

# Air bag safety in road traffic accidents

## Introduction

Road traffic accidents (RTAs) are the leading cause of injury-related deaths and the second leading cause of non-fatal injuries (Runge, 1993). These injuries include simple abrasions, lacerations, bruising, contusions, burns, fractures, and more serious visceral organ damage affecting any part of the body. Although most injuries are usually blunt, penetrating injuries can still occur, often with devastating results.

Fortunately in both the UK and USA, the number of car users who have been killed or seriously injured has fallen over the past 30 years despite huge increases in the volume of traffic (Wallis and Greaves, 2002).

However, sternal fractures are still common and remain one of the non-fatal RTA-related injuries that have actually increased in frequency over the last two decades even after the introduction of seat-belt legislation. Sternal fractures are associated with

transfer deceleration forces to the occupant of the vehicle, either directly by impact or indirectly via restraints. Subsequent legislation required that air bags be placed in cars as standard equipment (US Department of Transportation, National Highway Traffic Safety Administration, 1984). Previous studies have demonstrated the effectiveness of air bags in reducing occupant fatalities in RTAs (Antosia et al, 1995). Despite the ability of air bags to lower the risk of fatal and non-fatal injury in high-energy RTAs, their deployment is not without risk, and may occasionally cause injury or even fatal trauma (Cunningham et al, 2000).

This article presents a case report of a husband and wife who were involved in a high-speed, head-on RTA. Both had seat-belt restraints. Air bag deployment occurred on the driver's side only. Both patients sustained sternal fractures with the husband's fracture more displaced, resulting in an increased analgesic requirement and hospital stay for him. This highlights the need to remain vigilant for more serious injuries in a patient with the combined protection of both seat-belt restraint and air bag compared to seat-belt restraint only, especially when multiple patients are injured in the same vehicle. This article discusses the history and mechanism of air bag function with a review of air bag safety following RTAs.

## Discussion

An air bag is a deflated balloon that inflates rapidly following a motor vehicle crash impact to cushion the occupant from injury. They are usually contained in the steering wheel or dashboard but can also be found in side-impact panels.

Triggering of a deceleration sensor located in the front bumper or engine firewall

results in the activation of a pyrotechnic device containing sodium azide. The sodium azide is ignited, producing a rapid temperature variation from ambient to 700°C and back again in <100 msec. This process generates nitrogen which inflates the air bag (Cunningham et al, 2000).

Air bags deploy in 30–50 msec and flatten again in approximately 100 msec. Air bags deploy only once, thus any second collision can result in impact against the structures of the cockpit while the air bag is empty.

Previous studies have demonstrated the effectiveness of air bags in reducing occupant fatalities in RTAs. Estimates of reductions in deaths range from 20–29% with air bags and seat-belts compared to seat-belts alone (O'Neill and Lund, 1992; Zador and Ciccone, 1993). A 25–29% reduction in moderate to severe injuries following air bag deployment *vs* cars equipped with automatic safety belts has also been seen (Antosia et al, 1995).

Air bags appear most effective in fatality reduction in restrained *vs* unrestrained drivers (Zador and Ciccone, 1993). Serious head and torso injuries have also declined more than other injuries, as air bags help prevent the violent whiplash motion seen in front impact crashes (Jagger et al, 1987). However, these statistics have some limitations – they are not population based and do not account for confounding variables such as crash speed, driver's age, and other motor vehicle safety features.

Despite the ability of air bags to lower the risk of fatal and non-fatal injury in high-energy RTAs, the force required for deployment is not without risk and may occasionally cause injury or even fatal trauma. Burns to the eyes, face and upper limb have been described following deployment as a result of the small amount of sodium hydroxide produced by ignition of the air bag. Reports of blunt ocular trauma, causing periorbital contusion, corneal abrasions, subconjunctival haemorrhage, and traumatic hyphema with permanent visual impairment, have become more common (Lehto et al, 2003). Facial abrasion, lacerations to the chin, lips, nose, cheek and brow arch have also been reported. Other injuries include thermal burns caused by inspiration of hot gases, and barotrauma resulting in hearing deficits following initial inflation. There is also evidence of an increase in lower limb injuries as a result of a redistribution of forces in crashes with

air bag deployment especially in unbelted occupants (Antosia et al, 1995).

The force of impact between an unrestrained accelerating driver and inflating air bag is thought to produce a flexion mechanism as the driver is pitched forward, which can cause cervical and thoracic vertebral fractures. There is a lower frequency of injuries among restrained drivers, but they are still exposed to a forward displacement, which can cause sternal injuries as well as hyperextension injuries of the cervical vertebrae (Blacksin, 1993). Although Mr W had combined lap-shoulder seat-belt and air bag restraints, it was thought that his injury was related to this forward displacement, thus causing a similar injury to his wife. Another mechanism of injury in someone restrained by a three-point system involves the initial punch out of the air bag from the container, but this seems mainly to affect the unrestrained driver (Sutyak et al, 1997). Mr W made no reference to the deployment of the air bag and the onset of his symptoms.

