do not normally go, such as: rooftops, bridges for vehicles [10- 12].

Falls from higher buildings, homes of the victims or medical (psychiatry) facilities, as well as absence of resistance fight, speak in favour of a suicide. In the cases of a suicide, there would be objects which helped the victim overcome barriers on the place of the jump, such as chair, armchair, ladder.

Suicides most commonly happen in the night hours. Compared to the other types of suicides, very rare (10-25%) there would be a suicide note [6, 11, 13].

Bigger horizontal distance between the body and the object from which the fall happened, normally indicates active suicidal jump, however sometimes people do not jump, but rather allow their body to passively fall down [1, 6, 14].

Biggest number of these victims are found death on the place of the jump. In our study, out of 80 analysed cases, 25 victims have done a suicide by jump from height. In only three there was a suicide letter.

According to the literature, ethanol is found in 15-35% in the victims of fall from height. It is equally present in suicides and accidents, while the alcohol concentration in the blood is normally higher in suicides. Increased medicaments intake and doses, especially in psychiatry cases (benzodiazepine and antidepressants) is most commonly determined in suicides, however those are usually not in lethal doses [6, 11 15].

Our study determined blood alcohol in seven (7) cases, psychoactive substances in three (3) cases, medicaments in nine (9) cases and combination of toxic substances in six (6) cases.

Information about the psychiatry diagnose such as depression, schizophrenia, personality disorders, obtained as hetero-anamnesis and during the examination of the medical documentation, increases the chances for a suicide.

Type of injuries inflicted in suicides depend to a biggest extent on the height of the fall, part of the body who landed in the first impact, age and weight of the victim, clothes worn and body composition [1,6, 16, 17, 18, 19].

Defects and thorn parts in the victim's clothes may give additional information about the fall. In falls from higher heights above 20 meters, if the primary contact with the ground were the feet, there would be longitudinal lacerations in the trousers in the inguinal area. In essence, the injuries which can be detected in the external examination are relatively a smaller number than the ones inflicted in the internal organs of the victim, determined with the autopsy of the victim's body [11, 12].

There may be old or fresh attempt wounds, which indicate previous suicidal attempts (scars from wrist cuts). Our study found the latter in three of the cases.

Many mathematical models have been done to determine the relation between the conditions in which the fall happened and the severity of the internal injuries. It has been determined that the height of the fall and the age of the victims are the crucial determinants of the severity of the internal injuries. Although the fall from a bigger height causes multiple and extensive injuries, not always can the severity of the injuries determine the height of the fall [6, 11, 15, 20, 21, 22, 23].

When the feet suffer the first impact in the fall, the trauma caused by vertical deceleration is the cause of characteristic injuries, such as: aortal laceration and ring fractures of the skull base [11, 13, 14, 24].

In our study, the fractures of the skeletal system were present in a biggest number, found in all victims. Most frequent injuries of the skeleton were rib and spine fractures, while the liver was most affected internal organ.

According to the literature, head injuries are a frequent findings in suicides from height falls and those involve subarachnoid, subdural and epidural hemorrhage, intra-cerebral hemorrhage, brain contusions, partial or full loss of brain tissue.

When the head is the part of the first impact, it is entirely expected that it will suffer the biggest damage and injuries, such as opened fractures of the skull and face bones, splattering of the brain tissue in the wide surrounding area, while the other organs are less affected, especially in falls from height less than 25 meters [6, 11, 25, 26, 27, 28].

When the feet suffer the first impact, dominating are the injuries to the brainstem (lacerations, contusion and transections), accompanied by ring fracture of the skull base.

There are divided opinions about the influence of the height on the head injuries. While some authors find that it proportional, others believe that falls from less than 10 meters height and bigger than 25 meters cause more severe head trauma, compared to falls from 10-25 meters heights [6, 11, 15].

In our study, skull fractures were found in 14 victims of falls from height from 7 to 20 meters.

In the forensic-medical autopsy of the bodies after the suicides with fall from height, concluded are injuries of the thoracic walls, the heart, big blood vessels and the lungs [11, 12, 13, 15]. In the walls of the thoracic cavity, most common are abrasions and bruises of the chest and multiple rib fractures.

In falls from heights greater than 20 meters, multiple fractures of the entire thoracic cavity, including the sternum, thoracic spine and vertebrae, are found. In falls into water, the injuries are slightly lower, but still present. Penetrating fractures of the ribs cause secondary injuries of the thoracic organs, which lead to haemothorax and/or pneumothorax [6, 15].

In our study, fractures of the ribs were found in all victims.

The frequency and intensity of the heart injuries

The frequency and intensity of the heart injuries grow with the increase of the height of the fall. Blunt heart injuries are witnesses in 54% of the cases in falls from heights, while 79% of them are multiple [10, 27].

