Case Report

Fatal Airbag-Mediated Atlanto-Occipital Dislocation in a Child

Radhiana HASSAN[1], Mubarak MOHD YUSOF[2], Norie Azilah KAMARUDIN[2]

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[1] *Department of Radiology, International Islamic University Malaysia, 25100 Kuantan, Pahang, Malaysia*

[2] *Department of Diagnostic Imaging, Hospital Tengku Ampuan Afzan, 25100 Kuantan, Pahang, Malaysia*

Abstract

An atlanto-occipital dislocation is a rare airbag-induced injury in trauma patients. We report a case of an atlanto-occipital dislocation in a 6-year-old patient who was an unrestrained passenger in the front seat of a vehicle involved in a low-speed motor vehicle accident. This case illustrates the fatal threat of airbag deployment to the child passenger travelling in the vehicle front seat even in a low-speed collision, and supports the recommendation that children under 12 years of age travelling in vehicles with dual airbag systems should be seated in the back.

Keywords: *air bags, atlanto-occipital joint, child, dislocation, traffic accidents, trauma*

Introduction

The dual-airbag system introduced in passenger vehicles has been proven to be effective in preventing fatalities among front-seat adults involved in motor vehicle accidents (1). However, this same system poses a potential threat to the front-seat child passenger even in the event of a low-speed collision (2). The bag inflates quickly from a chemical explosion, which has been likened to a collision at 300 km/h (3). This explosion can cause fatal injuries to the head and cervical spine. Atlanto-occipital dislocation is a serious and often fatal type of injury that can be caused by airbag deployment (4).

Case Report

A previously healthy 6-year-old girl was travelling with her family in a car. She was unrestrained and seated in the front passenger seat. The family was trapped in a traffic jam and the car was moving slowly, closely tailing a car in front of it. The car struck the rear end of the vehicle in front when it braked suddenly. The child was thrown forward towards the dashboard, and the impact deployed the airbag, which hit her on the face, causing her to immediately be knocked unconscious. The driver, who was her father, was not sure whether she actually hit the dashboard or not. No other people were hurt in the accident, including a 6-month-old baby who was on the mother's lap seated in the rear seat. The 6-year-old was sent to the nearest private hospital about 15 minutes later. Upon arrival in the emergency department, clinical assessment revealed a Glasgow Coma score of 3. She was hypotensive, apnoeic, and flaccid with bilaterally dilated and sluggish pupils. She also had a large laceration wound on her chin. Otherwise, there were no external injuries. Her abdomen was distended. Cardio-pulmonary resuscitation was performed for about 45 minutes. A bedside ultrasound of the abdomen showed the presence of free fluid. She was clinically diagnosed with an intra-abdominal injury with hypovolemic shock and hypoxic encephalopathy. She was rushed to the operation theatre and an emergency laparotomy was performed. Intraoperatively, there was a splenic laceration, which involved the splenic hilum. This laceration resulted in an estimated blood loss of 2 litres. The rest of the intraperitoneal structures were intact. The laceration wound at the tongue and chin was also sutured during the operation. Post-operatively, her condition remained the same, and she was referred to Hospital Tengku Ampuan Afzan for further management 2 days later. Computed tomography (CT) of the brain and cervical spine was done in our hospital. The head CT showed extensive subarachnoid haemorrhages in both cerebral hemispheres with generalised effacement of the cerebral sulci, a loss of grey and white matter differentiation and obliteration of the lateral ventricles and suprasellar cistern (images not shown). The cervical CT revealed an atlanto-occipital dislocation with a basion dental distance (BDI) measuring 25 mm and a basion

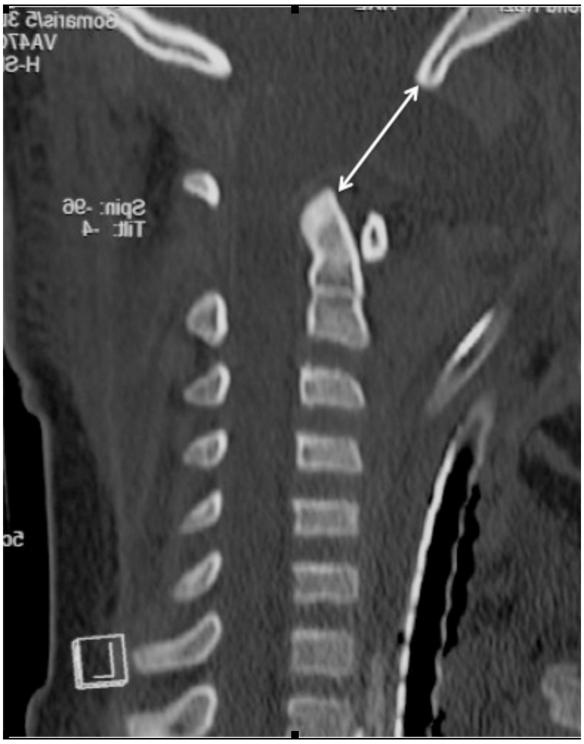

Figure 1: Mid-sagittal reformatted computed tomography scan of the cervical spine in the bone window setting demonstrates widening of the atlanto-occipital joint with a basion-dens interval (arrow) measuring 25 mm.