Protocols for the management of traumatic sternal fractures vary considerably throughout the UK from admission to the general, trauma and orthopaedic or thoracic surgical units through to the direct discharge of the patient from the accident and emergency department with early outpatient review (Velissaris et al, 2003). Conventional trauma management suggests that sternal fractures may be associated with serious intrathoracic injuries, particularly myocardial contusion and thoracic aortic injury. Most units including the authors' thoracic unit will admit these patients for pain control and observation in case of any significant injury. Velissaris et al (2003) completed a retrospective review of 73 patients with acute sternal fractures. They suggested that most patients who sustain isolated low-impact sternal trauma with an undisplaced fracture do not require admission. However, immediate discharge from the accident and emergency unit required appropriate analgesia and respira-

tory advice after a thorough assessment. Those requiring admission tended to have significant pre-existing co-morbidities, sustained high-impact thoracic trauma, significant associated injuries or poor social circumstances. The admission of Mr and Mrs W was felt to be appropriate given the speed and nature of their RTA.

## Conclusions

The combined use of vehicle lap-shoulder belt restraints and air bags offers the best protection to the occupant following a RTA but even if the air bag deploys successfully, the emergency team should never discount a more serious injury in that person, even if the accompanying passenger without air bag deployment has minor injuries. **BJHM**

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## Case Report

Mr and Mrs W were admitted to the regional thoracic unit with sternal fractures following a head-on road traffic accident at a combined speed greater than 70 mph. Both were wearing lap-shoulder seat-belts, but only the driver's side had an air bag, which deployed normally on impact. They were assessed and treated according to the Royal College of Surgeons Advanced Trauma and Life Support guidelines at the crash site and transferred to the regional trauma centre for further assessment and treatment. Manual extraction from the vehicle was not required.

### 1. What further information from the paramedic team would be helpful in this situation?

Both Mr and Mrs W complained of severe retrosternal pain exacerbated by inspiration. No other complaints were noted. Both patients had normal Glasgow Coma Scales and remained haemodynamically stable. Each had bruising and marked tenderness over the sternum. Mr W had further bruising and tenderness over the right supraclavicular fossa but no other abnormality. Auscultation confirmed normal heart sounds, and satisfactory air entry to both lung fields without added sounds. The rest of the clinical assessment was unremarkable. Both patients were previously well and smoked (20/day).

### 2. What initial investigations would you request?

Haematological investigations were normal with haemoglobin concentrations of 14.4 g/dl and 13.9 g/dl respectively. Serum creatinine kinase was raised as expected but the myocardial band isoform remained normal. Twelve-hour serum troponin-1 was also normal. Electrocardiograph demonstrated normal sinus rhythm with no acute changes. The sternal view radiograph revealed sternal fractures in both individuals with increased displacement of the posterior table in Mr W's X-ray. Frontal radiograph of the chest performed in both patients did not reveal any evidence of rib fractures, pneumothorax or haemothorax.

### 3. What are the treatment options for both patients?

Both patients were treated conservatively with oral analgesia, inhaled nebulisers, chest physiotherapy and monitored by cardiac telemetry for 24 hours. Throughout the admission, Mr W complained of more severe sternal tenderness than his wife, who remained comfortable. He also complained of back pain. Repeat clinical examination showed soft tissue tenderness at the level of the thoracic vertebrae. Thoracic spinal X-rays demonstrated old crush fractures with no acute injury. No active intervention was required following orthopaedic assessment.

Mrs W was discharged well on day 3 and Mr W on day 4. Mr W was reviewed 2 weeks post-discharge complaining of persisting sternal pain. Clinical examination elicited sternal tenderness as before but also a firm swelling in the line of his seat belt at the right supraclavicular fossa. Ultrasound showed a resolving haematoma with no evidence of a traumatic false aneurysm. At 6-month review, Mrs W remained well but Mr W still complained of persistent sternal tenderness requiring regular oral analgesia. Check X-rays of both patients showed healing sternal fractures with no other abnormality. No other investigation or treatment was required and they were discharged.

Mr ME O'Donnell is Specialist Registrar in Vascular Surgery, Mr D McCaul is Senior House Officer in General Surgery, Mr M Nazir is Specialist Registrar in General Surgery and Mr J McGuigan is Consultant Thoracic Surgeon in the Department of Thoracic Surgery, Royal Victoria Hospital, Belfast BT12 6BA

Correspondence to: Dr ME O'Donnell

## TEACHING POINTS

- Despite the introduction of seat-belt legislation, sternal fractures are still increasing in frequency following road traffic accidents.
- Although beneficial and protective in most cases, air bag deployment is not without risk and has its own unique complications.
- Even if an air bag deploys successfully, the emergency team should never discount a more serious injury in that person, even if the accompanying passenger without air bag deployment has minor injuries.