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### ON-SITE CHILD AIR BAG-RELATED SERIOUS INJURY INVESTIGATION

CASE NUMBER - IN-02-003  
LOCATION - OHIO  
VEHICLE - 1993 DODGE INTREPID ES  
CRASH DATE - July 2002

Submitted:

August 7, 2007



Contract Number: DTNH22-01-C-07002

Prepared for:

U.S. Department of Transportation  
National Highway Traffic Safety Administration  
National Center for Statistics and Analysis  
Washington, D.C. 20590-0003

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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.

## Technical Report Documentation Page

1. <i>Report No.</i> IN-02-003	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> On-Site Child Air Bag-Related Serious Injury Investigation Vehicle - 1993 Dodge Intrepid ES Location - Ohio		5. <i>Report Date:</i> August 7, 2007	
		6. <i>Performing Organization Code</i>	
7. <i>Author(s)</i> Special Crash Investigations Team #2		8. <i>Performing Organization Report No.</i>	
9. <i>Performing Organization Name and Address</i> Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501		10. <i>Work Unit No. (TRAIS)</i>	
		11. <i>Contract or Grant No.</i> DTNH22-01-C-07002	
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation (NPO-122) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003		13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: July 2002	
		14. <i>Sponsoring Agency Code</i>	
15. <i>Supplementary Notes</i> On-site air bag deployment investigation involving a 1993 Dodge Intrepid ES, four-door sedan, with manual safety belts and dual front air bags, and a 1997 Chrysler Sebring JX, two-door convertible			
16. <i>Abstract</i> <p>This report covers an on-site investigation of an air bag deployment crash that involved a 1993 Dodge Intrepid ES (case vehicle) and a 1997 Chrysler Sebring JX convertible (other vehicle). This crash is of special interest because the case vehicle's, unrestrained front right passenger (3-year-old, female) sustained a critical cervical injury from her deployed front right passenger air bag. The trafficway on which both vehicles were traveling was a four-lane, divided, city street, traversing in a north-northwesterly and south-southeasterly direction, and the case vehicle was approaching a four-leg intersection. The Chrysler had also been traveling north-northwestward and was stopped, heading northward, at a traffic signal light in the same lane of the same roadway. The front of the case vehicle collided with and underrode the back of the Chrysler, just southward of the traffic signal light, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's front right passenger was seated with her seat track located in its middle position, and she was not using her available, active, three-point, lap-and-shoulder, safety belt system. She sustained, according to the interview with the case vehicle's driver (i.e., father) and her medical records, critical injuries which included: an injury to her cervical spinal cord (i.e., most likely a laceration) with quadriplegia, a type II fracture of her odontoid (C<sub>2</sub>), and dislocation (i.e., distraction of C<sub>1</sub> on C<sub>2</sub> and subluxation of C<sub>2</sub> on C<sub>3</sub>). In addition, she sustained a serious nonanatomic brain injury; a small right subarachnoid hemorrhage; a left periorbital contusion; an avulsed front tooth; abrasions to her nose, face, chin, throat, and left forearm. This occupant's primary cervical and brain injuries were caused by direct contact with her deploying front right passenger air bag. The case vehicle's driver (i.e., father; 36-year-old, male) was seated with his seat track located between its middle and rearmost positions, and the tilt steering wheel was located in its middle position. He was not using his available, active, three-point, lap-and-shoulder, safety belt system, and he did not sustain any injuries as a result of this crash. The back right passenger (i.e., mother; 33-year-old, female) was seated but her seat track and seat back were not adjustable. She was not using her available, active, three-point, lap-and-shoulder, safety belt system. She did not sustain any injuries as a result of this crash.</p>			
17. <i>Key Words</i> Air Bag Deployment Motor Vehicle Traffic Crash Injury Severity		18. <i>Distribution Statement</i> General Public	
19. <i>Security Classif. (of this report)</i> Unclassified	20. <i>Security Classif. (of this page)</i> Unclassified	21. <i>No. of Pages</i> 17	22. <i>Price</i> \$15,000

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This on site investigation was brought to NHTSA's attention on July 17, 2002 by means of a newspaper article in a local paper. The crash involved a 1993 Dodge Intrepid ES (case vehicle) and a 1997 Chrysler Sebring JX convertible (other vehicle). The crash occurred in July 2002 at 10:05 p.m., in Ohio and was investigated by the applicable city police department. This crash is of special interest because the case vehicle's front right passenger [3-year-old, White (Hispanic) female] sustained a critical cervical injury from her deployed front right passenger air bag. This contractor inspected the case vehicle on July 18, 2002 and the scene on July 19, 2002. This contractor interviewed the driver for the case vehicle on August 9, 2002. This summary is based on the Police Crash Report, an interview with the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

## SUMMARY

### *Crash Environment:*

The trafficway on which both vehicles were traveling was a four-lane, divided, city street, traversing in a north-northwesterly and south-southeasterly direction, and the case vehicle was approaching a four-leg intersection (i.e., the city trafficway was divided but only at the mouth of the intersection). On the southern leg of the intersection, both the northerly and southerly roadways had two through lanes. At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was clear, and the roadway pavement was dry; see **CRASH DIAGRAM** at end.

