Traumatic pericardial tamponade following Airbag Deployment : A case report

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Abstract

It has been well documented in the literature that the introduction of frontal airbags has had a significant impact in reducing mortality and serious injury from motor vehicle accidents. However, the mechanism of action and speed of deployment of airbags can be associated with injury, some of them are even deemed life threatening. Of particular interest in this case is the increased risk of thoracoabdominal injury following air bag deployment.

The sheer complexity of the anatomical structures within the thoraco-abdomen and airbag deployment makes it of the utmost importance to timely and appropriately manage them.

Keywords : Pericardial injury, Blunt thoracoabdominal trauma, Airbag deployment

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ภาวะเลือดออกในเยื่อหุ้มหัวใจจากอุบัติเหตุถุงลมนิรภัย: รายงานผู้ป่วย

บทคัดย่อ

ถุงลมนิรภัยถือเป็นอุปกรณ์สำคัญที่ต้องมีในรถยนต์ทุกรุ่น เพื่อมีส่วนเข้ามาเป็นตัวช่วยป้องกันการกระแทก ลดอัตราการตาย และลดการบาดเจ็บที่รุนแรงจากอุบัติเหตุทางรถยนต์ ถึงแม้ถุงลมนิรภัยจะช่วยลดแรงกระแทกเมื่อเกิดอุบัติเหตุ อย่างไรก็ตามด้วยกลไกและระบบการทำงานของถุงลมนิรภัยสามารถทำให้เกิดการบาดเจ็บแบบไม่รุนแรงจนถึงการบาดเจ็บที่มีความเสี่ยงต่อการเสียชีวิตต่อผู้ขับขี่ได้ รายงานผู้ป่วย 1 ราย อุบัติเหตุขับรถยนต์ตกข้างทาง ถุงลมนิรภัยทำงานและกระแทกบริเวณหน้าอกด้านซ้าย ตรวจเอกซเรย์คอมพิวเตอร์พบว่ามีภาวะเลือดออกในเยื่อหุ้มหัวใจ และม้ามฉีกขาด ได้รับการรักษาแบบประคับประคอง ร่วมกับ หลังจากนอนโรงพยาบาล 6 วัน คนไข้สามารถออกจากโรงพยาบาลได้

คำสำคัญ : เยื่อหุ้มหัวใจฉีกขาด, การบาดเจ็บแบบกระทบกระแทกบริเวณช่องอกและท้อง, ระบบถุงลมนิรภัย

ภาวะเลือดออกในเยื่อหุ้มหัวใจจากอุบัติเหตุถุงลมนิรภัย: รายงานผู้ป่วย 1 ราย

Traffic accidents are the leading cause of injury related deaths in many countries. Driver side air bags are meant to provide protection during the rapid deceleration that occurs after accidents, particularly in those involving frontal collision. These have been shown to decrease the morbidity and mortality associated with high speed injuries when used in conjunction with lap and shoulder belts. The first airbag was fitted to a car in the USA in the 1950s. In the mid-1980s Passive Safety Federal Legislation was passed with a resultant increase in airbag use. In 1995, over 70% of new USA cars had airbags installed, and it has been mandatory in law to provide driver and passenger airbags in all new cars in the USA since 1998. At present, there is no law governing the use of airbags in Thailand (although there are rules for their storage and fitment)[3]. Air bags inflate at a rate of 6 l/ms, generating a velocity that has been measured at 157.7–339.6 km/h (98–211 miles/h; average 21.7 km/h or 144 miles/h)[4]. In some instances air bags have been implicated as the direct cause of the injuries, most of which are usually minor. However, major organ injury have not been reported. We present a patient who experienced traumatic pericardial tamponade following air bag deployment.

Case report

A 38 year old woman driving a 2014 registered Totota Yaris at an estimated 90 km/h was involved in a head-on collision passenger seat of a 2000 model automobile. There was structural damage to the front end and bonnet of the vehicle but no substantial intrusion into the passenger compartment and the windscreen remained intact. The driver of the Toyota Yaris had not been wearing her seat belt and her airbag was deployed. After deflation of the air bags they noticed the multiple injuries to both driver. She appeared to be conscious in the vehicle and the emergency services were activated by a passer-by. A paramedic crew arrived approximately 30 minutes after the crash. On arrival in the emergency department they were conscious. Resuscitation was continued according to advanced trauma life support protocol. The final diagnosis for the boy was abrasion at cheek, right arm and knee.

The boy was hospitalized in the pediatric surgery department of the hospital. The driver widespread abrasions and contusions involving the left anterior chest wall and left knee were detected on external examination (Figure 1).

