CASE REPORT

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Airbag Mediated Death of a Two-Year-Old Child Wearing a Shoulder/Lap Belt

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ABSTRACT: Airbag injuries have resulted in the deaths of several infants and small children, and such deaths are generally associated with rearward-facing infant seats or unrestrained children in front passenger seats of cars equipped with airbags. An airbag can also cause death in a small child wearing a shoulder/lap belt, however, as this case report illustrates. A two-year-old female was involved in a low-speed collision while riding in the front passenger seat of a dual-airbag-equipped automobile. Secondary impact with the airbag caused catastrophic occipitoatlantoaxial disarticulation with traumatic spinal cord separation, thermal injury and abrasions of the right forearm and distinctive patterned abrasions of the face. The possibility of airbag injury should be considered in all low-speed traffic fatalities, and the confirmatory injuries sought at post-mortem examination.

KEYWORDS: forensic science, forensic pathology, death, airbag, traffic fatalities, atlantooccipital dislocation

With the advent of the airbag as a means of passive restraint in automobiles—to prevent fatalities in high-speed collisions—a tragic irony has emerged in the form of child mortality (caused by the airbag itself) in low speed collisions. The most highly publicized reports to date involve rearward-facing infant seats secured to front passenger seats in dual airbag-equipped automobiles or, alternatively, airbag impact with an otherwise unrestrained child (1–3). Little attention has been directed to the potential for airbag fatality when shoulder/lap belts are concurrently in use. However, passenger-side airbags are capable of inflicting lethal neck injuries even in a properly restrained adult (4). This report describes the pattern of injuries sustained by a two-year-old child who was seated in an airbag-equipped front passenger seat, wearing a shoulder/lap belt, in a low-speed collision which occurred in a small town near Oklahoma City. The circumstances of this case serve to fortify the argument that there is no reliably safe way for a young child to travel in an airbag-equipped seat.

Case History

A two-year-old female was riding in a vehicle which rear-ended a stationary second car, at a speed estimated at 30 mph. The driver, a non-relative caretaker, was holding the unresponsive child in her arms when the investigating police officer arrived on the scene. The victim was helicoptered to a trauma center where she was maintained on life support for a time, during which a diagnosis of atlantooccipital/atlantoaxial dislocation was made on the basis of cervical spine X-rays. Artificial life support was subsequently terminated, and the body delivered to the medical examiner for post-mortem examination.

The driver, a licensed day care provider, told police that the victim and her three-month-old sibling were each secured into infant car seats in the back, the victim being situated on the passenger side. According to the driver, there had been the sound of a latch being unfastened a few moments before the accident, and the victim had come flying over the passenger-seat backrest upon impact. Nonetheless, noting that the infant seat in question was not buckled to the automobile seat, the investigating police officer issued a citation to the driver for having an unrestrained child in the car. The three-month-old sibling, incidentally, was properly fastened in at the scene and was unharmed. The driver was also without injury.

Autopsy Findings

The brain was evaluated in standard fashion, in addition to which the upper spinal cord was removed via an anterior approach, followed by a posterior neck dissection for direct visualization of the bony spinal column. The double vertebral traumatic disarticulation, associated with considerable soft tissue hemorrhage as well as subdural blood around the spinal cord, was visualized. The spinal cord itself had been traumatically separated in the medulla/spinal cord junctional area. Intracranially were found acute, bilateral subdural hematomata and diffuse subarachnoid hemorrhage over both cerebral hemispheres.

A straplike band of contusion/abrasion was present across the undersurface of the chin and right mandibular surface (Fig. 1*a*). Upon closer inspection, a fine weblike pattern was discerned, consistent with a fabric imprint (Fig. 1*b*). Faint abrasions were also observed on the right cheek, anterior chin and forehead. After holding the body overnight, a recognizable fabric pattern developed in these markings as well. In these facial lesions, however, the pattern had more of a checkerboard character than did the inferior chin markings, with a different periodicity and directionality (Fig. 2*a*). On the inner surface of the upper lip, to the right of the midline, were two small lacerations consistent with tooth marks.

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Finally, there was a crisply demarcated, yellow-tan, 11.5 × 4.0 cm lesion on the anteromedial right forearm, consistent with a superficial burn injury. At the leading edge of the burn was a cluster of parallel deep abrasions, curvilinear in shape, each measuring 3.0 to 4.0 cm in length (Fig. 3).

Investigative Findings

Postmortem comparisons were made with respect to the size of the victim's unclothed body and the car seat. It was possible to fit the child into the car seat at the existing strap adjustments, albeit very snugly. It was considered whether the chin imprint could have been made by one of the two vertical car seat straps, but the idea was discarded as being implausible, primarily because the strap mark crossed the chin horizontally. In order for a car seat strap to create such an injury, the child would need to be lying sideways with her head fastened between a strap and the edge of the car seat. In addition, the car seat strap was of insufficient width to account for the injury.