### *Pre-Crash:*

The case vehicle was traveling north-northwestward in the inside northern through lane of the northerly roadway. The Chrysler had also been traveling north-northwestward and was stopped, heading northward, at a traffic signal light in the same lane of the same roadway. Just prior to the crash the case vehicle's driver braked sharply, attempting to avoid the collision. The crash occurred in the same travel lane, just south-southeast of the intersection.

### *Crash:*

The front of the case vehicle collided with and underrode the back of the Chrysler, just southward of the traffic signal light, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy.

### *Post-Crash:*

As a result of the impact, the case vehicle pushed the Chrysler forward a short distance before its front wheels came to rest near the travel lane's stop bar heading northward. The Chrysler's final rest location is unknown, but based on the available information it was pushed a short distance into the intersection and subsequently driven into a parking lot off the northeast corner of the intersection.

***Case Vehicle:***

The 1993 Dodge Intrepid ES was a front wheel drive, four-door sedan (VIN: 2B3ED56F3PH-----). The case vehicle was equipped with full powered driver and front right passenger supplemental restraint (air bag) systems

***Vehicle Exterior:***

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-01 (0 degrees)**. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 25.0 km.p.h. (15.5 m.p.h.), -25.0 km.p.h., (-15.5 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.

***Other Vehicle:***

The 1997 Chrysler Sebring JX was a front wheel drive, two-door convertible (VIN: Unknown). The Chrysler was equipped with driver and front right passenger air bags which did not deploy as a result this vehicle's impact.

***Case Vehicle's Front Right Passenger:***

The case vehicle's front right passenger [daughter; 3-year-old, White (Hispanic) female] was seated upright with her seat track located in its middle position. She was not using her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her medical records and the interview with the case vehicle's driver, an injury to her cervical spinal cord (i.e., most likely a laceration) with quadriplegia, a type II fracture of her odontoid (C<sub>2</sub>), and dislocation (i.e., distraction of C<sub>1</sub> on C<sub>2</sub> and subluxation of C<sub>2</sub> on C<sub>3</sub>). In addition, she sustained a serious nonanatomic brain injury; a small right subarachnoid hemorrhage; a left periorbital contusion; an avulsed front tooth; abrasions to her nose, face, chin, throat, and left forearm. This occupant's primary cervical and brain injuries were caused by direct contact with her deploying front right passenger air bag.

***Case Vehicle's Driver:***

The case vehicle's driver [i.e., father; 36-year-old, White (Hispanic) male] was seated with his seat track located between its middle and rearmost positions, and the tilt steering wheel was located in its middle position. He was not using his available, active, three-point, lap-and-shoulder, safety belt system. According to his interview, he did not sustain any injuries as a result of this crash.

***Case Vehicle's Back Right Passenger:***

The case vehicle's back right passenger [i.e., mother; 33-year-old White (non-Hispanic) female] was seated but her seat track and seat back were not adjustable. She was not using her available, active, three-point, lap-and-shoulder, safety belt system, and she did not sustain any injuries as a result of this crash.

**Crash Environment:** The trafficway on which both vehicles were traveling (**Figure 1**) was a four-lane, divided, city street, traversing in a north-northwesterly and south-southeasterly direction, and the case vehicle was approaching a four-leg intersection (i.e., the city trafficway was divided but only at the mouth of the intersection—**Figure 2**). On the southern leg of the intersection, both the northerly and southerly roadways had two through lanes.

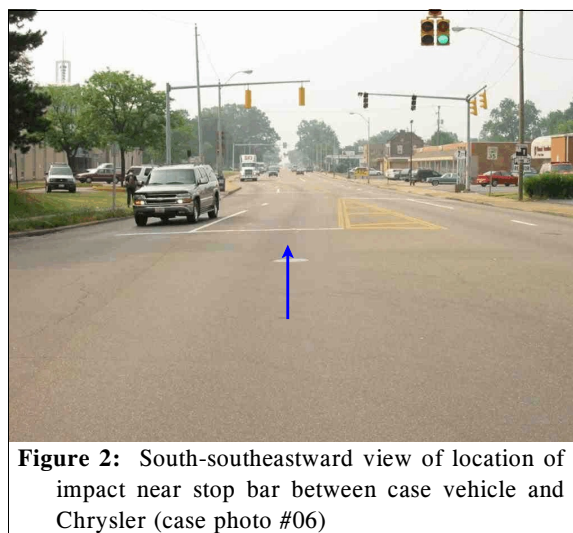
The city trafficway was straight and level at the area of impact. The pavement was bituminous, but traveled, and the width of the inside lane of the northerly roadway was 4.2 meters (13.8 feet) while the outside lane of the northerly roadway was 5.2 meters (17.1 feet). The roadway was bordered by mountable curbs. The left (western) side of the northerly roadway was adjacent to unprotected, marked, paved, triangular median. The median was 2.6 meters (8.5 feet) wide at the mouth of the intersection and extended 33.7 meters (110.6 feet) in a southerly direction until it reached its apex. Pavement markings consisted of a double solid yellow centerline that outlined the median separating both the northern and southern roadways on the southerly leg of the four-leg intersection, and the northern lanes were divided by a dashed white line. In addition, no edge lines were present. The

estimated coefficient of friction was 0.70. Traffic controls consisted of a regulatory speed limit sign (MUTCD, R2-1) on southern roadway of the southerly leg of the intersection, and on-colors, pre-timed, vertical mounted traffic control signals were located in each of the intersections four quadrants (i.e., the northeasterly quadrant contained the signals that controlled the case vehicle). The posted speed limit was 56 km.p.h. (35 m.p.h.). At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was not determined, and the site of the crash was primarily urban commercial; see **CRASH DIAGRAM** at end.

