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CASE REPORT

PATHOLOGY/BIOLOGY

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Unusual Elevator-Related Deaths: A Report of Two Cases

ABSTRACT: We present two cases of elevator-related deaths that occurred in two different elevators, and deaths were caused by a similar, but unusual, mechanism. An elevator is a platform or compartment housed in a shaft for raising and lowering people or things to different levels. Elevator-related deaths and injuries are rarely reported in the literature. In most of these cases, cause of death was attributed to falls. It seems that most of the elevator accidents may be attributed to factors related to device maintenance inadequacies or even to device malfunctioning. In our cases, both elevator cars were not equipped with full-length inner doors, thus allowing both accidents to occur. Since 2014, the European Union adopted a relative directive, which imposes the need to equip all elevators with such full-length doors. The enforcement of the above-mentioned EU Directive is crucial, in order to prevent similar accidents in the future.

KEYWORDS: forensic science, forensic medicine, elevator deaths, neck injuries, autopsy

Elevator-related deaths and injuries are rarely reported in the literature. A reported 443 fatal cases involving elevators took place in the United States during 1992–2009. In most of these cases, cause of death was attributed to falls (1). On the other hand, elevator-related injuries are estimated to occur more commonly in the United States, involving both children and older adults (2,3).

A study from Iran revealed 1819 elevator-related accidents during 1999–2003 that involved 3661 people, including 15 fatal cases (4).

In this report, we present two cases of elevator-related deaths that occurred in two different elevators, and deaths were caused by a similar, but unusual, mechanism.

Case Reports

Case 1

On a Friday evening, a 21-year-old female was found dead at her workplace, a children's toy shop, with her body hanging inside an elevator. The scene investigation was performed at about thirty minutes after the discovery of the deceased. A portable three-stair ladder had trapped her, pressing her neck, and the head against the ceiling of the elevator. The exact position of the deceased inside the elevator is shown in Fig. 1. The external injuries on the anterior neck at the scene are shown in Fig. 2*A*.

The postmortem examination was performed on Monday, three days after the incident. External examination at autopsy revealed three blanched compression injuries. We also observed a parchment-like abrasion at approximately the middle of the third pressure mark. The external injuries on the anterior neck of the deceased during autopsy are shown in Fig. 2*B*.

Another blanched compression injury was observed on the posterior neck. We also noted three contusions, both above and below, the above-mentioned posterior pressure mark. These pressure marks were compatible with the pressure exercised by the ladder. No other external injury was observed.

FIG. 1—*(A) The exact position of the deceased, inside the elevator as photographed during scene investigation. (B) Detail showing neck compression by the ladder (Case 1).*

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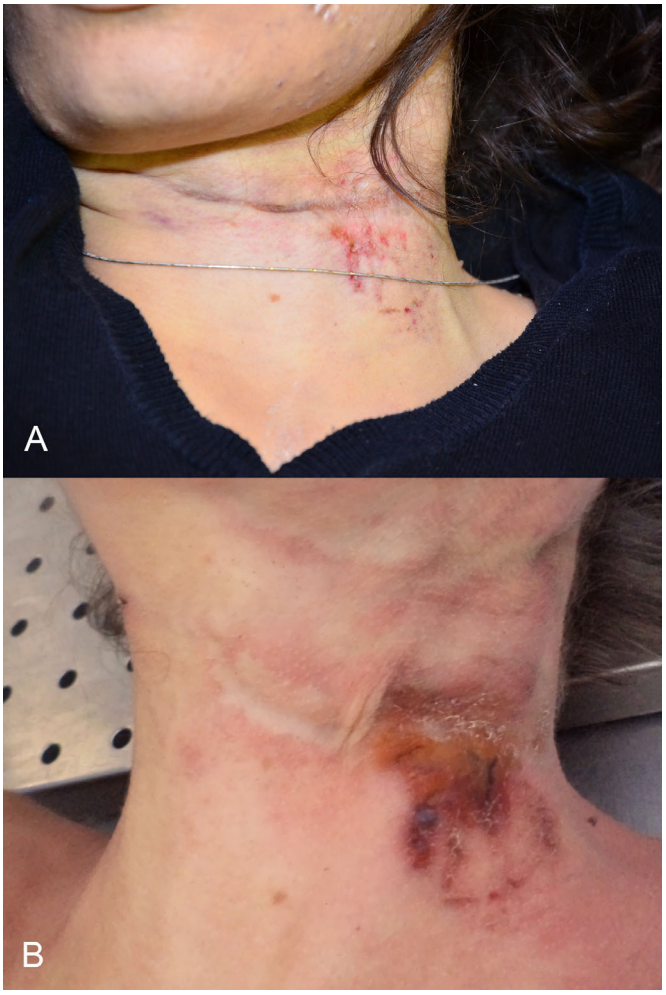

FIG. 2—*(A) External injuries observed on the anterior neck at scene. (B) The same injuries at autopsy, after 3 days interval (Case 1).*

FIG. 3—*(A) The broken hand-made chair found inside the elevator. The chair was removed from the elevator prior to investigation. (B) The two rectangular indents (white arrows) left on the wall of the elevator shaft, compatible with the wooden legs of the chair (Case 2).*

Upon dissection of the body, we had the following relevant findings: fracture of C1 (anterior arch) and C2, dislocation of the atlantoaxial joint, and complete transection of the spinal cord at C1–C2 level.

