A CASE OF SEVERE THERMAL AND CHEMICAL BURN CAUSED BY AIRBAG DEPLOYMENT

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ABSTRACT

Introduction: Airbags significantly reduces mortality and morbidity in motor vehicle crashes. However, the airbag produces its own range of injuries. These are usually minor ones, but in certain circumstances they could be severe or even fatal. This is a case report of a serious hand burn of a driver after airbag deployment in a moderate frontal collision. **Materials and methods**: Full forensic examination, including analyses of medical documentation, inspection of photos from the early stages of the injury and series of examination of the injured person. **Case Presentation**: In order to escape a hurdle a driver lost control over his automobile and hit frontally a tree next to the road. The airbag opened due to the crush. Right after the accident, the driver saw that his left wrist was edematous and inflamed, with formation of blisters. The medical examination established 3rd degree burn in the area. During one month of special therapy the status of the patient was studied by our team and more burns of 2nd degree on the right forearm and the front right surface of the neck were established. **Discussion**: The analysis of the morphological findings, compared to the present knowledge of the airbag's set-up, led to the conclusion that the injury was due to combined mechanical, thermal, and chemical action. The injury of the wrist cannot be taken as an acceptable or ordinary one for the airbag. It is probably a result of a defect of the activated airbag module. **Conclusion**: The present case is an indicator for the fact that one can never be 100% sure of "safety" of the car safety system, until an accident happens.

***Key words**: airbag, full thickness burn, wrist combustion*

INTRODUCTION:

Air bags fitted in the majority of new automobiles are nylon-and-rubber safety devices, installed into the steering wheel, instrument panel, doors, ceiling beams or car seats. [4] Airbags provide a softened and wider contact surface, which is far less traumatic than a dashboard, steering wheel, windshield, or the other parts of the interior of the vehicle. [8] AB is activated when a sudden deceleration causes the ignition of a propellant cartridge containing sodium azide. [9]

Even though air bags are considered safe, lifesaving devices, their deployment may cause injury. The most commonly observed injuries are minor bruises and abrasions, mainly to the face, neck, and upper limbs. [1] These are often referred to as "bag slap" injuries. [5] Also, an alkaline chemical keratitis has been reported from the combustion byproducts of the conversion of sodium azide to nitrogen. [13] Superficial burns of the upper extremities, face, and neck are well documented [10][2], and full thickness burns can also occur. [17]

The bag is inflated by nitrogen liberated during the combustion. Deployment releases various high-temperature gases, including nitrogen and carbon dioxide, and produces sodium hydroxide, a highly irritant alkaline substance. In about 7%-8% of cases, air bags cause dermatologic injuries such as traumatic lesions, irritant dermatitis, and chemical and thermal burns. Non dermatologic lesions, such as ocular damage (alkali keratitis, corneal abrasions), ear lesions, bone fractures, and contusive damage can also be caused by air bag deployment. [12]

The sodium azide cartridge in an air bag is activated by a firing signal, at which point nitrogen, carbon dioxide, and other gases are released. The gases inflate a rubber-lined nylon bag in about 30-40 milliseconds and are released through exhaust ports to allow deflation of the bag within 2 seconds. Numerous metallic oxides are produced during combustion and these substances create a fine, alkaline dispersion inside the car. [4] Sodium hydroxide, a highly alkaline substance found in the aerosol is considered the principal cause of chemical burns. Due to its high pH, the fine alkaline aerosol containing sodium hydroxide and various metallic oxides may cause chemical burns. These appear to happen when the gases come into contact with body liquids such as sweat or tears. Alkaline irritants penetrate the skin and, due to skin's scarce capacity for counter alkalinity, may induce deep tissue injuries. [12]

Sodium azide is a highly reactive substance that may chemically react with water, leading to the production of toxic and explosive products. Being an inflammable gas, it may also cause thermal burns after ignition due to sparks produced by electrical devices or high temperatures. [14] Talcum powder may also be present in air bags because it is sometimes used in packaging the devices.