**Pre-Crash:** The case vehicle was traveling north-northwestward in the inside northern through lane of the northerly roadway and was approaching a four-leg intersection intending to proceed straight ahead (**Figure 1** above). The Chrysler had also been traveling north-northwestward and was stopped, heading northward, at a traffic signal light in the same lane of the same roadway. Based upon the inspection of the case vehicle and the available police photographs of the scene and



**Figure 1:** Case vehicle's northerly travel path in inside northbound lane of northbound roadway just prior to impact; Note: trafficway was divided near mouth of intersection only (case photo #02)



**Figure 2:** South-southeastward view of location of impact near stop bar between case vehicle and Chrysler (case photo #06)



damage to the Chrysler, just prior to the crash the case vehicle's driver braked sharply, attempting to avoid the collision (**Figure 3**). The Police Crash Report estimates the case vehicle's pre-crash speed at 56 km.p.h. (35 m.p.h.). The crash occurred in the same travel lane, just south-southeast of the intersection.

**Crash:** The front (**Figure 4**) of the case vehicle collided with and underrode the back (**Figure 5**) of the Chrysler, just southward of the traffic signal light, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy (**Figure 6**).



**Figure 3:** On-scene view of case vehicle's final rest position near stop bar and likely pre-crash skid marks; Note: trafficway divided at mouth of intersection (case photo #70)



**Figure 4:** Case vehicle's bumper and above bumper frontal damaged viewed from right of front with contour gauge positioned along top of bumper (case photo #28)



**Figure 5:** On-scene view of Chrysler's damage back (case photo #79)



**Figure 6:** On-scene view of case vehicle's deployed driver and front right passenger air bags; Note: cracked right windshield glazing above front right air bag's fabric (case photo #76)



**Figure 7:** On-scene view of case vehicle's frontal damage at final rest near intersection's stop bar; Note: upward rotation of bumper fascia as a result of underide impact (case photo #72)

**Post-Crash:** As a result of the impact, the case vehicle pushed the Chrysler forward a short distance before its front wheels came to rest near the travel lane's stop bar heading northward

(Figure 7 above). The Chrysler's final rest location is unknown, but based on the available information it was pushed a short distance into the intersection and subsequently driven into a parking lot off the northeast corner of the intersection.

#### CASE VEHICLE

The 1993 Dodge Intrepid ES was a front wheel drive, five-passenger, four-door sedan (VIN: 2B3ED56F3PH-----) equipped with a 3.5L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front and rear disc system. The case vehicle's wheelbase was 287 centimeters (113.0 inches), and the odometer reading at inspection was 189,605 kilometers (117,815 miles).

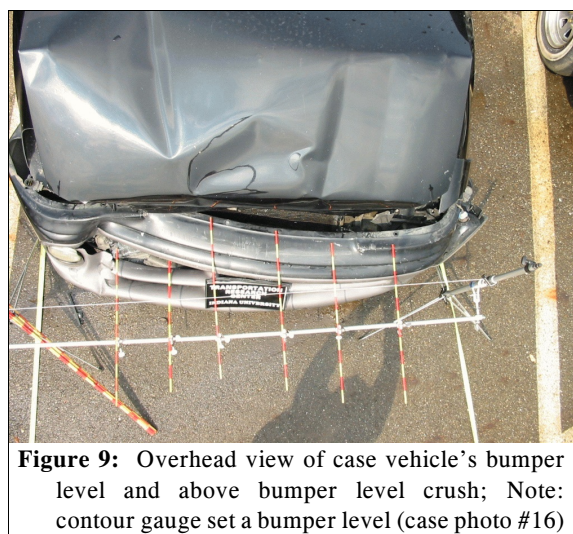
Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat without head restraints for the back seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. Both the driver and front right passenger had their upper anchorage adjusters located in the upmost positions. The vehicle was equipped with knee bolsters for both the driver and front right passenger seating positions, neither of which showed evidence of contact or deformation. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of the case vehicle's frontal impact with the Chrysler.



**Figure 8:** Case vehicle's front bumper and above bumper damage with contour gauge positioned at top of bumper's fascia (case photo #07)

#### CASE VEHICLE DAMAGE

**Exterior Damage:** The case vehicle's contact with the Dodge involved the entire front bumper (Figures 8 and 9). Direct damage extended from bumper corner to bumper corner and measured 110 centimeters (43.3 inches). Crush measurements were taken on the actual metal bumper because of a gap between the bumper and plastic bumper fascia and above the bumper as well. Residual maximum crush at the bumper was measured as 25 centimeters (9.8 inches) at C<sub>4</sub>. Above the bumper the residual maximum crush was measured as 7 centimeters (2.8 inches) at C<sub>5</sub>.



