The Role of the Medico-legal Expert in the Interpretation of Airbag and Seatbelt Injuries: Two Case Reports

Case report

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Introduction

Road traffic trauma is a preventable cause of morbidity and mortality across the globe. A wide array of automotive safety measures have been implemented over several decades. They provide with active safety and passive safety. Seatbelts and supplementary restraint systems (SRS airbags) have undoubtedly been recognized as two important passive safety measures for vehicle occupants though they themselves may occasionally cause significant injuries in severe crashes. Injuries caused by inbuilt safety devices upon the occupants often come in atypical forms whose interpretation would be dubious unless carefully appreciated by forensic medical practitioner. This fact is elaborated with the following two case examples.

Case reports

The first case is regarding superficial burns on the face as a result of the deployment of airbags. The exact type, mechanism and the cause of the injuries were not recognized during the initial management. The second case is a diaphragmatic rupture which is extremely rare in healthy individuals with properly fastened seatbelts.

Conclusions

Injuries of both cases were properly interpreted at the clinical forensic examination. As correctly expected from a clinician he or she very justly pays more attention on the acute management, critical care and therapeutic aspects of such injuries rather than attempting to identify the exact type, mechanism of causation and other medico-legally significant issues. Yet, in the big picture outside the boundaries of providing critical care, including the implementation of preventive measures, precise identification and interpretation of such injuries become the vital obligation of the forensic medical expert.

Key words: Injury patterns, Seatbelt injuries, Airbag injuries, Traffic accidents

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Introduction

Automotive safety measures are generally divided into two: active and passive; based on as to how a particular mechanism behaves during a crisis situation of the vehicle. "Active safety" is employed to avoid accidents. They are always active in the system to prevent accidents. Some common examples include anti-lock brake systems, electronic stability control, surround camera systems, parking assistance and auto-steering control etc. [1,2] Passive safety measures minimize the adverse outcome both on the occupants as well as the pedestrians once a vehicle meets with an accident. Airbags, seatbelts, headrests, non-protruding cabin structures, collapsible steering column, crush model of the outer hull of the vehicle, side-impact crash bars for doors and safety windscreen glass etc are some classic examples for passive safety devices.[1, 2] This case study describes two passive measures and related injuries which are airbag and seatbelt injuries along with the undesirable effects caused by extreme conditions. Diaphragmatic rupture due to fastened seatbelt is not a typical type of injury. Burns caused by different mechanisms is also a rarely expected occurrence with the deployment of airbags. Further, the importance of analysis of the injury pattern by a forensic practitioner is also highlighted.

Case report 1

A nineteen-year-old male, front-seat passenger of a car sustained injuries to his left ear, face, left side of the neck and left upper limb during a high-velocity frontal collision of his car with a lamp-post. He was fully conscious during and after the accident. He was admitted to an accident services unit of a tertiary care hospital to exclude any major injuries to his eyes, brain and other major organs. The injuries on the left cheek, left earlobe and the left forearm were unusual in appearance. Those injuries were initially identified as abrasions. The patient was referred to the clinical forensic examination and at that point, his injuries were accurately recognized as superficial burns but not as abrasions as it was previously recognized (Fig. 1). After analyzing the total picture it was opined that the injuries were caused by the thermal and chemical effects following deployment of the airbag. Except for the injuries caused by airbag deployment no other injuries were identified in this patient.

Figure 1: The left side of the face: superficial chemical burns with brownish eschar formation. Hair of left eyebrow, eyelashes and above the left ear were found melted. Note also the reduced density of hair.

Case report 2

A thirty-year-old male was sleeping in the front seat of a saloon car, quite inebriated after a party, with the seatbelt fastened, when the vehicle met with a frontal collision at a substantial speed against a lorry parked by the side of the road without parking lights. He was unconscious on admission to a tertiary care hospital and he could not remember anything about the incident. With subsequent investigations, the ultrasound scan revealed diminished diaphragmatic movements on the left side without any further explanation. The neurological assessment was unremarkable. He had only minor external injuries on the body including minor abrasions and healing abraded superficial lacerations on the medial end of the left clavicle (Fig. 2).

He was referred to the medico-legal specialist for further medico-legal management. The rib fractures were excluded with multiple views of chest radiography. The forensic specialist suspected the

possibility of the impaction of the seatbelt in causing the diaphragmatic injury.

For this, he had to carefully exclude any other forms of direct trauma over the anterior abdomen with the light of the history, examination and the post-crash analysis of the vehicle. The unusual imprint abrasion with the superficial laceration on the left clavicle was interpreted as caused by the seatbelt during the violent crash which itself was an evidence of the amount of pressure applied by the seatbelt.

Figure 2: A healing abraded laceration just on, above and below the medial end of the left clavicle caused by the seatbelt.

With the repeated radiological assessment of the abdomen and chest revealed a ruptured left dome of the diaphragm with herniation of the intestines into the thoracic cavity compressing the lower lobe of the left lung (Fig.3).

The examinee was immediately subjected to open surgery and followed by uneventful recovery. The exploratory laparotomy revealed diaphragmatic rupture (left side) involving gastro-oesophageal area with a herniated transverse colon, stomach and gastric omentum into the left plural cavity.

The scene investigation also did not reveal any explicable mechanism in causing such injuries other than the seatbelt worn at the time of the accident.

