

# Pathologic Features of Fatal Falls From Height

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**Abstract:** Deaths due to falls from height are common in urban settings. At the time the body is found, it is often unclear whether the mode of death is accident, suicide, or homicide. To assess the injury pattern in fatal falls from height with special regard to criteria that might be helpful in discrimination between accident, suicide, and homicide, respectively, we reviewed 68 medicolegal autopsy cases (22 females, 46 males, age range 13–89 years) of fatal falls from height regarding demographic data, findings at the death scene, results of the postmortem examination, psychiatric history, and toxicologic findings. Among the 68 cases, there were 34 suicides, 23 accidents, and 11 unclarified cases, in 3 of which homicide was suspected. In general, suicides were from greater heights than accidents (mean height 22.7 m for suicides and 10.8 m for accidents, respectively; 79% of suicides from more than 16 m). Strikingly, severe head injuries predominantly occurred in falls from heights below 10 m (84%) and above 25 m (90%), whereas in the group of falls from 10 to 25 m, these lesions were seen less frequently (28%). Neck injuries like muscle bleeds and fractures of the hyoid bone were found in 33% of falls from more than 10 m and did not occur from less than 10 m. Our data stress that the evaluation of pathologic features alone is not sufficient to assess the mode of death in fatal falls from height. Instead, postmortem findings have to be considered within the framework of the subject's social, medical, and psychiatric history in conjunction with findings at the death scene and toxicology results to obtain the clearest possible picture of the circumstances of death.

**Key Words:** fall from height, mode of death, forensic pathology

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Deaths due to blunt trauma as a sequel of falls from heights are a common phenomenon especially occurring in urban settings. A fatal fall from height can result from accident, suicide, or homicide. In particular cases, the mode of death is unclear at the time the body is found, and the

presence of multiple blunt force injuries makes it hard to differentiate between fall-induced injuries and those that have been inflicted before the fall.

The focus of this study was on pathologic features of fatal falls from height, as well as their limits for the elucidation of the mode of death (suicide, accident, and homicide, respectively) on the basis of 68 medicolegal autopsy cases of falls from height.

## MATERIALS AND METHODS

The forensic pathology files from 1997 to 2001 at the Institute of Legal Medicine, University of Hamburg, Germany, were reviewed for fatalities due to falls from height. Falls from standing height and from stairs were not included. Individual cases were analyzed as to the gender, age, race, scene findings with special reference to building height, survival time, findings at external examination, autopsy results, outcome of toxicology, psychiatric history, and circumstances at the death scene. In addition, information from official reports and police files was evaluated when available. The height was estimated by the number of stories assuming an average height of 3 m per story.

In each case, a blood sample from the femoral vein obtained at autopsy was toxicologically analyzed for alcohol concentration using gas chromatography and enzymatic (alcohol dehydrogenase-specific) assays. Toxicology for drugs was performed in all cases with a known or suspected history of drug use, in cases where a psychiatric history was known or could not be excluded, and in cases where no data concerning the social or medical history could be obtained. Toxicologic analysis was performed on specimens of cardiac blood, urine, liver tissue, and stomach content using a full complement of analytical methods such as high-pressure liquid chromatography and gas chromatography with mass spectrometry.

## RESULTS

Sixty-eight deaths due to falls from height occurred in the 6-year period. They comprised 1.1% of the 6039 autopsies that were performed during that time. Among the 68 cases, there were 34 suicides (50%), 23 accidents (34%), and 11 unclarified cases (16%) where the mode of death could not

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be definitely determined and in 3 of which homicide was suspected. All deceased were Caucasian.

### Age and Gender Distribution

The age range was from 13 to 89 years (13 to 89 for suicides, 22 to 88 for accidents). In accidents, there were almost exclusively male victims (91%). In contrast, gender was nearly equally distributed in suicides (56% males, 44% females). For men, the mode of death was accident in 21 cases (43%), suicide in 19 cases (39%) and unclarified in 9 cases (18%; 2 of which were suspected homicides). For women, there were 15 suicides (79%), 2 accidents (10.5%) and 2 unclarified cases (10.5%; 1 suspected homicide). A summary of the age and gender distribution is given in Table 1.