The release of irritant gases and particulates during deployment can lead to or exacerbate respiratory problems, especially in asthmatic patients. [6]

About 7%-8% of all injuries caused by air bag deployment are cutaneous lesions. [19] With widespread use of this safety device, new, unexpected cutaneous and traumatic injuries have increasingly been reported. [18] The upper chest, arms, and face may show erythema, swelling, and purpura. Pruritus, burning, and stinging are the most frequently reported symptoms. Thermal lesions on the hands, caused by the hot gases ejected under pressure from the lateral ports of the air bag during the deflating phase, have been described as cigarette-like burns with blisters. [15] Dermatitis usually resolves in a few days with a scaling reaction and pigmentation changes.[7] Severe burns have been rarely reported. [10][2][16][3] High-temperature gases and the explosion of chemical products that come in contact with electrical wiring are directly responsible for thermal burns.[11] Melted fabrics or overheated metallic accessories can also injure the skin, producing extremely localized burns with figurate areas.

We report a case of a car driver who sustained chemical/thermal burns as a result of the activation of an automobile air bag.

MATERIALS AND METHODS

To follow up the case, a detailed forensic examination was carried out, including analyses of medical documentation performed by specialized treatment, inspection of photos from the early stages of the injury and series of examinations of the patient.

CASE PRESENTATION

In order to escape a hurdle a driver lost control over his automobile and hit frontally a tree next to the roadway. By driver’s testimony, the speed of the automobile at the moment of impact was about 40km/h. The steering wheel airbag opened due to the crush. The driver was with his seatbelt on. Right after the accident, the driver saw that his left wrist was edematous and inflamed, with formation of blisters. The medical examination established 3rd degree burning in the area. The specialized therapy continued for a month. During that month the status of the patient was studied by our team and more burnings of 2nd degree on the right forearm and the front right surface of the neck were observed. Pictures №1 and №2 show the burnings of the left wrist two hours after the accident. The maceration of the epidermis is a result of necrosis due to the action of the hydroxyl anion.

Pic. 1

Pic. 2

Edema in depth of the soft tissues was also seen. The borders of the injury were well limited. The morphology of the injury showed circular features. Its surface was approximately 65% of the circumference of the limb, as it was found in the areas of contact with the airbag. The first forensic medical examination of the patient was performed two days after the accident. There was an antiseptic bandage over the injury, which was not removed due to medical consideration. During the examination a specific burning of 2nd degree over the front surface of the lower part of the right forearm was observed. The burning was an unique specific imprint from the emblem of the automobile, situated over the decorative cap of the air bag module of the steering wheel (Picture №3). There was also spot-like burning of 1st-2nd degree over the left-front surface of the neck(Picture №4).

Pic. 3

Pic. 4

The recoveries of both burnings were corresponding with the timing maintained by the victim. Ten days after the accident second examination was performed. The burning of the right forearm was healing, with crusts falling off. On the left-front surface of the neck there was increased pigmentation as a result of the healing process. The 3rd degree burning of the left wrist, correspondingly to the time that had passed and the subsequent treatment, was healing properly too (Pictures №№5, 6). The pictures show the remains of necrotizing epidermis, which falls off as crusts and reveals the fresh new granulation tissue. In the borders of the injury, where the burning was 2nd degree there is increased pigmentation.

Pic. 5

Pic. 6

DISCUSION

The analysis of the morphological findings, compared to the present knowledge of the airbags' set-up, leads to the conclusion that in the present case there was combined mechanical (impact), thermal, and chemical action. The morphological findings are quite similar to the cases described in the literature [3]. The severe burning of the left wrist is due to the action of the gases from the inflating airbag. These gases consist of pulverized sodium hydroxide and sodium carbonate, metal oxides, and still burning sodium azide. The surface of the burning (even limited), is much bigger than the deflating ports of the device. The conclusion is that the air bag ruptured in an explosion-type of way. The spot-like features and the less severe grade of the burning of the neck show overlaying effects of the thermal/chemical factors and mechanical slap effect. This leads to the conclusion that the material of the substance of the airbag most probably was loosened and partly left the gases to escape.

The certain mechanism of the injury on the front aspect of the right forearm remains a scientific enigma. Its morphological features show that the 2nd degree burning is a contact injury caused by the emblem of the steering wheel.

The burning of the left wrist cannot be accepted for "normal" and "expected" for the action of the steering wheel airbag. It obviously is a result of the imperfection or defect of the activated airbag module.

CONCLUSION

The established facts do not allow a certain estimation if it is a problem of the restraint devices of a whole series of automobile, or is an accidental defect of that single one. Unexpected and severe injuries of the similar kind, associated to the activated airbag, would come out in cases of impact with comparatively low speed, when the seat belt provides enough protection of the occupants. The present case is for certainty demonstrative for the fact that one can never be 100% sure in "safety" of the car safety system, until an accident happens.

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