No other internal injuries or any significant pathology were observed. Cause of death was attributed to injuries of the cervical spine due to neck hyperextension after compression of the neck by a ladder. Toxicological investigation was negative for any psychotropic substances.

Case 2

A 60-year-old female was found unconscious inside the elevator of an apartment building. She was pronounced dead at the hospital, approximately thirty minutes later. Inside the elevator, a broken hand-made chair made of wood and plastic was found (Fig. 3*A*). The wall of the elevator shaft, between the floors, had two rectangular indents, compatible with the imprint of the wooden legs of the hand-made chair (Fig. 3*B*). Furthermore, the mirror inside the elevator was broken and fragments were found in the hair of the deceased.

External examination at autopsy on next day, revealed multiple bruises on the head (forehead, nose, chin), the neck, the torso, and the right elbow. Three band-like bruises were observed at the neck region, two at the anterior surface and one at the right lateral surface (Fig. 4). An inverted L-shaped bruise was present at the right side of the anterior surface of the thorax.

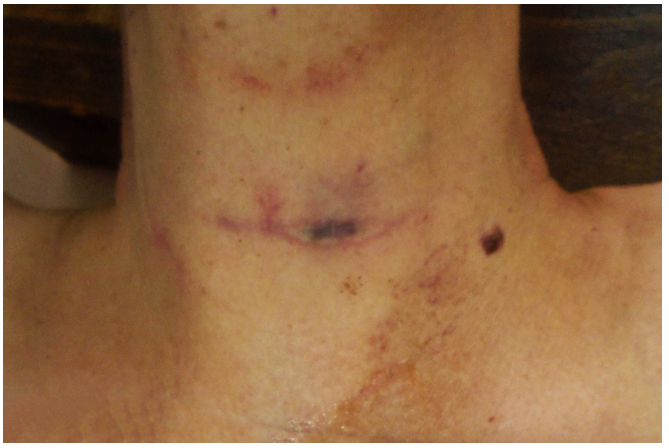

FIG. 4—*External injuries observed on the anterior neck (Case 2).*

Another bruise was observed at the posterior surface of the torso, at the level of the lower thoracic and upper lumbar spine.

Upon dissection of the body, we had the following findings: fracture of C1 (anterior arch) and C2, dislocation of the atlantoaxial joint, complete transection of the spinal cord at C1–C2 level. Focal subarachnoid hemorrhage was also noted at the cerebellar area, probably due to the spinal hemorrhage caused by the fractures.

No other internal injuries, or any significant pathology, were observed. Cause of death was attributed to injuries of the cervical spine due to neck hyperextension after compression of the neck by a hand-made chair. Toxicological examination revealed a small postmortem 0.08 g/L blood alcohol concentration.

Discussion

Elevator accidents appear to be uncommon, but nevertheless may cause serious injuries or even death (4). Elevators are one of the safest means of transportation; nevertheless they can become sites of deaths and injuries, mainly because of their high-traffic volume (2). Moreover, urbanization has increased the number of the elevators that are used on a daily basis (4).

According to McCann, more than half of the elevator-related deaths (59.4%) reported in the United States during 1992–2009 involved construction workers in or near elevator shafts and elevators, while in 20.5% concerned elevator passengers not at work, and in 20.1% cases working passengers, such as clerks/stock handlers, and janitors/cleaners (1). In most of these cases, deaths were attributed to injuries due to falls from height, a form of blunt force trauma that is frequently encountered in forensic medicine. Elevator-related accidents represent a small portion of the falls from height (5).

These incidents may involve adults or even children. In the United States, according to the US Consumer Product Safety Commission (CPSC), it is estimated that about 9800 elevator-related injuries occur each year (2). In the adult subgroup, the injuries inflicted upon elderly have greater importance because they can lead to increased morbidity and mortality (3).

Elevator accidents may occur during working hours (6) or even during leisure time. They can cause delayed death, if the person survives the accident. In a case of accidental hanging inside an elevator from India in 1999, the victim was resuscitated after the incident and subsequently passed away due to septicemia, following cerebral hypoxia due to compression of the neck (7).

Reconstruction of elevator-related accidents is crucial both for judicial and safety purposes (5). Most of the elevator accidents may be attributed to factors related to device maintenance inadequacies or device malfunctioning (4). Elevator-related injuries also depend on the specific setting of each incident. For example, it was found that almost one third of elevator-related injuries can be the result of the door closing on a person (3).