### Scene Findings

The building heights ranged from 3 (1 story) to 57 m (19 stories) for buildings. For bridges and building sites, the height range was from 3 to 30 m. In suicides, greater heights were clearly preferred (79% >16 m). For the accidents, the heights were more randomly distributed (Table 1).

The falling site was the deceased's home in 23 (68%) of the suicides and in 5 (22%) of the accidents. Sixteen accidents (70%) occurred at building/construction sites, whereas none of the suicides happened at building sites. Six suicidals jumped off bridges (18%). In contrast, none of the accidents were from bridges. Of the suicides, 4 (12%) were from the window of a psychiatric ward. One of the accidents occurred

at a geriatric ward. All 3 suspected homicides occurred at the deceased's home.

Suicide notes were found at the death scene in 3 of the suicides. A summary of the scene findings is given in Table 1.

### External Examination

At external examination, hematoma and abrasions of the extremities were seen in all cases. In 17 cases (25%), palmar skin tears, together with open wrist fractures, were present. Plantar injuries with open fractures of the ankle joint or calcaneus were seen in 8 cases (12%). Tears due to stretching of the loin region, involving clothing (Fig. 1), were only seen in 3 cases (4%). Despite regularly situated clothing, abrasions of the trunk were present in 32 cases (47%). These were always confined to 1 surface plane of the body. Minor head injuries like abrasions or hematoma were present in 27 cases (40%). Sparse postmortem lividity as a sign of major blood loss was present in 30 cases (44%). Scars of the wrists according to hesitation marks as a sign of previous suicide attempts were found in 5 of the suicides (15%), in 1 accident and in 2 of the suspected homicides. Fresh hesitation marks were seen in 3 suicides. Fresh grab marks at the inner surface of the upper arms were detected in 2 of the suspected homicides but in none of the accidents or suicides. Four of the female suicidals were having their menstruation at the time of death.

**TABLE 1.** Findings at the Death Scene Observed in Cases of Fatal Falls From Height

	Suicide	Accident
Total number	34	23
Men:women	19:15	21:2
Height, m		
0-5	—	n = 4
6-10	n = 3	n = 11
11-15	n = 4	n = 1
16-20	n = 6	n = 2
21-25	n = 9	—
>25	n = 9	n = 3
Unknown	n = 3	n = 2
Site of fall		
Home/roof	n = 1	—
Home/window or balcony	n = 22	n = 5
Work/construction site	—	n = 16
Bridge	n = 6	—
Psychiatry/hospital	n = 4	n = 1
Other	n = 1	n = 1
Suicide note found at the death scene	n = 3	—



**FIGURE 1.** Inguinal longitudinal clothing tears indicating feet-first impact.

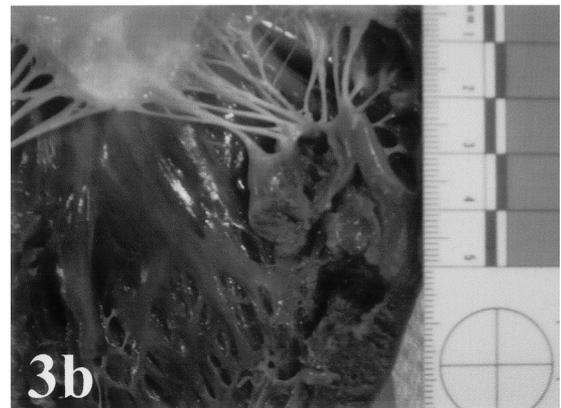
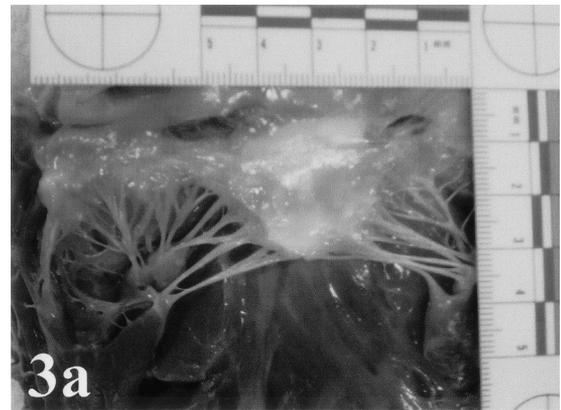
**Autopsy Findings**