A pathologist and an investigator inspected the vehicle at its place of impoundment. The damage to the front end of the car appeared consistent with a 30 mph impact, and the windshield appeared to have been fractured by secondary impact of the passenger side airbag module cover. The absence of a fabric pattern on the back of the passenger headrest was noted, indicating that the

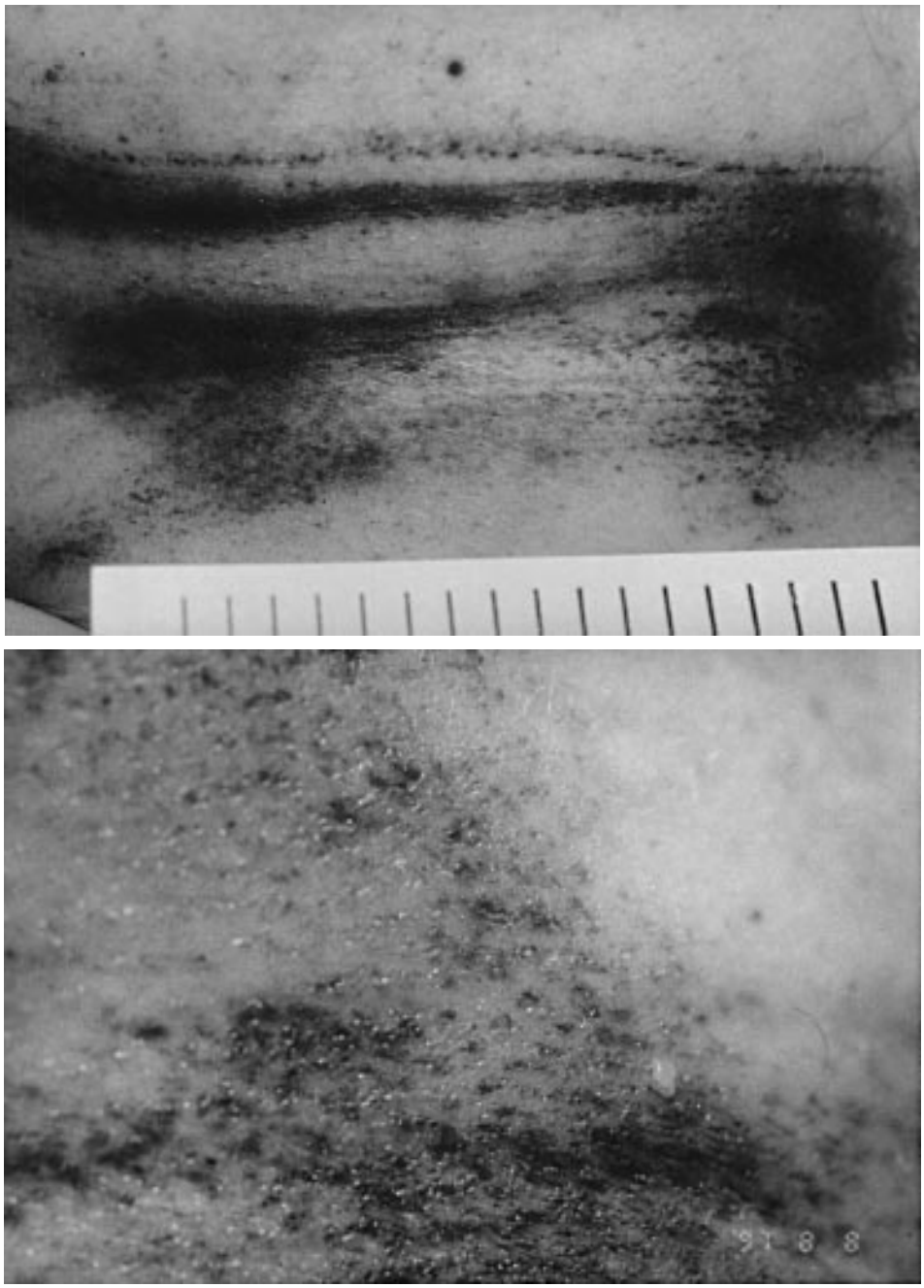

FIG. 1—(a) *A belt-like band of contusion extends across the undersurface of the victim's chin, consistent with the predicted level of a shoulder belt across a two year old child.* (b) *Close-up of the lesion reveals a fine pattern suggestive of fabric weave.*