In the biggest number of cases, there were pericardial and epicardial tears. Pericardial tears are most likely to be found in the right posterior part and can be of longitudinal orientation. Epicardial tears and hemorrhage are frequent around the ostium of the lower vena cava and are witnessed in falls from heights less than 15m. Endocardial tears are more characteristic finding in the falls from higher heights, which also frequently involve rupture of the entire heart wall.

Total and subtotal trans-mural tears are more commonly found in the right heart [6, 30]. I

n the examination of the heart septum, more frequently we witnessed tears of the inter-atrial septum than inter-ventricular septal tears. Myocardial hematoma is more frequently witnessed in the left heart [29].

In falls from much bigger heights, we witnessed tears of the coronal blood vessels, but also possible is the heart torn off from the bigger blood vessels [29].

Less often we witnessed rupture of the papillary muscles of the heart and the valves. Correlation between the fractures of the sternum and the intensity of the injury of the heart cannot be detected. Sometimes, minor changes are present that may contribute to fatal outcome.

It is important to diagnose a possible contusion in the survived, for which use of troponin I is recommended [30,31].

Rupture of the thoracic aorta is most frequent in the injuries of the thoracic blood vessels, commonly followed by mediastinal bleeding.

The rupture edges are smooth, which appear, as sharp transection and sometimes can be multiple. The frequency of aortic rupture increases with greater falling heights. Pulmonary artery and venous ruptures are seen less frequent [11, 13, 15, 20].

In our series, heart injuries were a present findings in all victims after the fall from height above 20 meters (12 cases) and the most affected where the right atrium and the aortal arc.

Minor or major contusions of the lungs can be found in almost all fatal falls from height, with severity increasing with greater falling distance. In greater falling heights, complete pulmonary ruptures or hilus ruptures can be detected. Very often, additional injuries caused by penetrating rib fractures were witnessed [11, 15]. I

n our study, hiluses ruptures are found in 10 cases, which is due to the deceleration force during the impact on the ground, tears of the lobes was found in 12 cases, as a result of the penetration of the fractured rib fragments.

Liver rupture was most frequent finding in the abdominal injuries (17 cases of our study), which matches with the published data, reporting 52-68% in the cases of falls from height. The right lobe is damaged more often.

Tears are often irregular in their nature, but relatively parallel in their orientation. In fall from greater heights, there can be a complete disruption of the liver, vascular avulsion and hilar rupture. Findings also show that even in the most extensive ruptures, the accompanied abdominal bleeding is minimal due to the rapid death [11, 15].

Spleen rupture is a common finding in falls from height and often they are multiple [6, 15]. In our study, spleen rupture was found in 10 cases, of which six (6) were multiple and found mainly in the lower part of the spleen.

In the retroperitoneal space, most common finding is the rupture of the abdominal aorta, which is less frequent than the rupture of the thoracic aorta.

According to some authors, retroperitoneal bleeding is rare (6), while according to others, it is relatively often [6].

Adrenal, renal and renal hilus ruptures are commonly found. Renal injuries can be extensive and influence the fatal outcome.

Correlation between the renal damage and the height of the fall is not determined, while there is a correlation between the part of the body which takes the first impact. The most severe injuries are found in victims falling and laying on the sides. In our study, renal rupture was found in six (6) cases and those ruptures were around the hilus.

### **Cause of death**

Most of the victims of falls from heights die at the scene of the fall, immediately or after couple of minutes [6].

The survived most often die during the reanimation attempts at the intensive care units, short after the admission, where only a small number survive from four hours to couple of days [6, 11].

The cause of immediate death is most commonly poly-trauma, accompanied by head injuries and internal bleeding. In the victims who have managed to survive from four hours to couple of days, the most common cause of death is head trauma [11].

After couple of days, the most common cause of death is also the pulmonary embolism and systemic failure of the internal organs caused by sepsis. In falls in water, the most common cause of death is drowning [12, 13].

In our study, 19 persons died immediately at the scene of the fall or in the period of 24 hours after being admitted in the hospital.

The common cause of death was the traumatic shock, followed by brain injuries.

### **Conclusion**

Our findings show that the biggest percent of the falls from height can be as a result of an accident. However, the type of injuries determined in the autopsy is not sufficient for successful assessment of the manner of death in the fatal falls from height. In the suicidal falls from height, most frequent injuries of the skeleton were those on the ribs and spine, while the liver suffered the most out of the internal organs.

Most common cause of death was traumatic shock, followed by brain injuries. Most of the victims have passed away on the place of the fall or in the period of 24 hours after the hospital admission.

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