A traffic accident resulting in a degloving injury of the passenger: Case report and biomechanical theory

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Abstract: A degloving injury is likely to cause minimal to extensive loss of skin with variable amounts of deep tissues loss through a defence mechanism or trauma. This injury usually occurs in vehicle-pedestrian accident victims who are run over, and less commonly one in a vehicle’s passenger. In our case, three soldiers had an accident while they were travelling in a military vehicle during a reconnaissance mission. After the accident, the vehicle started to roll over several times, and the soldier who was sitting on the front passenger seat was thrown away from the vehicle and died several minutes later. At the autopsy a complete detachment of the skin of left leg and foot was observed, showing the typical features of degloving injuries.

According to our reconstruction, three different forces were applied simultaneously to the body, resulting in a severe degloving injury to the leg and the foot.

These methods presented here were applicable for the cause of death diagnosis in medico-legal autopsy.

Key Words: forensic science, degloving injury, detachment injury, traffic accident, skin disease.

Traffic accidents are one of the most common causes of death and injury in industrialized countries. The main role of the forensic pathologist in traffic accidents is to describe the injuries found on the victim’s body in order to reconstruct the traumatic event. The reconstruction of an accident is based on a detailed collection of scene data, such as vehicle or human final positions, road marks, vehicle damage, and body injuries [1]. The role of the forensic pathologist is to describe the injuries suffered in as much detail as possible. Injuries may be different due to the type of vehicle and the position of the body (drivers, passenger, pedestrian) [2].

Sliding skin injuries are common in traffic accidents involving a pedestrian struck by a motor vehicle. They are usually due to a "run over" mechanism: the grinding action of the spinning wheel causes tearing and separation of the skin from the subcutaneous tissues and musculature [3]. A sliding skin injury of the body limbs is called a “degloving injury”, by analogy to the process of removing a glove.

We report a case of degloving injury of the leg and the foot in a passenger of a motor vehicle, and suggesting a biomechanics of the injury.

MATERIAL AND METHOD

Three soldiers were in a military motor vehicle carrying out a reconnaissance mission. Suddenly, the driver saw a fixed obstacle in the middle of the road and he swerved to avoid it. Unexpectedly, the vehicle rolled over several times after hitting a bump. The soldier sitting on the front passenger seat was thrown out while the vehicle was overturning and he died several minutes later. A forensic autopsy of the victim was performed two days later. On the right temporal area, 10 cm from the top of the head and 8 cm from the median line, there was a “V”-shaped laceration, 0.5 x 3 cm. Epistaxis, otorrhagia, and raccoon eyes were present. Upon reflecting the scalp,

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on the right temporal area there was a subgaleal circular haemorrhage, 2x3 cm. The calvarium showed multiple linear fractures.

Several abrasions on the thorax and abdomen were present. The pelvis was fractured.

On the left leg and foot, there was a detachment of the skin and underlying soft tissues (Fig. 1). The appearance and the features of the lesion were compatible with a degloving injury. The lesion started on the lower third of the left leg, 14 cm from the calcaneus, where a clear concentric linear-shaped edge of laceration was observed (Fig. 2). The lesion affected the skin and subcutaneous tissues of the lower leg and the foot, exposing the underlying muscles and bones (Fig 3). A simple fracture of the ankle joint was also observed. A plastic bag accompanied the body. In the bag a grey sock was present, inside which the avulsed skin of the left leg was present (Fig. 4). On the detached skin, a laceration of the fourth toe and several areas of bruising were present. Injuries showed no significant vital reactions, indicating that the victim was already dead when the degloving injury occurred.

Figure 1. Degloving injury of the left leg and foot.

Figure 2. Circumferential line of skin transection showing linear-shaped laceration and rim of mild abrasion and bruise.

Figure 3. Underlying muscles and bones after skin detachment.

Figure 4. Complete and clear skin detachment found in the left sock.
injury occurred. No other lacerations or abrasions of the skin were observed. According to the investigations, the victim wore the left boot after the accident. When the rescuers tried to remove the boot, sock and skin were removed with it. The circumferential line of skin transection corresponded to the margin of the boot and showed a mild rim of abrasion and bruising.

RESULT AND DISCUSSION

Traffic accidents may result in laceration, bruises, fractures, amputation, and other skin injuries.

A degloving injury is a minimal to extensive loss of skin with variable amounts of deep tissues loss through trauma. Degloving injuries usually occur in pedestrians run over by vehicles but they have also been described in other situations, such as aircraft crashes, explosions, wringer or industrial roller injuries, and victims hit by heavy objects falling from a height [4-7].

Several mechanisms may explain the development of a degloving injury. According to the theory of a tangential stress, the skin and the subcutaneous tissues are sheared off the deep fascia and the skin detachment leaves the limb unwrapped. The deep fascia is also shredded, but the muscles and surrounding deep tissues, protected by the skin, are only split away from each other and usually remain intact [8].

According to a recent theory, the detachment may originate with tissue compression due to a perpendicular force applied to the body [9]. When a skin tear occurs a large flap of full-thickness skin may arise. Regarding foot injuries, after appropriate force skin and subcutaneous tissues can be detached with ease. Skin detachment commonly starts at the point of less resistance, several centimetres from the ankle joint, where a circumferential-shaped line of transection is usually observed. Then the stripping proceeds distally, the shearing force strips the plantar skin and varied depths of its attached subcutaneous tissue from the underlying structures.

Whatever the mechanism, a degloving injury occurs when a body part is caught firmly and pulled violently at the moment of the impact, so skin may be pulled back over underlying tissues [10].

In our case, an interesting degloving injury of the left leg and foot was found. This injury may be due to different mechanisms which acted simultaneously. According to our reconstruction, three forces acted simultaneously and rapidly, causing the skin detachment. During the rolling over movement of the vehicle, the victim was pushed out from the “cockpit” due to a tangential force, striking his head on the ground, causing his death. While the victim's body was partially out of the vehicle, his left leg got stuck briefly in the cockpit between the door and the vehicle. The vehicle door caught the left leg in proximity to the ankle joint, and a perpendicular force acted, resulting in a circumferential line of skin transection at the top of the boot. The rim of abrasion and bruise due to the compression of the leg between two surfaces were produced. In addition, a torsion force twisted the foot in one direction while the leg was blocked inside the cockpit and the vehicle was rolling over.

We assume that, the left leg was caught inside the cockpit due to a perpendicular force while the body of the victim was exiting the vehicle due to a centrifugal force. This resulted in a stretching of the skin at the point of compression between the two surfaces. Finally, the torsion of the skin due to the rolling movement of the vehicle resulted in additional damage that caused the final detachment of the skin. A graphic representation of our theory is shown in figure (Fig. 5). The two squares that represent the closing door that caught the foot, and three forces (tangential – A, perpendicular – B, and torsion – C) are shown.

In this case, a complete detachment of the skin of the left leg and foot was observed. Similar cases of degloving injuries are described in literature [11,12], but a complete skin detachment was not observed.

We assume a peculiar biomechanics of degloving injury development due to the simultaneous action of three different forces. A possible explanation is that the body was ejected with considerable force while the vehicle was rolling over, and the leg was compressed between two surfaces. In conclusion, we tried to reconstruct the accident from the injuries after careful observation of human remains. Our theory was plausible but should not be accepted as definite without further studies.
References