At autopsy, severe injuries of the head like multiple skull fractures, ruptures of brain structures, and severe intracranial bleeding were seen in 34 cases (50%). A ring fracture of the skull basis (Fig. 2) was seen in one case. Strikingly, these injuries predominantly occurred in falls from heights below 10 m (84%) and above 25 m (90%), whereas in the group of falls from 10 to 25 m, these lesions were seen less frequently (28%). Severe injuries of the internal organs included ruptures of the aorta and other large vessels, cardiac ruptures (Fig. 3a, b), liver (Fig. 4) and spleen ruptures, ruptures in the intestinal root and lung injuries such as contusions, bronchus ruptures, and penetrating rib fractures. Aortic ruptures were seen in 10 cases (15%), 8 of which occurred in falls from above 10 m (80%). Eighty percent of these ruptures were localized in the descending aorta in the isthmus area (Fig. 3a, b). In one case, the aorta was ruptured near the heart basis. In one case, the aorta was ruptured at the isthmus and also directly underneath the diaphragm. Cardiac ruptures were present in 36% of falls from above 10 m. Liver and spleen (Fig. 4) ruptures were present in 52% and 55% of falls from above 10 m, respectively. Intestinal root ruptures were found in 24% of all falls from above 10 m. Lung injuries, mostly penetrating rib fractures and lung contusions, were seen in 62% of all cases. Blood aspiration with compensatory acute pulmonary emphysema was seen in 50% of all cases and showed no preference for specific heights. Neck injuries like muscle bleeds and fractures of the hyoid bone were found in 33% of falls from more than 10 m and did not occur in falls from less than 10 m.

Seventy-eight percent of all fatalities showed rib fractures, 36 of which were multiple. Pelvic fractures were observed in 67% above 10 m and only in 12% below 10 m. Fractures of the extremities were present in 59% of all cases. Thirty-three percent of these were open fractures, all of which occurred in falls from more than 10 m.



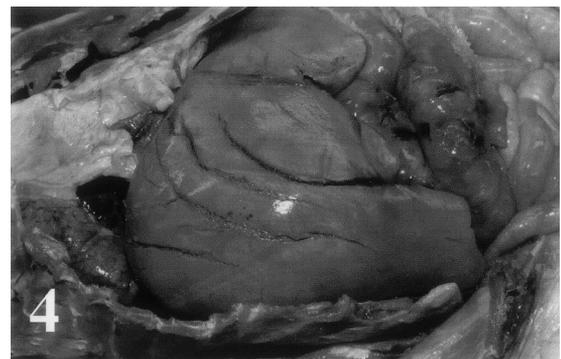
**FIGURE 2.** Ring fracture of the skull in a witnessed case of feet-first impact.



**FIGURE 3.** Ruptures of the mitral valve (a) and posterior papillary muscle (b).

**Cause of Death, Survival Time**

The cause of instant death was head trauma in 24 (35%), internal blood loss in 9 (13%), and polytrauma in 30 (44%) cases. Other causes of death, where the individuals survived the trauma for a longer period, included septic multiple organ dysfunction syndrome and pulmonary embolism (Table 2). Head trauma was the cause of death in 11 of



**FIGURE 4.** Parallel longitudinal ruptures on the surface of the right and left lobe of the liver.

**TABLE 2.** Number of Fatalities in Relation to Survival Time and Cause of Death

Cause of Death	Survival Time		
	Seconds to Minutes	Hours	Days
Head trauma	n = 15	n = 4	n = 4
Polytrauma	n = 29	n = 1	—
Blood loss	n = 7	n = 2	—
Septic MODS	—	—	n = 3
Pulmonary embolism	—	—	n = 2
Other	—	n = 1	—

MODS indicates multiple organ dysfunction syndrome.

the 19 cases that were from 9 m or less (58%). In contrast, head trauma was the cause of death in only 8 of the 33 cases that were from heights between 10 and 25 m (24%; Table 3). In this group, polytrauma was the main cause of death (72%). Of all cases, 51 (75%) died within a few minutes. A survival time of several hours up to 1 day was observed in 8 cases. Nine patients survived for several days (up to 16 days). Five of these fell from heights below 10 m.

