

Airbags and children: a spectrum of C-spine injuries

Journal of Pediatric Surgery
June 1998; Vol. 33, No. 6; pp. 811-816

JF Giguere, D St-Vil, A Turmel, M Di Lorenzo, C Pothel, S Manseau and C Mercier
 The authors are from the Division of Pediatric General Surgery and Neurosurgery,
 Hospital Sainte-Justine, Montreal, Quebec, Canada.

KEY POINTS FROM THIS ARTICLE:

- 1) Over 30 children who were improperly restrained or in rear facing safety seats have been killed in motor vehicle accidents (MVA) involving airbags.
- 2) Airbags deploy by releasing a hot effluent at 300 km/h [186 m/hr].
 Mechanisms of injury include:
 - A)) Direct contact of hot gas with facial skin.
 - B)) Energy transmitted directly from the airbag system to the child's head and neck.
- 3) In the US airbags were first offered as an option in a few cars in the 1970s. The percentage of new cars equipped with driver's side airbags was 68% in 1993 cars and 91 % in the 1994 cars.
- 4) In the US, the combination of driver and front seat passenger airbags and three-point seatbelts became mandatory September 1997 in all passenger cars.
- 5) "Numerous studies have confirmed that airbags reduce fatalities in frontal car crashes." They "estimated the risk of fatal injury to be reduced by 23% when combining manual seatbelts and airbags relative to manual seatbelt alone."
- 6) "Although there is a significant decrease in fatality rate with the use of airbags, there is a growing amount of literature on lesions caused by airbag deployment."
- 7) In a recent report of 614 airbag-induced injuries affecting 279 people (both drivers and passengers) from 1980 to 1994, most occupants sustained abrasions, contusions, and lacerations. Ninety-six percent of the injuries were classified as minor, 3% moderate, 0.8% severe, and 0.1% critical.
- 8) Fatal injuries have been described in adults as well as in children, in low-speed accidents (10 to 20 km/h) [6.2-12.4 m/hr]. These deaths were a direct consequence of airbag deployment, and in nearly every case, a proper seat belt was not used. All deaths were caused by thoracic or brain injuries with no spine injury.

9) In this article, the authors describe 3 cases of airbag-induced injury to the cervical spine causing minor to fatal injuries in properly restrained children seated in the front passenger seat.

Case 1

A 10-year-old boy was involved in a low-speed (40 km/h) [25m/hr] motor vehicle accident (MVA) that resulted in deployment of both airbags. He was a front seat passenger properly restrained by a seatbelt. The driver was uninjured but the boy complained of blurred vision, a stiff and painful neck, and facial burn. His eye injury was the result of direct contact of the hot gas released from the airbag.

Neurological examination results were normal except for neck pain. Cervical spine x-rays showed no abnormality except loss of cervical lordosis. He recovered without complication.

Case 2

A 4-year-old boy was involved in a low velocity (20 km/h) [12.4 m/hr] car accident with deployment of both airbags. He was in a front booster seat, restrained only by the abdominal component of the seatbelt and was moving forward toward the dashboard at impact. Immediately after the collision he was unconscious and soon died. Cervical spine x-rays showed atlanto-occipital dislocation, resulting in complete spinal cord transection at the C1 level.

Case 3

A 3-year-old boy in the front seat was involved in a 60 km/h [37 m/hr] MVA. He was properly restrained in his booster seat with a three-point seatbelt. Brain CT scan showed a subarachnoid brainstem hemorrhage, raising a strong suspicion of a ligamentous tear at the craniocervical junction. CT scan eventually showed a partial alar ligament avulsion, yet initial and 1-month follow-up flexion/extension cervical radiographs remained normal.

10) Airbag deployment has been reported to cause abrasions to the face, eye lesions caused by abrasion or powder in the deployment gas, limb fractures, and asthmatic attacks. The great majority of these injuries are minor but some are fatal. The causes of death reported in pediatric patients were mainly brain trauma.

11) In children, the craniovertebral junction is quite vulnerable to trauma induced by deployment of a high velocity airbag. "Chin, mandible, and facial lesions associated with airbag deployment indicate that the head received a significant impact during the deployment. The head to torso ratio is much higher in children than in adults, resulting in a greater momentum of the head movement after impact, which could be enough to produce at least a cervical sprain or whiplash-like syndrome."

12) The occiput-atlas junction has increased injury vulnerability in children because:

A)) The occiput condyle is relatively flat condyle and the atlas articular surfaces shallow so that structural integrity depends on ligaments.

- B)) These ligaments are relatively lax in the children.
- C)) Ligaments have increased stress because of the relatively large head and poorly developed cervical musculature in children.
- D)) Airbag deployment injury is primarily ligamentous by hyperextension.
- E)) The Occipital-atlas ligaments most injured are the tectorial membrane, the alar ligaments, and the apical ligament of the dens.

13) Many cases of occiput-atlas injury in children and adults are missed using plain lateral cervical spine x-ray, but are noted with high-resolution CT images, which are the study of choice when there is a suspicion of occiput-atlas injury.

14) The alar ligament is the most powerful stabilizer of the atlanto-occipital joint; its disruption is disastrous for cranio-cervical stability, and consequently a potential life-threatening condition.

15) In accidents involving children where the airbag deployed, occiput-atlas injury must be ruled out, even if the actual accident appears to be minor. The cervical spine must be stabilized at the accident site without any hyperextension or distraction. Cervical x-rays and CT or MR to evaluate occiput-atlas ligaments must be performed.

16) Because of airbags, all children below 12 years of age or less than 40 kg [88 lbs.] of weight should be properly restrained in the rear seat. This also applies to short-stature adults.

17) In the pediatric population, occiput-atlas injury associated with airbag deployment is a potentially fatal lesion at any impact velocity.

COMMENTS FROM DAN MURPHY:

1) Children can sustain serious cervical spinal injuries by deployment of a passenger-side airbag, even when properly restrained, and in low speed collisions.

2) The predominance of these injuries are at the upper cervical spine.

3) The mechanism of injury is hyperextension.

4) Standard radiographs, including stress radiography of flexion/extension can miss serious soft tissue injuries.

5) High-resolution CT scanning is the modality of choice for the diagnosis of these injuries.

6) Children are anatomically unique as compared to adults, and this anatomical uniqueness predisposes them to upper cervical injuries.

7) The safest place for children younger than age 12 is in the back seat.