Figure 1 : Bruise at left costal margin Figure

Figure 3 : Chest X-Ray shows widened mediastinum

A baseline chest radiograph (CXR) is shown which was suggestive of mediastinal widening (Figure 2). An computed tomography (CT) scan chest with intravenous contrast disclosed a doubtful image of traumatic pericardial tamponade (Figure 3, 4), pulmonary contusion.

Figure 3 : An axial shows thicken pericardium

Figure 4 : A coronal view shows thicken pericardium

Contrast-enhanced CT scan of the abdomen shows splenic injuries (AAST-OIS grade 2) (Figure 5, 6). This patient were admitted to the trauma service and were initially managed conservative treatment. The patient was discharged on hospital day 5 and no morbidity reported.

The subject of this report was a middle aged woman. Crash investigators have postulated that the unexpectedly multiple injuries sustained were caused by airbag was deployed. As a result, the bag expanded suddenly into her chest and downwards to the lower extremity, rather than the body impacting with the fully expanded bag as intended by design. This lead to sudden forced hyperextension of the chest and abdomen resulting in the thoracoabdominal injuries as described.

Figure 5 : An axial view shows splenic laceration

Figure 6 : An axial view shows perisplenic hematoma

Discussion

Motor vehicle accidents remain a leading cause of mortality and morbidity in many countries. Many efforts have been made to increase the security level of occupants of vehicles, and following refinement in seat belts, development of air bags created a new era in the security options in new automobiles. Both engineering data and the data obtained from studies of road traffic accidents show a definite effect of the air bag system in reducing the fatalities. With the increasing prevalence of airbags in North America, reports began to appear in the medical literature there in the early

1990s of injuries related to airbag deployment[5]. The different constituents of the airbag, propellant capsule[6] and chemicals[7] airbag module cover[8], and the actual bag itself, have all been implicated in different injuries. However, most of the more serious injuries are caused by the act of deployment and are secondary to the shearing forces produced by the "punch-out" of the bag[9]. Despite the fact that air bags have emerged as a routine part of the automobile's safety system in almost all newly produced automobiles, there now exists an increasing number of articles showing air bag mediated injuries, some of which are fatal. Air bag deployment has been reported to lead to ocular injury, barotraumas to the ears, and abrasion and contusions especially in face, neck and chest regions. Facial and corneal burns and pulmonary contusions were also reported to result from air bag deployment. Most of these traumas were attributed to the so-called "bag slap" effect of deployed air bags. Although rare, air bag-related fatalities were also reported by some authors[10].

In the present case, a 38 year old woman sustained immediately fatal thoraco-abdominal injuries from the impact of the inflating air bag to the left anterior chest wall. This occurs primarily when the occupant is in the "deployment zone" of the airbag. Specifically, if the occupant is too near the steering wheel, the lower part of expansion of the airbag is restricted by the chest leading not only to excessive forces being applied to the thorax but also to a greater upward expansion of the bag. The velocity of air bags during deployment has been measured at 98 to 211 mph (average, 144). This may be sufficient to fatal torso injuries, since it is one of the thinnest vascular structures in the thorax. The absence of a rib fracture can probably be attributed to the patient's youth and relatively pliable thorax. The fact that she was not wearing a seat belt may have aggravated the situation by increasing the total velocity of the impact as well as by putting her thorax closer to the rapidly inflating air bag[11].

Air bags reduce mortality[12], but fatalities may occur in high-speed collisions that result in multiple trauma. This case is unusual in that it did not involve a high-speed collision and no rib fractures or other signs of serious trauma were noted.

This case brings up two important points. First, traumatic pericardial tamponade can occur even in the absence of rib fractures with severe barotrauma. Second, even in low-velocity collisions, the efficacy and safety of the air bag may be enhanced by the use of shoulder seat belts.

Airbag technology continues to evolve. These devices are still in the trial phase, but are looking promising for the future. Different car occupants would be sensed, and a number of alterations automatically made to the airbag. Future advances include the development of "smart" airbags that will adjust to seat position and passenger weight and height. Potential developments include adjustment of the triggering force, gas volume and inflation rate. Advanced sensing and control systems will be necessary for these to become a reality.

Conclusions

The reduction in morbidity and mortality since airbags became widely available in new vehicles is well established. This report, the first fatal thoraco-abdominal injury attributed to airbags reported in the Thailand, highlights the need to be aware of potential hazards associated with their use. There is no doubting the overwhelming evidence that airbags are effective at saving lives and preventing serious injury, particularly if used with a well fitted three point seat belt, and any injury attributable to their use must be seen in light of this knowledge. Future advances in airbag technology will help to reduce injuries caused by these devices, but will need to be implemented in conjunction with advances in other restraint and sensing systems to be most effective.

Conflict of interest statement

We hereby certify that there is no conflict of interest in this study.

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