

CASE STUDY OF A FATAL FALL FROM STAIRS: CAN WE DETERMINE THE FALLING PATTERNS OF A FATAL FALL FROM STAIRS?

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Taking one fatal case of an aged female who died due to falling down the stairs at home, the cause of that fatal fall was investigated. In this case one witness, who was with the victim, when the fatal accident occurred, reported that the aged female had misfooted, lost her balance at the top of this stairs, and fell from the upper floor to a lower floor. The cause of a fatal fall from stairs can sometimes be determined from injuries to the corpse and circumstantial evidence. It was problematic whether this female witness's statements were true or not. It was very difficult for forensic experts to determine the actual falling patterns from the body and circumstantial evidences. A forensic approach is presented by a safety researcher for slip, trip and falls in this paper. The fatal fall was examined using a dummy and experimental stairs with the same configurations as the dimensions of the tread rise etc. From the analysis of the experimental results, deep questions against the witness's statements arose.

Introduction

In Japan the annual number of fatal falls from stairs was 755 in 2011. The number is gradually increasing year by year mainly due to the growth of the aged population in Japan. Most fatal falls from stairs were caused at home by serious head injuries while descending stairs at home. Whenever a fatal stair-accident occurs, the duration time of falls down the stairs is usually within a few seconds. It is very difficult to find a witness who sees the entire falling process down stairs. In the case of no witness, the cause of a fatal fall can be sometimes determined from injuries on the body and circumstantial evidence. Computer simulation is sometimes adopted to determine the falling process; nevertheless, these simulated results are likely to be largely influenced by initial input parameters, and are not suitable to identify the specific cause of an actual fatal fall. Taking one fatal case of an aged female who died of severe head injuries due to a fall down the stairs at home, the cause of that fatal fall was investigated. In this case one witness, who was with the person, when the fatal accident occurred, reported that the aged female had misfooted, lost her balance at the top of this stairs, and fell from an upper floor to a lower floor. The witness explained that the fatal victim always descended the stairs backwards, because of shallow treads. It was problematic whether this witness's statements were true or not. The falls are examined using a dummy and experimental stairs with the same configurations, such as the dimensions of the tread rise etc. From the analysis of the experimental results, deep questions against the female witness's statements arose. The investigation of the falling process of the fatal fall from stairs is presented in this paper.

A fatal fall from stairs

It was reported that one female aged 79 years old fell from the top of the stairs at her home at the end of the year 2010, according to the witness's statements. But strong doubts arose from statements from the rescue crew members. They found broken debris scattered around the top of the stairs just after arrival at the victim's home. This apparently implied that some skirmish, such as pushing and shoving had occurred.

Accident stairs

The wooden stairs with width of 900mm consisted of 12 steps with a tread of 166mm and a rise of 220mm except for the top step, which had a tread of 230mm and a rise of 250mm. The incline of stairs was 53 degrees except for the top part of the stairs which was 47 degrees.

Autopsy

The victim died in two days after the fall. According to results of the autopsy, the back of the head and the top of the left shoulder were fractured. A clear ellipse-shaped impact mark could be seen on the back of the head, and rib bones were broken on both the frontal and back sides. It is apparent that the head was strongly impacted on a solid flat surface. Red congestion in the upper part of the left breast and bruises at the right backward side of hips were observed. The major fatal causes of death were intracranial injuries and the fracture of the skull.

Methods

Falling patterns

Actual falling patterns were investigated using actual configurations of the stairs and the injuries to the body. Experimental stairs, a dummy and a model of a head were prepared. Various falling patterns were analyzed in case of natural fall and forensic falls. Each falling pattern was recorded by a high speed camera at the rate of 240fps (Type: Casio EX-FH25). The following four experiments were conducted:

