

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

Veridian Engineering
Buffalo, New York 14225

**VERIDIAN ON-SITE REAR SEAT ADULT PASSENGER
SEAT BELT FATALITY INVESTIGATION**

VERIDIAN CASE NO. CA01-055

VEHICLE - 2000 CHRYSLER CONCORDE LXI

LOCATION - STATE OF FLORIDA

CRASH DATE - DECEMBER, 2001

Contract No. DTNH22-01-C-17002

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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 are 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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16. <i>Abstract</i> <p>This on-site investigation focused on the injury mechanisms that caused the death of a 73 year old female rear right passenger of a 2000 Chrysler Concorde Lxi. The 2000 Chrysler Concorde was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset frontal collision with a 2000 Toyota Tundra SR5 pickup truck. The driver of the Toyota pickup truck was operating the vehicle westbound on a two lane intrastate roadway and negotiating a right curve on wet pavement. As the Toyota Tundra reached the apex of the curve, the driver allowed the vehicle to cross the centerline into the path of the eastbound Chrysler Concorde. As the Toyota crossed the eastbound lane, the front right area impacted the front right area of the Chrysler which resulted in moderately-severe damage to both vehicles.</p> <p>The restrained occupants of the 2000 Chrysler Concorde initiated a forward and slightly lateral trajectory in response to the 11 o'clock impact force. The 75 year old male driver loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster indirectly resulted in a fractured right femur. He also sustained a right calcaneus (heel) fracture from contact to the brake pedal. The 50 year old female front right passenger was out-of-position in a bracing posture with her right arm extended forward. She loaded the manual restraint, instrument panel, and deployed redesigned passenger air bag. Loading of the mid-instrument panel resulted in fractures of the right hand and distal ulna while loading of the glove compartment door resulted in bilateral soft tissue injury to the lower extremities. Both front seated occupants of the Chrysler were transported to a nearby trauma center and admitted for treatment. The 73 year old female rear right passenger was also out-of-position in a bracing posture with her right arm extended forward. Loading of the front right seat back resulted in multiple soft tissue injury, and an open fracture of the right distal radius. She also sustained an unspecified cervical spine fracture resulting from the sudden forward movement of the head as the body loaded the belt system (flexion). Occupant loading of the 3-point manual restraint system was compounded by loose cargo stowed in the trunk area. Excessive loading forces against the rear seat back frame produced a "vise" mechanism which resulted in extensive abdominal and underlying internal laceration/avulsive type trauma. The rear right passenger was pronounced deceased at the scene.</p>		13. <i>Type of Report and Period Covered</i> Technical Report Crash Date - December, 2001	
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VERIDIAN CASE NO. CA01-055
VEHICLE - 2000 CHRYSLER CONCORDE LXI
LOCATION - STATE OF FLORIDA
CRASH DATE - DECEMBER, 2001**

BACKGROUND

This on-site investigation focused on the injury mechanisms that caused the death of a 73 year old female rear right passenger of a 2000 Chrysler Concorde Lxi. The 2000 Chrysler Concorde was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset frontal collision with a 2000 Toyota Tundra SR5 pickup truck. The driver of the Toyota pickup truck was operating the vehicle westbound on a two lane intrastate roadway and negotiating a right curve on wet pavement. As the Toyota Tundra reached the apex of the curve, the driver allowed the vehicle to cross the centerline into the path of the eastbound Chrysler Concorde. As the Toyota crossed the eastbound lane, the front right area impacted the front right area of the Chrysler which resulted in moderately-severe damage to both vehicles.

The restrained occupants of the 2000 Chrysler Concorde initiated a forward and slightly lateral trajectory in response to the 11 o'clock impact force. The 75 year old male driver loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster indirectly resulted in a fractured right femur. He also sustained a right calcaneus (heel) fracture from contact to the brake pedal. The 50 year old female front right passenger was out-of-position in a bracing posture with her right arm extended forward. She loaded the manual restraint, instrument panel, and deployed redesigned passenger air bag. Loading of the mid-instrument panel resulted in fractures of the right hand and distal radius while loading of the glove compartment door resulted in bilateral soft tissue injury to the lower extremities. Both front seated occupants of the Chrysler were transported to a nearby trauma center and admitted for treatment. The 73 year old female rear right passenger was also out-of-position in a bracing posture with her right arm extended forward. Loading of the front right seat back resulted in multiple soft tissue injury, and an open fracture of the right distal ulna. She also sustained an unspecified cervical spine fracture resulting from the sudden forward movement of the head as the body loaded the belt system (flexion). Occupant loading of the 3-point manual restraint system was compounded by loose cargo stowed in the trunk area. Excessive loading forces against the rear seat back frame produced a "vise" mechanism which resulted in extensive abdominal and underlying internal laceration/avulsive type trauma. The rear right passenger was pronounced deceased at the scene.