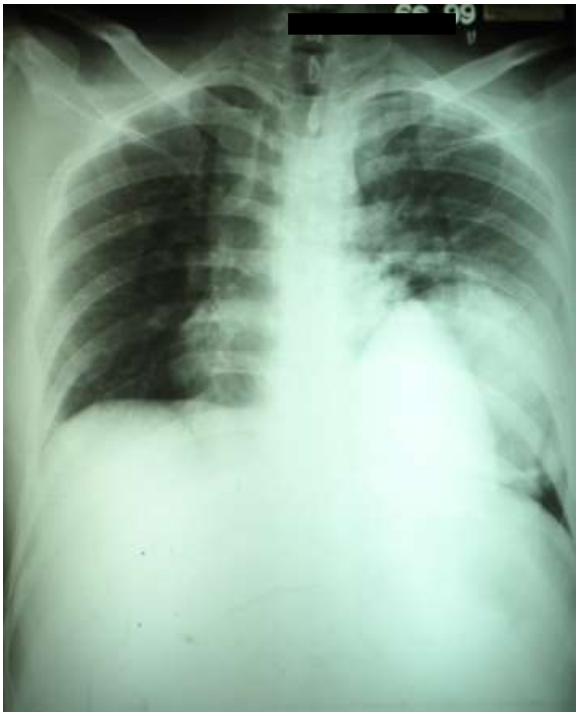

Figure 3: Note the abdominal contents in the left pleural cavity with the elevated left dome of the diaphragm.

Discussion

Attending clinicians in trauma management in general including general surgeons, cardiothoracic surgeons, neurosurgeons, vascular surgeons, eye, ENT or dental surgeons or acute care physicians are heavily burdened with the primary obligation of preventing or minimizing morbidity and mortality. It is unrealistic to expect the recording, describing or interpretation of seemingly unimportant injuries on trauma patients which fall outside the above mentioned primary goal from them. On the other hand, a forensic clinician or a forensic pathologist is appropriately trained on recognition and interpretation of and drawing opinions on the above injuries. Therefore, when a case of traffic trauma comes to the hands of a forensic specialist, each and every injury should be analyzed until it is convincing enough as per the causation and reconstruction. Further, he should be able to make certain conclusions, medical judgments or opinions to primarily help the execution of criminal justice and secondarily to assist civil compensation, other treating

medical colleagues and in the broadest picture in the decision making of the country pertaining to road safety etc. [3]

Though a rare occurrence, an array of injuries ranging from trivial to fatal could occur following deployment of airbags, either due to the mechanical force of deployment or due to thermal and chemical effects of deployment. The mechanical force creates by "concussion mechanism following the direct action" at the deployment can cause contusions [4] and even friction burns. These friction burns could easily be identified as they show numerous fine parallel superficial lesions caused by the outer covering of the air-bag. Yet, in this case, such kind of injuries were not recognized. Injuries due to chemical and thermal effects of deployment are very different from the mechanical type of injuries due to the friction of the exploding airbag.

Different mechanisms will produce different injuries and it is pertinent to identify the correlation of the injury with the most plausible mechanism by a forensic pathologist.[4] For instance, an array of chemical and thermal burns may occur due to corrosive alkali and hot gases.[5] Aerosols containing sodium azide and hydroxide and numerous other metallic oxides cause chemical burns especially when they come in to contact with body fluids containing water such as sweat. [4] With these alkali burns, soft friable brownish eschars are the result and in this case study also it was prominently evident with melted hair and eyelashes due to the high temperature caused momentarily within the proximity of the deployment (Fig. 1). Not only the face but also the left external ear too had sustained the same type of chemical burns.

There were no internal injuries to the eye, mouth, oro or nasopharynx due to the effects of the deployment. Though not essential, it would be prudent for medical practitioners of other specialities other than forensic specialists, such as emergency physicians, surgeons, eye surgeons and dermatologists to have some understanding of the possible injury types due to automotive safety devices.[6]

Diaphragmatic rupture due to seatbelt following high impact motor vehicle collisions has been recognized in the medical literature.[7] Diaphragmatic rupture following application of blunt force over upper abdomen and the lower thoracic area is anyway not an uncommon entity in surgery.[8] However, it has been recognized that diaphragmatic rupture due to seatbelts are secondary to the faulty placement of the seatbelt or sliding of the victim during the accident.[9,10] In other words, it is not a well-recognized entity to have ruptured diaphragm with properly fastened seatbelts. The mechanism of causation of the rupture is due to the abrupt increase in intra-abdominal pressure during the blunt force trauma with the seatbelt.[11] In the case under discussion, there was a healing abraded laceration measuring 4x3 cm in size, surrounding the medial end of left clavicle indicating the patient was wearing the seatbelt (Fig. 2). The long bone clavicle lies very superficially without any muscles on it. Additionally, it is anchored on both ends with relatively immobile joints. As such with a sufficient force, the clavicle is able to be even fractured with fastened seatbelts.[12] There were no other external or internal injuries on his body. The authors had investigated into the damages sustained by the motor car in which the victim had been occupying at the time of the crash and were satisfied that no force had been driven into the cabin compartment to attribute with the causation of the abdominal injuries leaving the only possibility of seatbelt force as the sole causative agent for the diaphragmatic rupture. A thorough analysis of the injury pattern, post-crash analysis and the examination of the vehicle enabled the forensic pathologists to postulate the mechanism of causation of a rare injury.

Conclusion

Careful analysis of different injury patterns created by the safety mechanisms in operation at the time of the collision should be performed in a logical way by the forensic practitioner. The same obligation lies on the shoulders of the clinical team though to a lesser degree. This will prevent giving a blanket cover to all the injuries sustained in the process of collision as "road traffic injuries" which could be regarded as a way out by oversimplifying the different mechanisms leading to different injuries caused during a traffic collision.

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