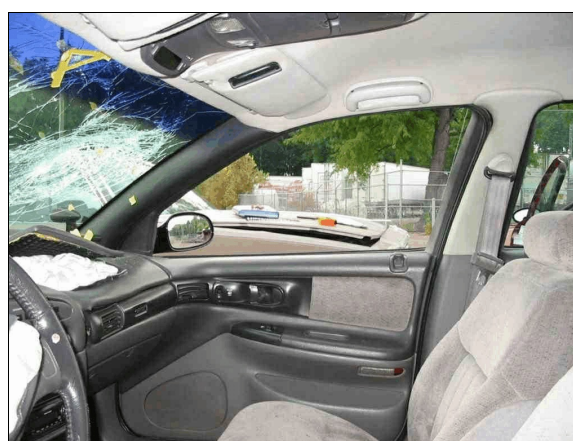
**Figure 9:** Overhead view of case vehicle's bumper level and above bumper level crush; Note: contour gauge set a bumper level (case photo #16)

and C<sub>6</sub>–6 centimeters (2.4 inches) at C<sub>4</sub>. Because the crush averaging requirements were not met, only the bumper level crush was used.

Units	Event	Direct Damage		Field L	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	150	25	110	4	10	18	25	21	13	0	0
in		59.1	9.8	43.3	1.6	3.9	7.1	9.8	8.3	5.1	0.0	0.0

The wheelbase on the case vehicle’s right side was shortened at most 1 centimeter (0.4 inches) while the left side was unaltered from the crash. The case vehicle’s front bumper, bumper fascia, grille, hood, and right and left headlight and turn signal assemblies were directly damaged and crushed rearward. Induced damage was present on the hood and both the right and left fenders. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle’s exterior.

The recommended tire size was: P225/60 R16 97S, but tire size: P255/60R16 97V, was optional; the case vehicle was equipped with tire size: P255/60R16. The case vehicle’s tire data are shown in the table above. None of the tires were physically restricted or deflated; however, the case vehicle’s left rear tire had a much lower tire pressure than the vehicle’s other three tires.

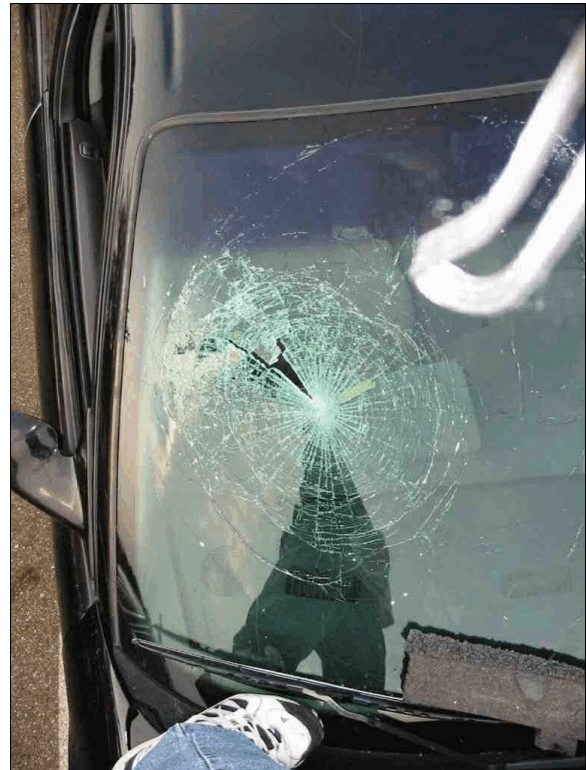


**Figure 10:** Case vehicle’s front right passenger seating area viewed from left showing deployed air bags and spider-web type contact evidence on right windshield’s glazing; Note: yellow tape that appears to be on right “A”-pillar is actually affixed to a hair hanging from windshield’s glazing (case photo #34)

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 <sup>nd</sup> of an inch			
LF	259	38	241	35	5	6	None	No	No
RF	255	37	241	35	3	4	None	No	No
LR	128	19	241	35	4	5	None	No	No
RR	272	40	241	35	6	8	None	No	No



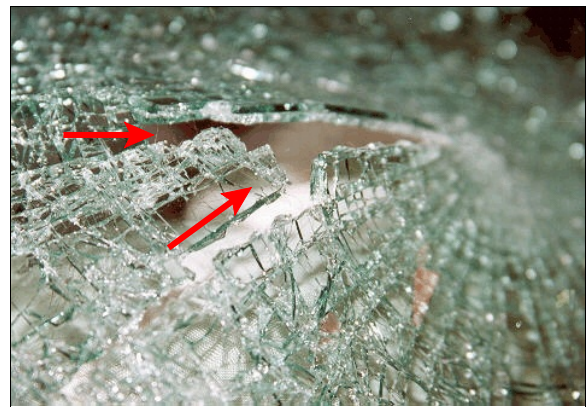
**Figure 11:** Vertical view of case vehicle's front right seating area showing uneven opening pattern to front right air bag module's cover flap, spider web-type contact to right windshield's glazing, and lack of contact evidence on right sun visor, "A"-pillar, or knee bolster (case photo #38)



**Figure 12:** Overhead view of hole in case vehicle's front right windshield glazing in contact by front right passenger's scalp(case photo #42)



**Figure 13:** Close-up of contact evidence on case vehicle's right windshield glazing; Note: yellow tape marks strands of hair in glazing (case photo #41)



**Figure 14:** On-scene close-up view of case vehicle's holed right windshield glazing showing strands of hair in glazing from scalp of front right passenger (case photo #77)