In our cases, both victims were alone in an elevator, with no inner doors. In the first case, the victim was carrying a three-stair ladder that was held by the victim next to the shaft wall. As the elevator was set in motion, we assume that this ladder was in contact with the shaft wall. At some point, with the elevator still in motion (descending from the first to the ground floor), the ladder was forced into the victim's neck when it was caught on a bulge of the top part of the ground floor case, and thus trapping her between the ladder and the ceiling of the elevator. The result was fractures of C1 and C2 and complete transection of the spinal cord at this level. The elevator was missing its internal doors as installation was not yet complete.

In the first case, we noticed totally different appearance of the external injuries on the anterior neck, when comparing them at the scene and at autopsy (Fig. 2*A*,*B*). This difference can be explained when taking under consideration three basic parameters: i. the decongestion of the head and neck after its release, ii. the development of lividity, and iii. the drying of the affected tissue near the initially perceived abrasion of the left anterior neck. The cessation of the mechanical pressure combined with the development of livor mortis may have contributed to the decongestion of the anterior neck (8,9). The loose supportive tissue of the neck combined with the postmortem evaporation of tissue fluids (drying up) may provide explanation with regard to the parchment-like abrasion, which become apparent during autopsy (10,11).

In the second case, the victim was carrying a hand-made chair next to the shaft wall. As the victim was found unconscious in the elevator and was immediately transferred to hospital for first aid, scene investigation was performed without the body *in situ*.

Two indents on the shaft wall were compatible with the wooden legs of the hand-made chair, and we noted the broken mirror inside the elevator. After the autopsy, during which mirror fragments were recovered from the hair of the deceased, we concluded that the mirror was broken by a head impact. This conclusion was also supported by the soft tissue injuries observed.

According to our opinion, it is highly probable that the chair was held by the shaft wall, with the elevator in motion, thus causing entrapment of the deceased against the chamber wall with the mirror. The victim's neck was held against the chamber wall, in a way that resulted in complete spinal cord transection at C1–C2 level.

The spinal column is quite a complex structure that has, by its design, the ability to flex to a great extent, but lateral movement and extension are much more limited (12). Anterior arch fractures of C1 are mainly due to hyperextension, while posterior arch fractures are due to a combination of hyperextension with axial loading. The most common condition that leads to axial loading is extension or flexion. Atlantoaxial dislocations (C1–C2) are less dramatic and more difficult to detect, in comparison with atlanto-occipital dislocations (13).

An injury to the cervical spine can lead to an interruption of the respiratory pathways, thus resulting in possible respiratory muscle paralysis. Approximately one third of cervical spine fractures occur at the level of C2. Mechanical loading to the cervical spine can result in acute death (14).

Pure C1–C2 dislocations can be the result of a violent flexion mechanism with rupture of the transverse ligament, projection of the dens of C2 into the neural canal, and spinal cord trauma that is generally incompatible with life (15). Hyperextension of the neck is considered to cause more severe injuries than hyperflexion, because flexion is protected by contraction of the strong posterior neck muscles (16).

Injuries to the spinal cord may be penetrating or not (17). Damage to the spinal cord can be the result of the intrusion of part of the spinal column into the vertebral canal (e.g., bony fragments, ligamentum flavum, intervertebral disk annulus, extruded nucleus pulposus) (18). Furthermore, in cases of blunt neck trauma, the soft tissues (integument, muscles, thyroid, vessels) and the airways may be affected (14). Blunt force trauma of the spinal cord, in case of severe displacement may result in complete transection. In the case of a fatal C1–C2 dislocation,

there may be very subtle gross or even microscopic findings (17). Our findings are suggestive of hyperextension of the neck in both cases; thus, the prevertebral neck structures (i.e., hyoid bone, thyroid cartilage, trachea) were not affected due to compression of the neck above the larynx (submandibular region).

To the best of our knowledge, these are the first two cases of deaths in elevators with such an unusual mechanism of death. In such cases, and in absence of eyewitnesses, scene investigation is crucial for establishing manner of death. A detailed photographic documentation of the injuries, both during scene investigation and autopsy is very important, as it may prove extremely useful for the explanation of any postmortem alteration that may occur. Furthermore, in deaths where there is suspension or trapping of the body inside the elevator, a postmortem radiographic examination should be performed (if available) prior to autopsy for detecting any evidence of cervical spine injuries. The forensic pathologist must always keep in mind the possibility that the appearance of an injury observed during the scene investigation, especially if the latter is performed very close to death, may be different the next day at autopsy. Therefore, the time interval between the scene investigation and the postmortem examination should always be taken under consideration for the evaluation of injuries.

In both cases described, the accidents could have been avoided if inner elevator doors were installed and working. This precautionary measure would have prevented either the ladder or the chair from trapping the victims' neck.

The European Union adopted a relative directive since 2014, according to which elevator cars must be equipped with full-length doors. These doors must be so designed and installed that the car cannot move unless the doors are closed, and comes to a halt if the doors are opened (18). Enforcement of the EU Directive would prevent fatal accidents, such as the two cases presented here.

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