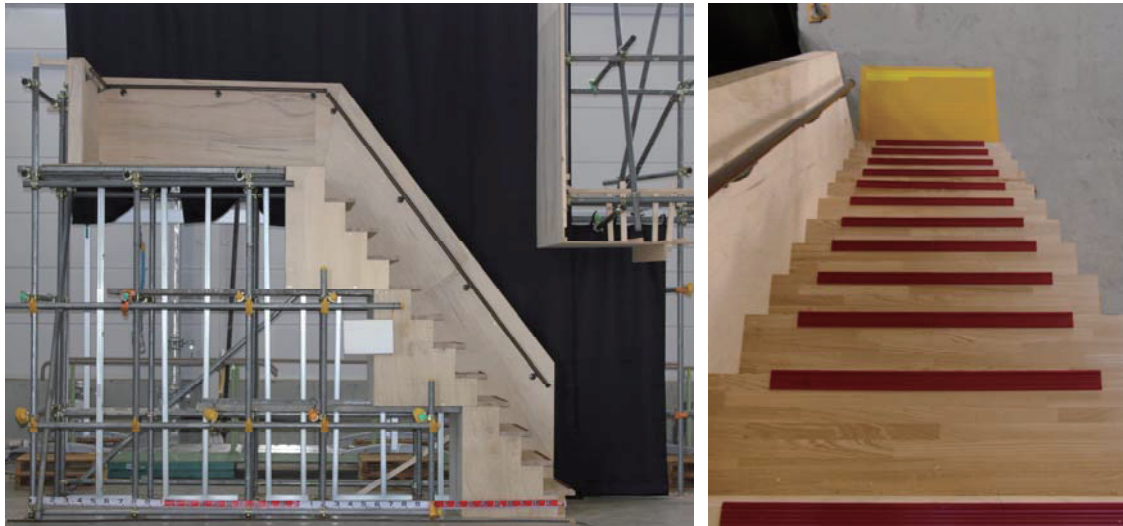
- Natural fall without external forces from the top of stairs,
- Intentional falls around the top of stairs
 - Shoving a dummy from the top of stairs,
 - Shoving a dummy while moving at the initial horizontal speed of 1.6 km/h.

Clay head

Clay head with the same configurations was made as shown in Figure 1. The head model was used to seek the impact point determining from dimensional configurations.



Figure 1. Model of a head with the same dimensional configurations



a) Side view of stairs

b) View from the top of stairs

Figure 2. Experimental stairs



Figure 3. Dummy

Stairs and dummy

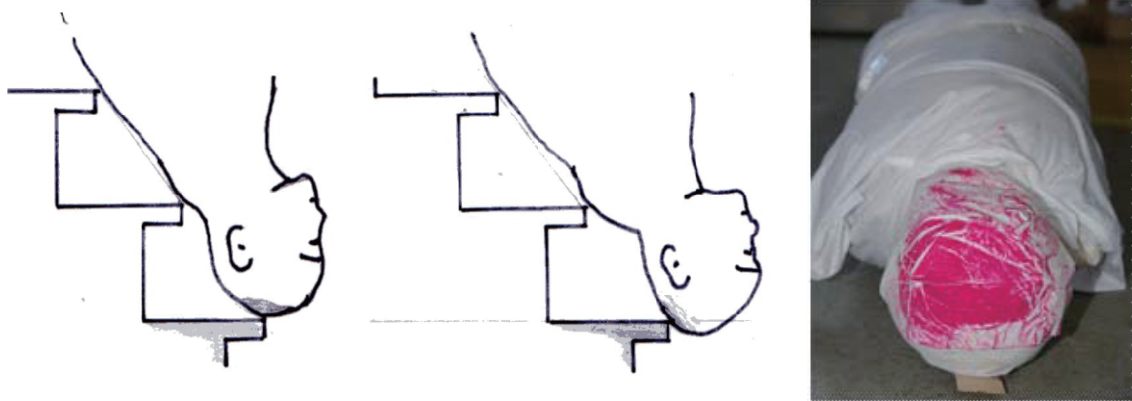
To obtain the fundamental factors as the victim of falling down the stairs, experimental stairs and a dummy with the same configurations were set up. Experimental stairs made of the wooden materials supported by steel scaffolding as shown in Figure 2.

The dummy weight was 64kg, and the height was 150cm, approximately the same dimensional configurations as shown in Figure. 3. The major structure of a dummy was steel covered with urethane. The gravity centre of each limb and whole body weight were adjusted by the insertion of lead or iron inside the dummy.

Fatal fall analysis

Analysis of external injuries

By studying the external injuries to the head, it was apparent that a fatal victim fell backwards and struck the back of her head on the flat surface. Utilizing a clay model of a head to the step, and impact measurements by pressure sensitive paper, external injuries on the back of head were not impacted on the step, but on the flat surface like the lower landing. Strong impact was observed at top of head as shown in Figure 4(b).