**Psychiatric History**

A history of psychiatric illness including substance abuse was present in 47% of the suicides, in 9% of the accidents, and in 9% of the unclarified deaths. Psychiatric illnesses included depressions alone (4 in suicides, 1 in accidents), substance abuse alone (6 in suicides), depressions and substance abuse in combination (5 in suicides, 1 in accidents, 1 unclarified), and schizophrenia (1 suicide).

**Toxicology**

Ethanol was detected in 18% of the suicides and in 17% of the accidents. Blood alcohol concentrations ranged from 6 to 274 mg/dL for suicides and from 120 to 268 mg/dL for accidents. Illicit drugs (morphine, cocaine) were detected in 21% of suicides and in 9% of accidents. Psychiatric medications were detected in only 6% of suicides.

**The Suspected Homicides**

In one case of suspected homicide, a witness stated that he had seen the deceased’s husband pushing her out of the window after an argument. Autopsy revealed blunt force injuries of different age and fresh grab marks at the inner surface of the upper arms. In another case, the deceased had been held out of the window on his arms before falling down. It remained unclear if someone has intentionally held him out or if someone tried to save him from committing suicide. At autopsy, wrist scars according to hesitation marks were present in this case. In the third case, the deceased was not identified when the autopsy took place. There were no witness statements. At autopsy, signs of blunt force that could not easily be explained by a fall from height were seen, thus raising the suspicion of homicide.

**DISCUSSION**

There are many findings at the death scene that can be helpful to differentiate between the different modes of death. The easiest way to underline the suspicion that the mode is suicide is if a suicide note is found at the jumping site. This is, however, closer to being the exception than the rule. In the present study, suicide notes were only found in 3 of the suicides (9%). This is less than reported in other studies of falls from height.<sup>1,2</sup> Thus, other findings at the scene have to be taken into consideration. It has been suggested that the barrier preventing an accidental fall should be carefully documented. If this barrier is higher than the person’s center of gravity, this will make an accident unlikely.<sup>1</sup> In some cases, a chair or a ladder might have been employed by the suicidal to get over the barrier, strongly hinting at a suicidal fall.

Sixty-eight percent of the suicidal jumps were from the suicidal’s home window or balcony, whereas very few accidents were, an observation that is in line with the findings of previous studies.<sup>1</sup> In case of an accident at home, scene findings may include tools indicating that the person has been working in a dangerous position (ie, cleaning a window). None of the suicides happened at the person’s working place. In contrast, most of the accidents were from working places,

**TABLE 3.** Number of Fatalities in Relation to Cause of Death and Falling Height

Falling Height, m	Cause of Death					
	Head Trauma	Polytrauma	Blood Loss	Septic MODS	Pulmonary Embolism	Other
0–9 (n = 19)	n = 11	n = 5	n = 1	n = 1	n = 1	—
10–25 (n = 33)	n = 8	n = 17	n = 5	n = 2	—	n = 1
>25 (n = 11)	n = 2	n = 7	n = 2	—	—	—
Unknown (n = 5)	n = 2	n = 1	n = 1	—	n = 1	—

MODS indicates multiple organ dysfunction syndrome.

predominantly construction sites. Accordingly, most accidents happened during the day in the “working hours,” whereas most suicides happened in the evenings or at night. Six of the suicides investigated in the present study were from bridges. Two persons jumped off a bridge where no pedestrians were allowed, suggesting a suicidal intention. In general, suicides were from greater heights than accidents (mean height 22.7 m for suicides and 10.8 m for accidents, respectively). There were no suicides from less than 5 m. This is in agreement with the finding of a previous study.<sup>1</sup> As there is a correlation between falling height and survival time, a greater jumping height means that a higher number of suicides will be dead at the time when they are found.

It has been suggested to use the distance of the dead body from the falling site as a helpful tool to differentiate if someone jumped from a building or just fell down since in suicides the distance between the body and the building wall is assumed to be frequently greater than the one in accidents.<sup>3</sup> In the present study, these data were not available in all cases and, therefore, we are unable to comment on this parameter. We believe that the usefulness of these data is very limited in many cases. This is to say that if someone jumps off a building, it does not necessarily mean he has a suicidal intention. In the present study, one person with substance abuse jumped out of the window after consumption of different kinds of drugs. This death was termed “unclarified” as a clear suicidal intention could not be made out and it could not be excluded that the person just thought he could fly because of the drug effect. In another case, a man jumped out of the window because of a fire in his flat. This was classified as an accident as there was no suicidal intention. In addition, the position of the body is often changed by members of the rescue team without the original position being documented.

