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TRANSPORTATION SCIENCES CENTER
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Division of Arvin/Calspan
[redacted] New York [redacted]

CALSPAN REMOTE AIR BAG DEPLOYMENT INVESTIGATION

CALSPAN CASE NO. 91-6

VEHICLE - 1990 AUDI 100

LOCATION - [redacted]

ACCIDENT DATE - [redacted], 1990

Contract No. DTNH22-87-C-27169

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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15. Supplementary Notes Remote investigation of an air bag deployment crash that involved a 1990 Audi. A 2 year old child occupant (unrestrained) vaulted over the front seat back and came to rest on the left front floor where air bag generant residue spewed onto his face producing thermal burns.

16. Abstract

This remote investigation focused on a 1990 Audi 100 that was involved in a head-on crash. The frontal impact sequence resulted in a sufficient longitudinal deceleration to deploy the Audi's driver air bag system. A 2 year old male was positioned in the rear seat area of the vehicle and was not restrained. At impact, he vaulted over the front seat back and came to rest on the left front floor area in a face-up attitude. Air bag generant residue exhausted from the bag's venting ports and spewed onto the child's face resulting in thermal burns (AIS-1) of the cheeks and thermal burns of both corneas (eyes).

The child was transported to a local hospital and was treated by an opthamologist. Inputs for this remote investigation were obtained from the attorney who is representing the child's family and from the ophthalmologist who treated the child.

17. Key Words	18. Distribution Statement
Frontal crash Air bag deployment Thermal burns of the face and eyes Air bag generant residue	General Public

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CALSPAN REMOTE AIR BAG DEPLOYMENT INVESTIGATION

CALSPAN CASE NO. 91-6

VEHICLE - 1990 AUDI 100
LOCATION - [redacted]

SUMMARY

This remote investigation focused on an air bag deployment crash that resulted in facial and eye injuries to a 2 year old who was unrestrained in the rear seat area of a 1990 Audi 100. The investigation was triggered by an article which appeared in a medical publication that was authorized by the ophthalmologists who treated the child. The ophthalmologists reported "that the air bag had burst during the crash sequence and showered the occupants with a fine black powder that consisted of ash and small amounts of sodium hydroxide." Information for this report was obtained from the attorney who represents the victim's family and from the ophthalmologist who treated the 2 year old child.

This crash occurred on [redacted], 1990, in [redacted]. The 1990 Audi was traveling on an undivided roadway at a moderate rate of speed. An approaching vehicle crossed the centerline of the roadway and entered the Audi's path of travel. The vehicles subsequently impacted in a head-on configuration which resulted in severe damage to the Audi. The attorney stated that the Audi was a total loss and was disposed of through the insurance company. As a result of the crash, the Audi's driver air bag system deployed.

The driver of the Audi was an adult male (2 year old's uncle) who was reportedly restrained by the active 3-point lap and shoulder belt system. The active belt and the deployed air bag provided sufficient restraint to the driver and prevented him from injury. The right front occupant was the mother of the 2 year old. She was also restrained by the active 3-point lap and shoulder belt system. The right front occupant was reportedly wearing a tank- or halter-top. She loaded the active belt webbing and sustained a diagonally orientated contusion across her chest (AIS-1) from the belt webbing. Both front seat occupants noted a blackish smoke within the vehicle immediately following the crash that they later identified as discharge from the deployed air bag.

The 2 year old male occupant was positioned in the rear seat area of the Audi. He was not restrained in either a child seat or the 3-point active belt system that was available in the rear seated positions. The unrestrained child was thrust forward by the impact force and either traveled between the front seat backs or vaulted over the seat back, before coming to rest on the left front floor area. It was unknown if the child had contacted the deployed air bag, or had struck another object or occupant before coming to rest.

The child came to rest on his back with his face under the steering assembly and the deployed air bag. Hot particles (generant residue) exhausted from the air bag's venting ports and settled onto the 2 year old's face. He was subsequently removed from the vehicle and transported by ambulance to a local hospital emergency room. The child was examined and closely monitored for signs of internal injuries. Following a 4-5 hour stay in the emergency room, he was transferred to the ophthalmology department for a thorough eye exam.

The ophthalmologist who initially examined the child noted a sunburn type burn (AIS-1) that extended from the child's forehead, across both eyelids, and onto his cheeks, forming a butterfly type pattern. He reported that the child also sustained a contusion (AIS-1) over his right eyelid. Upon examination of the child's eyes, the ophthalmologist noted small superficial burns (AIS-1) to both corneas. He stated that the burns contained a small black particle with a ring encircling the particle. The burns were visible in both corneas; however, the ophthalmologist noted that the left eye contained a greater number of the superficial burns.