**Interior Damage:** Inspection of the case vehicle's interior revealed that there was a significant spider web-type contact to the windshield (**Figure 10** above and **Figure 11**), including a small hole in the windshield's glazing (**Figure 12**), most likely from contact by the front right passenger's head. Furthermore, there was hair hanging in the broken glazing (**Figures 13** and **14**). The

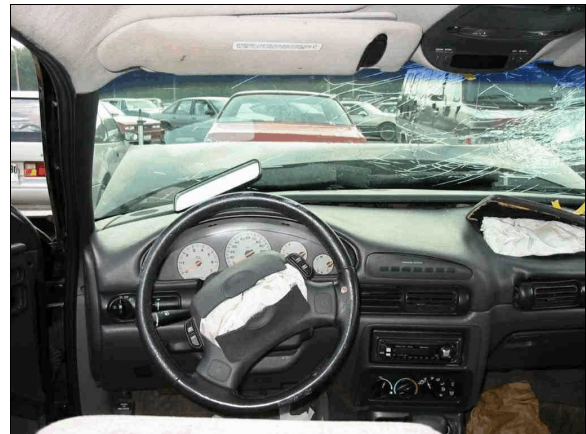
windshield mounted rearview mirror had been displaced from the windshield (**Figure 15**). Finally, there was no evidence of intrusion to the case vehicle's interior, no evidence of compression to the energy absorbing shear capsules in the steering column, and no deformation to the steering wheel rim.

**Damage Classification:** Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-01 (0 degrees)**. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 25.0 km.p.h. (15.5 m.p.h.), -25.0 km.p.h., (-15.5 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The case vehicle was towed due to damage.

#### AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both frontal air bags deployed as a result of the frontal impact with the Chrysler. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of symmetrical "H"-configuration cover flaps made of thick vinyl with overall dimensions of 16.5 centimeters (6.5 inches) at the horizontal seam and 7 centimeters (2.8 inches) vertically for both the upper flap and lower flaps. An inspection of the air bag module's cover flaps and the air bag's fabric revealed that the cover flaps opened at the designated tear points and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each estimated at approximately 6 centimeters (2.4 inches) in width. The driver's air bag had no vent ports. The deployed driver's air bag was round with a diameter of 62 centimeters (24.4 inches). An inspection of the driver's air bag fabric revealed no contact evidence readily apparent on the air bag's fabric (**Figure 16**).

The front right passenger's air bag was located on the top of the instrument panel. There was a single, rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were 36 centimeters (14.2 inches) at the lower horizontal seam and 15 centimeters (5.9 inches) along both vertical seams. The profile of the case vehicle's instrument panel resulted in a 6 centimeter (2.4 inch) setback of the leading edge of the



**Figure 15:** Case vehicle's driver seating area showing deployed air bags, displaced rear view mirror, and no obvious evidence of occupant contact in driver's area (case photo #36)



**Figure 16:** Case vehicle's deployed driver air bag showing no obvious evidence of occupant contact (case photo #47)

cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag's fabric. However, there was an uneven opening of the module's cover flap, with the left portion more open than the right (**Figure 11** above and **Figure 17**). Furthermore, there was a cut on the leading edge of the flap near the center (**Figure 18**), most likely from impacting the windshield's glazing. The front right passenger's air bag was designed with two very wide tethers. The upper tether measured approximately 44 centimeters (17.3 inches) and lower tether measured 47 centimeters (18.5 inches) in width. The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 71 centimeters (28.0 inches) and a width of approximately 55 centimeters (21.7 inches). An inspection of the front right passenger's air bag fabric revealed blood stains on the front left portion of the bag, above and below the air bag's middle (**Figure 19** below). Furthermore, there were more significant blood stains on the left side of the air bag (facing the driver) near the vertical center.



**Figure 17:** Close-up of case vehicle's front right passenger air bag module showing distortion to module's cover flap caused by uneven opening (case photo #68)



**Figure 18:** Close-up of case vehicle front right passenger air bag module's cover flap showing cut near front edge of flap (case photo #67)

### **CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS**

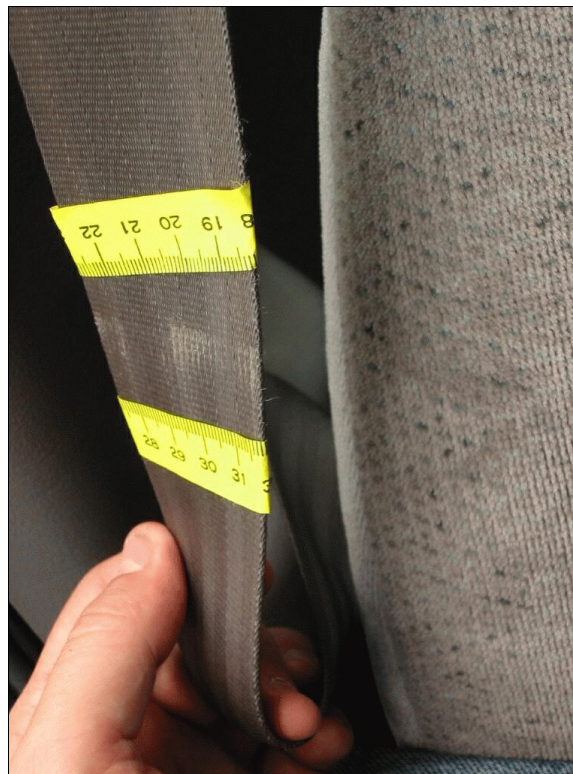
Immediately prior to the crash the case vehicle's front right passenger [daughter; 3-year-old, White (Hispanic) female; 107 centimeters and 16 kilograms (42 inches, 35 pounds)] was seated upright with her back likely leaning forward of her seat back with her legs dangling over the front edge of the seat's cushion angled downward, and her hands holding a CD player. According to the case vehicle's driver, her seat track was located in its middle position, and the seat back was upright. During the vehicle inspection, the front right seat track was located in its rearmost position, and the seat back was slightly reclined. The seat track was most likely moved backwards prior to this contractor's inspection.