NHTSA's Office of Crashworthiness Standards received notification of this crash from the regional Medical Examiner's Office. The notification was forwarded to NHTSA's Crash Investigation Division and subsequently assigned to the Veridian SCI Team on Friday, December 14, 2001 as an on-site investigative effort. The Veridian SCI Team established cooperation with the Medical Examiner and completed field activities on Wednesday, December 19, 2001.

SUMMARY

Crash Site

This two vehicle crash occurred during the afternoon hours of December, 2001. At the time of the crash, it was daylight with intermittent rain conditions as the roads were wet. The crash occurred in the eastbound lane of a (level) two lane intrastate roadway which curved right for westbound traffic (see **Figure 18 - page 18**). The asphalt roadway was bordered by narrow paved shoulders with a wooded area located 8.6 meters (28.2 feet) off the south pavement edge, and a W-beam guardrail located 2.8 meters (9.2 feet) off the north pavement edge. No traffic control was present at the crash site which had a posted speed limit of 97 km/h (60 mph).

Pre-Crash

The 42 year old male driver of the 2000 Toyota Tundra SR5 pickup truck was operating the vehicle westbound (**Figure 1**) at a (driver reported) speed of 89 km/h (55 mph), and negotiating a right curve on wet pavement. As the Toyota reached the apex of the curve, the driver reportedly observed a westbound (non-contact) vehicle ahead begin to slow in the roadway. The Toyota driver “tapped” his brakes in response and allowed the vehicle to cross the centerline into the path of the eastbound Chrysler. The driver stated during the SCI interview that he felt the truck just “lift up” and begin to hydroplane into the opposing travel lane. Upon recognition of the impending harmful event, the Toyota driver steered left in avoidance (increased braking unknown). The front right passenger position of the Toyota was occupied by a restrained 7 year old male child. The rear right position was occupied by a 3 year old male child who was restrained within a forward facing child safety seat.

The 75 year old male driver of the 2000 Chrysler Concorde Lxi was operating the vehicle eastbound (**Figure 2**) at a (driver reported) speed of 72 km/h (45 mph) when he observed the Toyota Tundra encroach into his lane of travel. Upon recognition of the impending harmful event, the Chrysler driver steered left and braked in avoidance, partially entering the westbound lane prior to the collision. This pre-impact trajectory was evidenced by the physical evidence documented at the crash site during the SCI inspection.



Figure 1. Westbound approach for the 2000 Toyota Tundra pickup truck.



Figure 2. Eastbound approach for the 2000 Chrysler Concorde Lxi.

Crash

As the Toyota Tundra pickup truck entered the eastbound lane of the two lane intrastate roadway, the front right area impacted the front right area of the Chrysler Concorde (**Figure 3**) resulting in moderately-severe damage to both vehicles. The pre-impact braking actions of the Chrysler driver

produced an underride/override configuration as the bumper and hood structures underrode the Toyota pickup truck. This configuration allowed the bumper on the Chrysler to engage the undercarriage of the Toyota pickup, which resulted in deployment of the redesigned frontal air bag systems in each vehicle. The trajectory algorithm of the WinSMASH reconstruction program computed impact speeds of 20.8 km/h (12.9 mph) for the subject vehicle and 67.4 km/h (41.9 mph) for the striking Toyota pickup truck. The damage algorithm computed velocity changes of 41.1 km/h (25.5 mph) for the subject vehicle and 36.8 km/h (22.9 mph) for the striking Toyota pickup truck. Respective longitudinal components were -38.7 km/h (-24.0 mph) and -36.2 km/h (-22.5 mph).