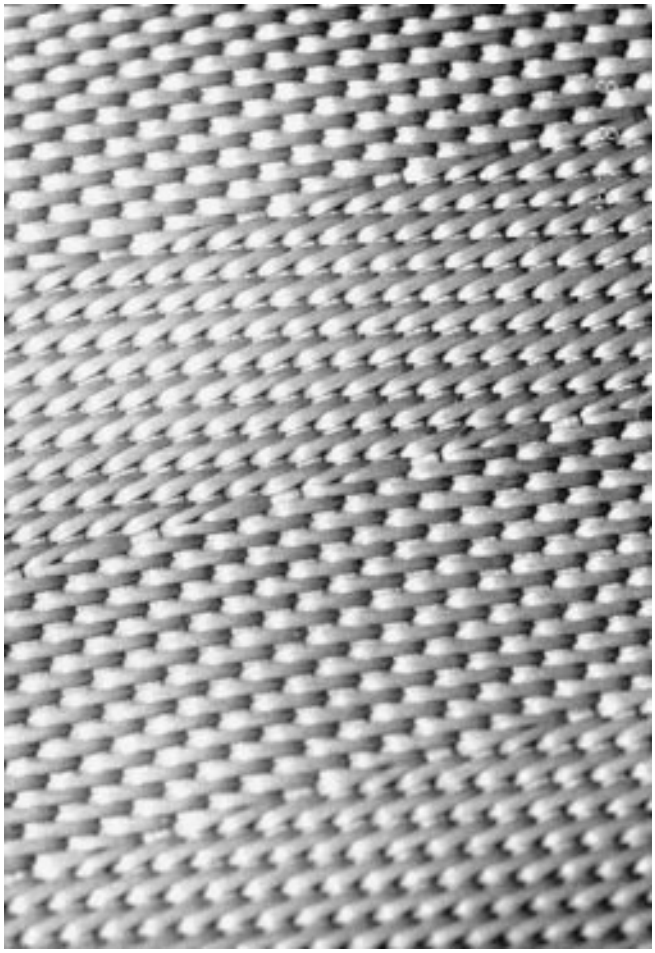

FIG. 1—(c) *Appearance of the belt weave is consistent with the contusion pattern.*

facial abrasions were not caused by impact with the automobile seat, and the weave patterns of the airbag and the shoulder/lap belt were observed and photographed. The pattern of the chin contusion was consistent with the weave pattern of the shoulder belt (Fig. 1*c*), and the fabric pattern of the airbag corresponded to the abrasion pattern on the victim's face (Fig. 2*b*). The airbag had two gas exhaust ports, one on either side, consisting of round apertures with reinforced plastic rims, thereby accounting for the apparent burn and curvilinear abrasions on the right forearm.

The console cupholder contained a soft drink cup on the driver's side and a Styrofoam ice cream cup on the passenger side. In addition, further investigative policework produced a witness who worked at a local drive-in and who could recall having seen the victim seated in the front passenger seat shortly before the accident.

Collectively, the autopsy and investigative findings were interpreted as being consistent with the victim having been seated in the front passenger seat, restrained by a shoulder/lap belt (or at least encircled by the shoulder belt portion), and having been mortally injured through violent hyperextension of the neck by the deploying airbag. The findings were regarded as being altogether inconsistent with seating in the rear, either restrained or unrestrained.

Discussion

Disruptions of the occipitoatlantoaxial complex are a catastrophic consequence of violent hyperextension of the neck (5–8). Although the injury is certainly not limited to the pediatric population, very small children are much more susceptible than adults, due to the relatively flat and horizontal interface presented by the occipital condyles in relation to the superior articular facets of the atlas (9). With growth, the atlantooccipital articulation develops a more curved, cuplike character, which greatly enhances its anterior/posterior stability. Therefore, atlantooccipital dislocation is a predictable consequence of a young child being struck in the face by an airbag. Peak deployment speeds in airbags may exceed 350 mph (10).

Any child fatality in a low-speed collision should raise the question of an airbag deployment, and should prompt careful examination for corroborative evidence of an airbag induced lesion. This is particularly important when atlantooccipital disarticulation is discovered to be the lethal injury. Use of a shoulder/lap belt does not prevent airbag lethality; indeed for a small child the shoulder strap tends to pass immediately beneath the chin and may actually aggravate neck hyperextension through a submarining effect.