The ophthalmologist irrigated the eyes with a balanced salt solution, followed by 3 liters of [redacted] solution to neutralize the PH of the eyes. He used finger and picture tests to determine the extent of damage to the child's eyes. The ophthalmologist stated that the child could not see an eye chart on the day of the crash and that his visual acuity was significantly impaired.

Follow-up visits to the ophthalmologist were necessary to track the improvement of the child's injuries. He stated that 4-6 weeks post-crash, the child's vision had returned to 20/40 in the right eye and 20/30 in the left. The ophthalmologist did not foresee any long term visual impairments.

The child's mother initially reported to the ophthalmologist that the air bag had ruptured, thus spewing black ash into the vehicle and onto her child. The attorney who is representing the family stated that the air bag did not rupture as initially reported by the parent and that the black residue exhausted through the venting ports on the air bag.

Newspaper articles related to this crash are included as an attachment.

RELATED NEWSPAPER ARTICLES

AIR-BAG KERATITIS

To the Editor: We recently encountered a previously undescribed complication associated with an automobile air-bag malfunction. A two-year-old boy had been an unrestrained passenger in a two-car motor vehicle accident and was thrown from the rear seat to the front, landing face up under the dashboard. The driver's air bag had inflated and burst, showering the occupants of the car with a fine, black powder. The four passengers were examined in a local emergency room, and the child's eyes were briefly irrigated with normal saline. The patient was seen by an ophthalmologist four hours after the injury and had bilateral photophobia, tearing, and redness. The other three occupants of the car had normal tear pH and no ocular symptoms.

Visual acuity of both of the child's eyes was measured by finger counting. Ocular examination revealed erythema of the facial skin and eyelids and moderate conjunctival injection. Both corneas showed focal clouding, with large, interpalpebral epithelial defects. The tear pH was 8.5 to 9.0 in both eyes. Double eversion of the eyelids and sweeping of the conjunctival fornices yielded a small amount of particulate foreign material. Each eye was irrigated with balanced salt solution, followed by 3 liters of [redacted] solution, with use of an irrigating scleral lens. The pH immediately after and 30 minutes after irrigation was 7.5 in both eyes. One month later, the child's vision returned to 20/40 in the right eye and 20/30 in the left, with residual, small, superficial corneal scars. The child is being monitored closely by a pediatric ophthalmologist for the possible development of amblyopia.

An automobile air bag is a rubberized nylon bag that inflates on spark ignition of sodium azide and yields nitrogen gas, ash, and a small amount of sodium hydroxide.[1] These products most likely were responsible for the ocular injuries and facial burns sustained by our patient. We have subsequently examined a second patient who sustained chemical burns to the face and eyelids, without keratitis, after an air bag inflated and burst.

The severity of an alkaline burn to the eye depends on the duration of exposure and the concentration and pH of the alkali.[2] Alkalis penetrate the eye more readily than acids and cause more extensive damage. Prompt irrigation of the eyes with any clean aqueous solution is essential, and pH testing should be done before, immediately after, and 30 minutes after irrigation. A rising pH suggests that trapped particulate matter is releasing additional chemical, as noted in our patient. Corneal edema implies a serious injury, and blanching of the conjunctiva is an ominous sign. This patient was fortunate that the alkali inoculation was limited, minimizing the damage done by prolonged ocular exposure. We were surprised to see a chemical keratitis in this setting, and we hope this report will alert our colleagues to this potentially serious and vision-threatening entity.

[redacted] M.D.
[redacted] M.D.
[redacted] M.D.
[redacted] 11030 [redacted] Hospital

1. National Highway Traffic Safety Administration. Emergency rescue guidelines for air bag-equipped cars. Washington, D.C.: Government Printing Office, 1990.
2. [redacted] Chemical injuries of the eye. Ophthalmology 1983; [redacted]

Doctors warn of eye peril in exploding airbags

[redacted]) — Malfunctioning automobile airbags can explode, releasing a fine dust of powder that can cause burns and severely irritate the eyes, three [redacted] doctors warn in a letter to today's [redacted] Journal of Medicine.

Dr. [redacted] and his colleagues at the [redacted] Hospital in [redacted], say the problem is "potentially serious and vision threatening."

They discovered it when a 2-year-old boy developed an inflammation in both corneas — the eye's clear cover — after an air bag inflated and burst.

He was thrown from the back seat to the front floor of the car during an accident, landing face up under the dashboard as the broken air bag showered occupants of the car with a fine, black powder. After doctors spent 30 minutes washing out his eyes, the acidity of the eyes returned to normal. One month later, some superficial scars remained on the cornea.

The team said the nitrogen gas, ash and sodium hydroxide released when a spark ignites the sodium azide in the nylon airbag were probably "responsible for the ocular injuries and facial burns sustained in our patient."

They said they have subsequently treated a second patient for chemical burns to the face and eyelids "after an airbag inflated and burst." That patient, however, did not experience an inflammation of the cornea.