The case vehicle's front right passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, she was not restrained in a child safety seat. In addition, there was no evidence of belt pattern bruising and/or abrasions to the front right passenger's torso, however, the inspections of the front right passenger's seat belt webbing, "D"-

ring, and latch plate showed evidence of loading near the “D”-ring (**Figure 20**). In this contractor’s opinion, this loading evidence was not related to this crash.



**Figure 19:** Front surface of case vehicle’s deployed front right passenger air bag showing contact evidence situated along left side of bag’s fabric (case photo #52)



**Figure 20:** Close-up of case vehicle’s front right passenger safety belt showing evidence of loading, previous or otherwise, on inside of belt’s webbing near “D”-ring (case photo #32)

The case vehicle’s driver braked, attempting to avoid the crash. As a result of this braking and the nonuse of her available safety belts, the front right passenger most likely moved forward and slightly upward just prior to impact. The case vehicle’s impact with the Chrysler enabled the front right passenger to continue forward and upward along a path opposite the case vehicle’s 0 degree Direction of Principal Force as the case vehicle decelerated. Because the damage on the case vehicle was primarily above the bumper and produced an underride impact pattern, this underride type damage resulted in the air bag deploying late during the sequence of the impact. This delayed deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V–i.e., ramp versus spike). In this contractor’s opinion, the front right passenger moved forward with her head leading and was most likely just in front of the front right passenger air bag module at the moment of deployment. This child contacted the deploying air bag most likely hyper-extending the child’s neck.

Based on the available evidence (i.e., blood evidence on air bag), the child contacted the deploying air bag primarily along its left side. This is consistent with the uneven pattern shown by the air bag module’s cover flap where it appears that the more of the air bag’s fabric was able to get out through the side of the cover flap closest to the middle of the vehicle. Furthermore,

there is no indication (i.e., occupant injuries) that the child contacted the air bag module's cover flap during her forward movement. As a result, the front right passenger's trajectory was redirected slightly upward and to the right so that her head was redirected into the windshield's glazing, cracking the glazing in a spider web pattern as well as holing the glazing, to the right of the center of the air bag's module. However, it should be noted that there were no lesions reported to the front right passenger's scalp. After impacting the windshield's glazing, the front right passenger most likely rebounded backwards toward her seat back. The exact posture of this occupant at final rest is unknown. She was unable to exit the vehicle because of her injuries. Based on her medical records, this occupant was outside the vehicle upon arrival of the first rescue personnel.

### CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger was transported by ambulance to a local hospital and subsequently transferred to a larger metropolitan medical center. She sustained a critical cervical injury and was hospitalized. According to her medical records and the interview with the case vehicle's driver, the injuries sustained by the front right passenger included: an injury to her cervical spinal cord (i.e., most likely a laceration) with quadriplegia, a type II fracture of her odontoid ( $C_2$ ), and dislocation (i.e., distraction of  $C_1$  on  $C_2$  and subluxation of  $C_2$  on  $C_3$ ). In addition, she sustained a serious nonanatomic brain injury; a small right subarachnoid hemorrhage; a left periorbital contusion; an avulsed front tooth; abrasions to her nose, face, chin, throat, and left forearm. This occupant's primary cervical and brain injuries were caused by direct contact with her deploying front right passenger air bag.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration {transection}, most likely, cervical cord with quadriplegia, type II fracture of odontoid ( $C_2$ ), marked distraction <sup>1</sup> of $C_1$ on $C_2$ , and anterior subluxation of $C_2$ on $C_3$ <sup>2</sup>	maximum 640276.6,6	Air bag, front right passenger's	Certain	Hospitalization records
2	Nonanatomic brain injury with unconsciousness at scene, sluggishly reactive pupils, seizure, and visual field defect	severe 160804.4,0	Air bag, front right passenger's	Certain	Hospitalization records
3	Hemorrhage, subarachnoid, small, right parietal	serious 140684.3,1	Air bag, front right passenger's	Probable	Hospitalization records

<sup>1</sup> The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

*distraction (dis-trak/shen)*: a form of dislocation in which the joint surfaces have been separated without rupture of their binding ligaments and without displacement.

<sup>2</sup> This person sustained numerous complications, including bilateral atelectasis, chronic respiratory failure, and pneumonia.



Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
4	Contusion {bruise} around left eye	minor 297402.1,2	Air bag, front right passenger's	Probable	Interviewee (driver)
5	Avulsion {lost} tooth, front, not further specified	minor 251406.1,8	Air bag, front right passenger's	Probable	Interviewee (driver)
6	Abrasion across nose	minor 290202.1,4	Air bag, front right passenger's	Certain	Emergency room records
7	Abrasion face, not further specified	minor 290202.1,9	Air bag, front right passenger's	Certain	Emergency room records
8	Abrasion, superficial, under chin	minor 290202.1,8	Air bag, front right passenger's	Certain	Hospitalization records
9	Abrasion throat, most likely anterior surface but not further specified	minor 390202.1,5	Air bag, front right passenger's	Certain	EMS treatment record
10	Abrasion left antecubital fossa and/or radial forearm	minor 790202.1,2	Air bag, front right passenger's	Probable	Hospitalization records

#### CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [i.e., father; 36-year-old, White (Hispanic) male; 173 centimeters and 77 kilograms (68 inches, 170 pounds)] was seated in a slightly reclined posture with his back most likely leaning forward from the seat back, his left foot on the floor, his right foot on the brake, and at least one hand on the steering wheel, bracing in anticipation of the collision. His seat track was located between its middle and rearmost positions, his seat back was slightly reclined, and the tilt steering wheel was located in its middle position.

The case vehicle's driver was not using his available, active, three-point, lap-and-shoulder, safety belt system. There was no mention by the driver of belt pattern bruising and/or abrasions to his torso, and the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this braking and the nonuse of his available safety belts, just prior to impact the driver most likely moved slightly forward and upward but his movement was limited because he was bracing against the steering wheel. The case vehicle's impact with the Chrysler enabled the driver to continue forward and upward along a path opposite the case vehicle's 0 degree Direction of Principal Force as the case vehicle decelerated. Because the damage on the case vehicle was primarily above the bumper and produced an underride impact pattern, this underride type damage resulted in the air bag deploying late during the sequence of the impact. This delayed deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V-i.e., ramp versus spike). In this contractor's opinion, because the driver was bracing against the

steering wheel rim the delayed deployment had no effect on the driver's interaction with the deploying air bag. As a result of the crash, the driver most likely contacted his deploying driver air bag, but, there is no obvious evidence of contact on the air bag's fabric or injuries to the driver. After impacting the deploying air bag, the driver most likely rebounded backwards toward his seat back as the case vehicle came to final rest. The exact posture of the driver at final rest is unknown, but he was able to exit the vehicle without assistance.

### **CASE VEHICLE DRIVER INJURIES**

The driver was not transported by ambulance to the hospital. According to his interview, he did not sustain any injuries as a result of this crash.

### **CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS**

The case vehicle's back right passenger [i.e., mother; 33-year-old White (non-Hispanic) female; 157 centimeters and 48 kilograms (62 inches, 105 pounds)] was most likely seated upright with her back leaning slightly forward of her seat back and her feet on the floor, but the exact position of her hands is unknown. Her seat track and seat back were not adjustable.

The back right passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. There was no mention by the driver of belt pattern bruising and/or abrasions to the back right passenger's torso, and the inspection of the 's seat belt webbing and latch plate showed no evidence of loading.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this braking and the nonuse of her available safety belts, the back right passenger most likely moved forward and slightly upward just prior to impact. It is entirely possible that this occupant braced against the front right seat's back, inhibiting her forward motion. The case vehicle's impact with the Chrysler enabled the back right passenger to continue forward and upward along a path opposite the case vehicle's 0 degree Direction of Principal Force as the case vehicle decelerated. As a result, the back right passenger may have contacted the back surface of the front right seat back or the adjustable front right head restraint. On the other hand, there is no obvious contact evidence on the back surface of the seat's back or head restraint or intrusion to the front right seat (**Figure 21**). After the back right passenger reached her forward excursion, she most likely rebounded backwards toward her seat back as the case vehicle case to final rest. The exact posture of the back right occupant at final rest is



**Figure 21:** On-scene view of case vehicle's back seating area showing no evidence of occupant contact to back surface of front right passenger's seat back (case photo #78)

unknown, but she was able to exit the vehicle without assistance. In fact, according to the front right passenger's medical records, she was holding the front right passenger upon the arrival of the rescue personnel.

#### CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The back right passenger was also not transported by ambulance to the hospital and, based on the available evidence, she did not sustain any injuries as a result of this crash.

#### OTHER VEHICLE

Based on the manufacturer's specifications, the 1997 Chrysler Sebring JX was a front wheel drive, four-passenger, two-door convertible (VIN: Unknown) equipped with either a 2.4L, I-4 engine or a 2.5L, V-6 engine and a four-speed automatic transmission. Four-wheel, anti-lock brakes are an option for this model, but it is unknown if this Chrysler was so equipped. The Chrysler's wheelbase was 269 centimeters (106.0 inches), and the odometer reading is unknown because the Chrysler's interior was not inspected.

Furthermore, the Chrysler was equipped with driver and front right passenger air bags which did not deploy as a result this vehicle's impact (**Figure 22**). In addition, the Chrysler had manual, three-point, lap-and-shoulder, safety belt systems for at least the front outboard seating positions. The interior was equipped with bucket seats for the driver and front right passenger, and the back bench seat was non-adjustable.



**Figure 22:** On-scene view of Chrysler's interior showing non-deployed driver and front right air bags (case photo #81)



**Figure 23:** On-scene view of Chrysler's rear bumper viewed from right back showing contact evidence across bumper's fascia from impact with case vehicle (case photo #80)

**Exterior Damage:** Based on the available police photographs (**Figure 5** above and **Figure 23**), the CDC for this vehicle is estimated as: **06-BDEW-01 (180 degrees)**. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Chrysler's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 26.0 km.p.h. (16.2 m.p.h.), +26.0 km.p.h. (+16.2 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The Chrysler was driven from the scene.