Most states have laws which prescribe appropriate restraint applications for children below a specific age/size. In addition to criminal considerations, civil litigation is highly likely in any case involving a person killed by airbag deployment. Therefore, incentive for driver duplicity may be quite high, especially in cases involving a non-relative caretaker of a deceased child. This case illustrates the relative ease with which an autopsy can clarify issues of seating and restraint, provided that the accident history is

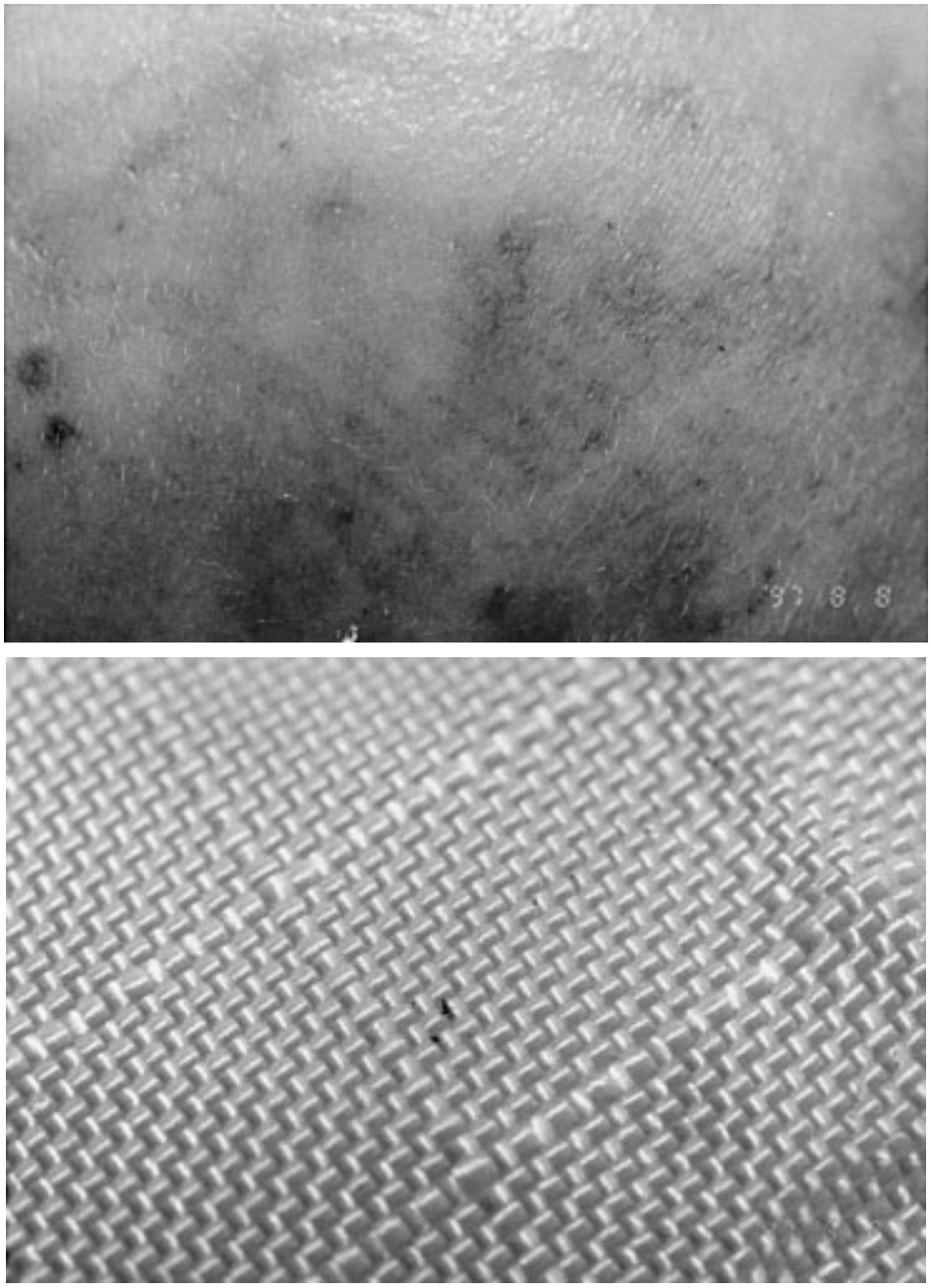

FIG. 2—(a) *The facial abrasions possess a faint but unmistakable weave imprint pattern, distinct from the pattern noted on the chin contusion. The pattern was initially focal and phantasmal in character, and was fully appreciable only after the body had been held overnight.* (b) *Close-up of the offending airbag surface.*

FIG. 3—*The anteromedial surface of the right forearm is superficially denuded in a manner suggestive of a burn. At the leading (distal) edge is a series of deep, curvilinear abrasions. The lesion was caused by hot gaseous effluents combined with a scrapping motion across the firm anterior edge of the airbag's exhaust port.*

weighed with judicious skepticism. Key autopsy findings to be sought in suspected airbag fatalities are: (1) cervical spine injury combined with evidence of blunt head trauma, (2) patterned abrasions of the face, which may not be immediately evident at the autopsy table if the postmortem interval is brief, and (3) thermal injuries from propellant exhaust. It is recommended that the vehicle and airbag be examined in addition to the victim, to satisfy the scientific imperative of the autopsy as well as to buttress testimonial credibility in future legal proceedings.

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