In agreement with others, we found blunt injuries as a sequel of a fall basically confined to 1 surface plane of the body, a phenomenon that has been termed “planar impacts” and results from a single impact on a flat surface.<sup>1</sup> Pathognomonic injuries seen at external examination include open fractures of the soles of the feet and inguinal lacerations of skin and clothing.<sup>1,2,4</sup> In the present study, some injuries were found even more frequently and can be regarded as typical pathologic features in falls from height. Such findings include open comminuted fractures of the wrists and knees. Overall, the injuries seen at external examination were relatively mild compared with the multiple severe internal injuries, a phenomenon that has especially been observed in fatal falls into water.<sup>5,6</sup>

At autopsy, classic findings in falls from height include aortic lacerations and vertebral compression fractures, as well as ring fractures of the skull base.<sup>2,4,7,8</sup> The latter was found in one of the cases investigated here. The others were found frequently and preferably occurred in heights above 10 m. Some attempts have been made to correlate the injury pattern

and findings at the death scene,<sup>9,10</sup> but the injury pattern is influenced by many factors such as body weight, clothing, ground composition, and landing position, making it nearly impossible to reconstruct the circumstances of death based on the injury pattern alone. Still, some special points should be stressed here. Rib fractures were present in almost all cases, but there was an increasing number of multiple fractures with increasing falling heights, and, accordingly, the number and severity of lung injuries increased in greater heights. Likewise, pelvic fractures, as well as ruptures of internal organs, were more frequent and more severe in falls from greater heights.

Most strikingly, a different pattern of incidence was observed for head injuries. Severe head injuries most frequently occurred in falls from heights below 10 m and above 25 m, whereas in the group that fell from 10 to 25 m, few head injuries were seen and they rarely were the cause of death. This finding might indicate that the falling position is changing during a fall, and the landing position is often head first in lower heights. Interestingly, in heights below 25 m, we found that if severe head injuries were present, there were only few injuries of other organs and vice versa, indicating that the part of the body that hits the ground first gets severely injured and cushions most of the impact. This is, however, not true for extremely great heights as the impact is probably big enough to inflict severe injuries upon the whole body. The shortest survival times were observed for subjects where polytrauma was the cause of death (Table 2).

As to the question if someone fell or jumped over by himself or has been pushed over by another person, in falls from heights some findings usually proposing infliction by another person can be quite misleading. For example, in falls from above 10 m, neck injuries like hematoma of the ventral neck muscles and fractures of the hyoid bone and the upper horn of the thyroid cartilage were seen in 33% of the cases. This finding is usually strongly indicative of strangulation and should direct the forensic pathologist’s thoughts into the homicide direction,<sup>11</sup> but our results suggest that in cases of falls from great heights, this interpretation should be taken with considerable caution. Hematoma of the inner surface of the upper arm according to grab marks was not found in any of the suicides or accidents and should therefore always raise the suspicion of infliction by another person.

Severe internal disease as an explanation for an accidental fall was not found in any of the cases investigated.

Expectedly, a history of psychiatric illness, especially depression and/or substance abuse, was present in nearly half of the suicides. This is in agreement with the findings of others.<sup>1,12,13</sup> Thus, it is justified to think of suicide when a known history of psychiatric illness is present. In the present study, illicit drugs or psychiatric medications were found in 9 of the suicidal deaths (26%). It is important to consider an acute episode of the psychiatric illness as a differential

diagnosis in such cases. Old hesitation marks as signs of possible earlier suicide attempts were present in 5 of the suicides. However, scars of hesitation marks were also seen in 1 accident and 2 suspected homicides in the present series.

Although in fatal falls from height the main question addressed to the forensic pathologist by the police is whether the mode of death is accident, suicide, or homicide, a reconstruction of the events preceding death is impossible based solely on pathologic features. A clearer picture can only be obtained on the basis of the individual characteristics of the case under question. When establishing the mode of death, it is essential for the pathologist to reconsider autopsy findings within the framework of the subject's individual factors, outcome of toxicology, and circumstances at the death scene.

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