***Chrysler's Occupant:*** According to the Police Crash Report, the Chrysler's driver [21-year-old, (unknown race and/or ethnic origin) male] was not using his available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital, but he did sustain a police-reported "C" (Possible) injury as a result of this crash.

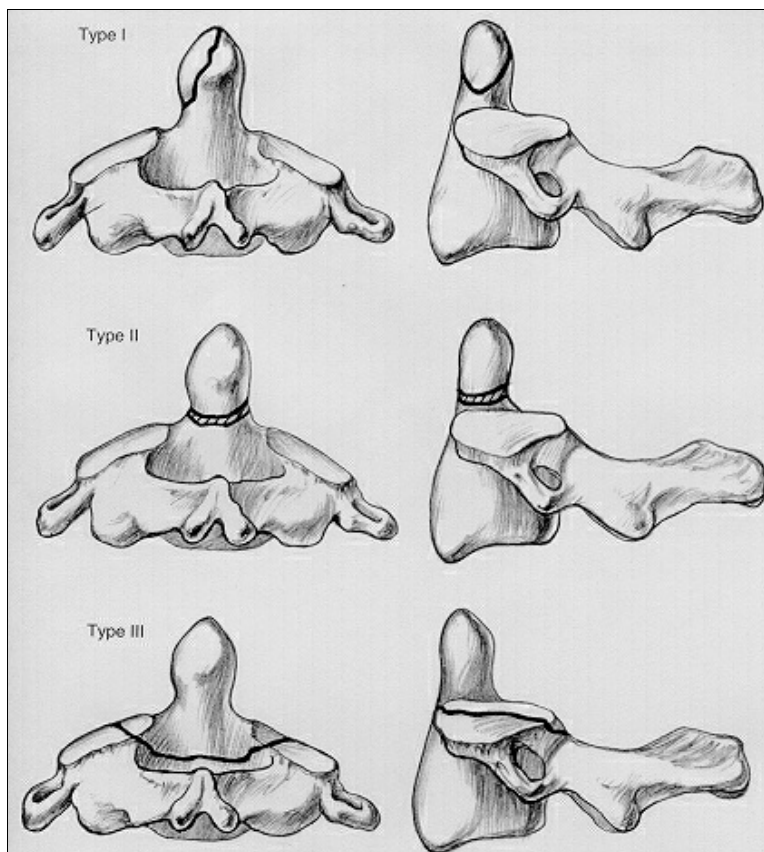
The following figure and information was taken from Chapter 18: **SPINE**, written by Anderson, Paul A., from the book "**Orthopaedic Trauma Protocols**", edited by Hansen Jr., Sigvard T., and Swiontkowski, Marc F. of Harborview Medical Center; Raven Press, New York, 1993.

**MECHANISMS OF INJURY:** Fractures of the odontoid process occur in 7% to 10% of all cervical spinal injuries. The usual mechanism of injury is forced extension of the head and neck secondary to a fall or a collision (e.g., striking the head on the dashboard or windshield of an automobile in a motor vehicle accident. Associated fractures of the atlas occur in 10% to 15% of these cases. Fractures through the pars interarticularis of the axis are commonly called hangman's fractures because their pathology is similar to fractures caused by judicial hangings. The high frequency of associated facial trauma attests to the mechanism of injury, which is usually hyperextension of the neck. Because the size of the spinal canal is enlarged by this injury, neurologic deficits are rare.

**ANATOMIC CONSIDERATIONS:** The odontoid process projects from the body of C<sub>2</sub> and is narrowest at the waist, where it is most commonly fractured. The pars interarticularis of C<sub>2</sub> lies between the anteriorly placed superior articular facets and the posteriorly placed inferior facets. This small tubular bone can be easily fractured by forced extension. After fracture, the anterior longitudinal ligament, the C<sub>2-3</sub> disc annulus, and the posterior longitudinal ligament are stressed and may progressively fail.

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**CLASSIFICATION: Odontoid Fractures** -- Anderson and D'Alonzo based their classification of odontoid fractures on the location of the fracture (see Figure). **Hangman's Fractures** - Bucholz described hangman's fractures as stable or unstable injuries on the basis of the amount of C<sub>2</sub>-C<sub>3</sub> discoligament injury associated with the fracture. Stable hangman's fractures are minimally displaced and the C<sub>2</sub>-C<sub>3</sub> disc is intact. In unstable hangman's fractures, the C<sub>2</sub>-C<sub>3</sub> disc is disrupted, resulting in C<sub>2</sub>-C<sub>3</sub> vertebral body subluxation. A rare third type of hangman's fracture was identified by Levine and Edwards. This injury consists of fracture of the pars interarticularis and dislocation of the C<sub>2</sub>-C<sub>3</sub> facet joints.



**Figure 24:** Anderson and D'Alonzo classification of odontoid fractures.  
 Type I: rare, stable avulsion fractures of the tip of the dens  
 Type II: unstable transverse fractures in the cortical bone of the waist of the dens  
 Type III: unstable fractures in the cancellous bone of the body of C<sub>2</sub>