Doctors should be aware of the potential problem, they said, and treat it promptly.

Doctors report injuries in two air bag explosions

By [redacted]

[redacted] — Exploded automobile air bags burned the eyes of a 2-year-old boy and the face and eyelids of another motorist in two separate accidents, doctors reported [redacted]

When the air bags burst, they apparently released nitrogen gas, ash and sodium hydroxide — all byproducts of the chemical reaction that inflates the bags, said [redacted] an opthalmologist in [redacted] N.Y.

"I think these are probably very, very rare events," said [redacted] who treated the boy and the driver and described the incidents in a letter to The [redacted] Journal of Medicine.

Nevertheless, he said that in the case of the boy, the accident provides another "good reason" why children should be secured in child seats or seat belts.

A spokesman for the National Highway Traffic Safety Administration said he had no knowledge of any similar air bag accidents.

However, safety guidelines issued by the administration note that byproducts of the chemical reaction which inflates the bags "may contain a small amount of a potential skin irritant, sodium hydroxide."

The guidelines state that rescuers "should take care to avoid introducing the residue into the eyes or any wounds" of injured occupants. If the residue does get into their eyes, they should be flushed immediately with water, the guidelines state.

The same advice holds true for anyone who comes into contact with air bag residue, [redacted] said.

"The message is, if the powder gets into your eyes or your child's, don't wait to go wait to go to a hospital. Irrigate the eyes as soon as possible," he said.

While it might be a "good idea" to devise an air bag that does not release toxic residue, "I would not tamper with the system just because of these two incidents. The advantages of air bags clearly outweigh the disadvantages," he said.

The boy was sitting unrestrained in the back seat of a car that was involved in a two-vehicle collision, he said. The force of the collision "propelled him at great velocity into the front seat and into the air bag, which exploded," he said.

Chemicals released from the bag, which [redacted] described as a "fine black powder," did not injure other occupants of the car, but got into the boy's eyes, causing inflammation and eventual mild scarring of his corneas. But the child's eyesight has returned to normal.

In the second incident, shattered glass from the windshield punctured the bag, causing the release of chemicals that caused minor burns, he said.

Doctor says exploded air bags cause injuries

[redacted] — Exploded automobile air bags burned the eyes of a 2-year-old boy and the face and eyelids of a motorist in separate accidents, a doctor said in a letter published in [redacted] edition of the [redacted] Journal of Medicine.

The air bags apparently released nitrogen gas, ash and sodium hydroxide — by-products of the chemical reaction that inflates the bags, said [redacted] an ophthalmologist in [redacted]

He said the accident provides another good reason why small children should be secured in child seats or belts.

Doctors warn about bursting air bags

By [redacted]

[redacted] (UPI) _ Exploded automobile air bags burned the eyes of a 2-year-old boy and the face and eyelids of another motorist in two separate accidents, doctors reported [redacted].

When the air bags burst, they apparently released nitrogen gas, ash and sodium hydroxide _ all by-products of the chemical reaction that inflates the bags, said Dr. [redacted], an opthalmologist in [redacted], N.Y.

"I think these are probably very, very rare events," said [redacted], who treated the boy and the driver and described the incidents in a letter to The [redacted] of Medicine.

Nevertheless, he said that in the case of the boy, the accident provides another "good reason" why children should be secured in child seats or seat belts.

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However, safety guidelines issued by the administration note that by-products of the chemical reaction which inflates the bags "may contain a small amount of a potential skin irritant, sodium hydroxide."

The guidelines said rescuers "should take care to avoid introducing the residue into the eyes or any wounds" of injured occupants. If the residue does get into their eyes, they should be flushed immediately with water, they say.

The same advice holds true for anyone who comes into contact with air bag residue, [redacted] said.

"The message is, if the powder gets into your eyes or your child's, don't wait to go wait to go to a hospital. Irrigate the eyes as soon as possible," he said.

While it might be a "good idea" to devise an air bag that does not release toxic residue, "I would not tamper with the system just because of these two incidents. The advantages of air bags clearly outweigh the disadvantages," he said.

The boy was sitting unrestrained in the back seat of a car that was involved in a two-vehicle collision, he said. The force of the collision propelled him at great velocity into the front seat and into the air bag, which exploded," he said.

Chemicals released from the bag, which [redacted] described as a "fine black powder," did not injure other occupants of the car, but got into the boy's eyes, causing inflammation and eventual mild scarring of his corneas.

Although the child recovered and his eyesight has returned to normal, [redacted] said his eye injury could have been serious if he had not received prompt medical attention.

In the second incident, shattered glass from the windshield punctured the bag, causing the release of chemicals that caused minor burns, he said.

[redacted] said he knew of no other similar incidents involving air bags. Representatives of Audi _ the manufacturer of the car the boy was riding in _ told him they knew of no other incident involving their cars, he said.