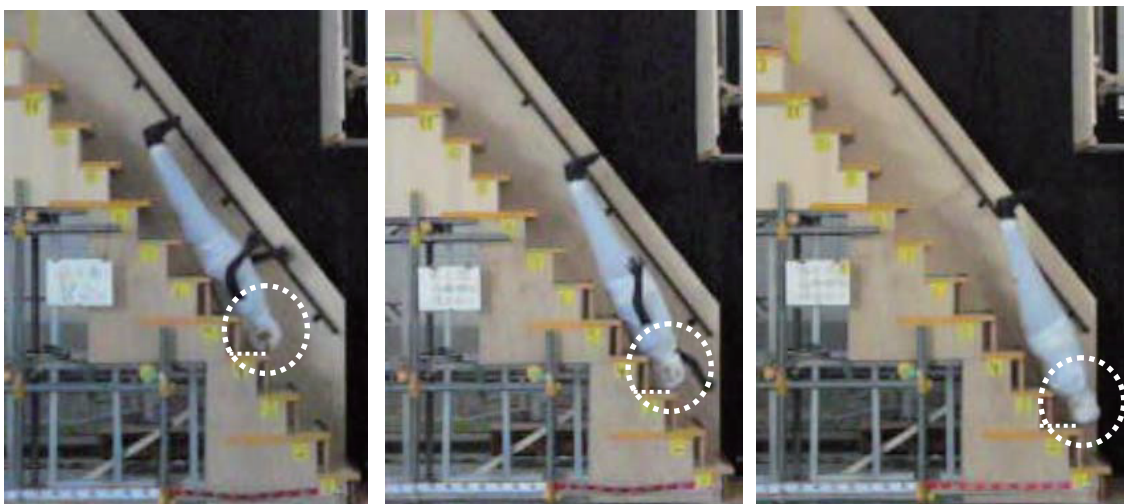


a) Predicted external injuries of a head b) Impact pressure on the dummy's head

Figure 4. Predicted external injuries on the step

Falling pattern and impact points of a head

- a) In case of a natural fall without any external forces
 - The dummy's head impacted on the fourth step from the lower landing as shown in Figure 5(a).
- b) Intentional falls in case that a female victim was pushed from the top of stairs.
 - Shoving the dummy from the top of stairs.
 - The dummy's head impacted on the third step from the lower landing as shown in Figure 5(b).
 - Shoving a moving dummy at the speed of 1.6 km/h.
 - A dummy's head impacted on the second step from the lower landing as shown in Figure 5(c).



a) Natural fall b) Shoving a standing dummy c) Shoving a moving dummy

Figure 5. Falling patterns to impact the head on the steps

Discussion

According to the results of experimental falls using a dummy, the dummy hit its head on the step. The victim struck her head strongly on the flat surface, such as the lower landing, judging from the external injuries to her head. It was determined that the victim was pushed from the top of stairs by very strong external forces in case that a fatal fall was initiated near the top of stairs.

If the victim was kicked, while descending a few steps below from the top of stairs, another scenario of the intentional fall can be considered. As it was reported that a red congestion on the upper part of a left breast was observed from autopsy, a victim was considered to be kicked strongly on the left breast by a right foot, when standing on the second or third step from the top of stairs as shown in Figure 6. In this case the victim would likely hit her head on the lower landing directly.

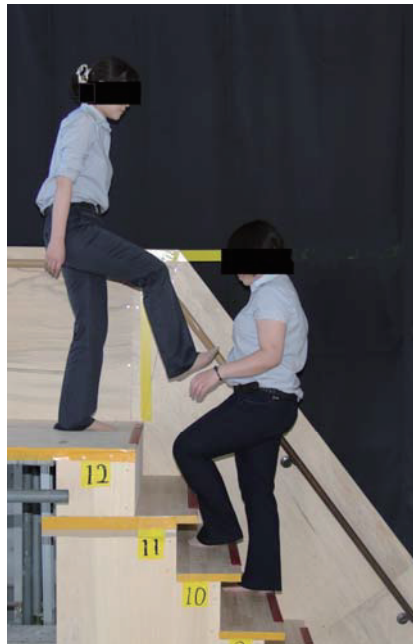


Figure 6. One of determined intentional kicks

Conclusion

It is very unnatural that the back of the head of the fatal victim was strongly impacted on the lower landing without any external forces. According to the experimental analysis of actual falls of a dummy from stairs, and observations of external injuries of the body, it is suspicious that the witness's statement that the victim fell down at the top of the stairs by herself without any external forces, is true,

Acknowledgements

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