Figure 2: Mid-sagittal reformatted computed tomography scan of the cervical spine in the soft tissue window showing pre-vertebral soft tissue swelling. The arrows show the fluid density area within this pre-vertebral swelling, which was suggestive of cerebrospinal fluid leakage.

axial interval (BAI) measuring 22 mm (Figures 1 and 2). There was no fracture of the cervical spine. The patient died 5 days after the accident due to multiple injuries.

Discussion

Airbag deployment systems in passenger vehicles were introduced for extra protection in addition to seatbelt use. Airbags are designed to cushion the adult's head and chest in a crash event. Numerous studies have confirmed that airbags reduce fatalities in frontal car crashes among the 13 years and older age group (1). However, they pose a potential threat to the front-seat child passenger even in the event of a low-speed collision involving a child properly restrained with a safety device (2).

When there is a frontal crash, airbag deployment can occur even during a low-speed collision ranging 13–62 km/h with an average of 27 km/h (4). The airbags inflates quickly from a chemical explosion—within 0.05 seconds or less—at speeds likened to a collision at 300 km/h (3). This forward-facing front-seat child victim was propelled forward toward the dashboard at the time of collision. If unbelted, the child may achieve a near-standing posture and will be closer to the airbag when it deploys (4). The face and frontal cranium receive the first impact, followed by violent hyperextension of the head and neck as the bag inflates and propels the child toward the rear end of the vehicle. The child may also be subjected to upward-directed forces, depending on the angle of deployment from the dashboard, and this might explain the wide separation of the atlanto-occipital joint and the associated soft tissue injuries to the chin and tongue seen in this patient. This severe form of cervico-cranial injury in paediatric patients as a direct result of a passenger airbag deployment occurring in a low-speed collision deemed otherwise survivable has been reported previously (4,5). However, the mechanism of injury causing splenic laceration in this patient was unclear. It might have occurred from the impact of blunt trauma to her body from any parts of the vehicle before or after the airbag deployment.

An atlanto-occipital dislocation is a rare airbag-induced injury. The exact epidemiology of atlanto-occipital dislocation is difficult to establish because lethal cases are not autopsied and reported in the medical literature (5). It is normally fatal when it occurs; however, increasing numbers of survivors have been reported. This increase is attributed to the improvements in on-site resuscitation, rapid transportation to the hospital with head support, and increasing awareness of this injury. The injury has been noted to be three times more common in children than in adults (5). Children are more vulnerable to this type of injury. The immature spine is hyper mobile because of ligamentous laxity, shallow and angled facet joints, underdeveloped spinous processes, and physiologic anterior wedging of vertebral bodies. Incomplete ossification of the odontoid process, a relatively large head, and weak neck muscles are other factors that predispose the joint to instability in this age group (6). In adults, this dislocation is frequently accompanied by a cervical bone fracture. However, in children, as in this case, vertebral body fracture is uncommon because of the inherent elasticity of the juvenile spine.

The diagnosis of the atlanto-occipital dislocation is often difficult because inadequate initial neurological assessments are made due to concomitant head injuries, blunt thoracic, and abdominal trauma and fractures of the limbs. A high degree of suspicion is mandatory in children who have experienced airbag deployment (5).

There are a variety of measurements proposed for the diagnosis of atlanto-occipital dislocation on radiograph and computed tomography, each with different specificities and sensitivities (7–9). The basion-axial interval (BAI) and basion-dental interval (BDI) method proposed by Harris et al. is recommended. The BAI is the distance, either anterior or posterior, between the basion and the rostral extension of the posterior cortical margin of the body of the axis (known as the posterior axial line). The normal BAI extends from 12 mm anterior to 4 mm posterior to the posterior axial line. The BDI is the distance between the basion and the tip of the dens and normally does not exceed 12 mm (7). Pre-vertebral soft tissue swelling at the occipitocervical junction is a consistent finding on lateral radiograph (10). However, many cases of atlanto-occipital dislocation are missed using only plain lateral cervical spine X-rays. The shortcomings of this approach are related to the magnification factors, variations in the position of the neck, and concomitant fractures of the atlas and axis. In paediatric patients, this is more challenging, and the identification of landmarks is more difficult due to the variability of bone ossification in the craniocervical junction (6). High-resolution CT with reformatted coronal and sagittal images is the imaging study of choice when there is suspicion of atlanto-occipital dislocation. Subarachnoid haemorrhage at the craniocervical junction is often associated with atlanto-occipital dislocation and should raise the suspicion of severe craniocervical ligamentous injury (11).

There is insufficient evidence to support treatment standards and guidelines for the management of atlanto-occipital dislocations (12). Without treatment, nearly all patients develop neurological worsening, and some did not recover. Traction and external immobilisation have been used successfully in some patients; however, transient or permanent neurological worsening and late instability have been reported more often with these techniques compared to surgical treatment. Craniocervical fusion with internal fixation is recommended for the treatment of patients with acute traumatic atlanto-occipital dislocation.

This case demonstrates the perils of sitting a young patient less than 12 years old in the front passenger seat of a vehicle with dual airbag systems. Fatal injuries can occur even in the event of a low-speed impact.

Authors' Contributions

Conception and design, drafting of article: RH
Analysis and interpretation of the data, critical revision of the article, final approval of the article, provision of patient: RH, MMY, NAK

Correspondence

Dr Radhiana Hassan
MD (USM), MMed Rad (USM)
Department of Radiology
International Islamic University Malaysia
25100 Kuantan
Pahang, Malaysia
Tel: +609-5572056
Fax: +609-5149396
Email: radhianahassan@gmail.com

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