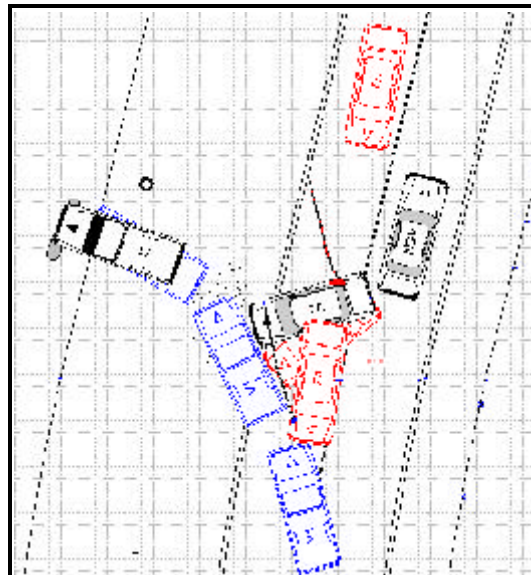


Figure 3. Collision dynamics.

At this point, the Chrysler Concorde rotated 65 degrees clockwise and traveled 3.1 meters (10.2 feet) to final rest perpendicular to the south fog line facing south. This trajectory was evidenced by 5.2 meters (17.1 feet) of post-impact scuff marks documented during the SCI scene inspection and attributed to the vehicle's right front tire. The Toyota pickup truck departed the south shoulder and continued in a southwesterly direction 8.6 meters (28.2 feet) to final rest against a wooded area facing south, evidenced by fluid pooling/damaged vegetation identified at the scene. During the Toyota's post-impact trajectory to final rest, the right front wheel/tire separated from the axle and was documented by police as coming to rest approximately 2.9 meters (9.5 feet) northwest of the vehicle position. The lack of furrowing into the soft soil adjacent to the roadway suggested this wheel separation occurred well after maximum engagement between the two vehicles.

Post-Crash

Following the crash, the Toyota driver exited the vehicle through the right front door under his own power. He attended to the two child passengers until police/rescue arrived on-scene within 20 minutes of the crash. The Toyota driver refused on-scene treatment as the child passengers were subsequently transported by ambulance to the emergency room of a nearby hospital. The 7 year old male child front right passenger of the Toyota was admitted overnight for observation as the 3 year old male child rear right passenger was treated and released.

The front seated occupants of the Chrysler Concorde were removed from the vehicle by rescue personnel due to perceived injuries, and transported by ambulance to a nearby trauma center and admitted for treatment. The rear right passenger was pronounced deceased at the scene. Both vehicles were towed from the crash site due to disabling damage.

VEHICLE DATA

2000 Chrysler Concorde Lxi

The 2000 Chrysler Concorde Lxi was manufactured in January, 2000 and identified by the vehicle identification number (VIN): 2C3HD36J2YH (production number deleted). The driver was the owner of the vehicle which was purchased from an out-of-state dealership in February, 2000. The 4-door

sedan was equipped with power windows, power seats, front-wheel drive, four-wheel ABS, and a 3.2 liter, V-6 engine. The odometer reading at the time of the crash was approximately 40,233 km (25,000 miles). The seating was configured with front bucket and rear bench seats. The driver reported no previous crashes or maintenance on the Chrysler's frontal air bag system. Cargo stowed in the trunk area consisted of miscellaneous personal items with a combined weight of 29.9 kg (66.0 lb).

2000 Toyota Tundra SR5

The 2000 Toyota Tundra SR5 was manufactured in July, 2000 and identified by the vehicle identification number (VIN): 5TBRT3419YS (production number deleted). The driver was the owner of the vehicle which was purchased from a local dealership in August, 2000. The 4-door extended cab 4x2 pickup truck was equipped with power windows, door locks, rear-wheel drive, and a 4.7 liter, V-8 engine. The odometer reading at the time of the crash was approximately 48,279 km (30,000 miles). The seating was configured with front bucket and rear (split) bench seats. The driver reported no previous crashes or maintenance on the Toyota's frontal air bag system. Cargo stowed in the bed area (secured to the vehicle with rope) consisted of ten medium sized storage boxes (containing personal items) with a combined weight of approximately 34.0 kg (75.0 lb). Four additional storage boxes containing glass figurines were stowed in the vehicle interior, behind the driver seat (weight unknown).

VEHICLE DAMAGE

Exterior - 2000 Chrysler Concorde Lxi

The 2000 Chrysler Concorde Lxi sustained moderately severe frontal damage as a result of the impact with the Toyota Tundra pickup truck (**Figure 4**). The direct contact damage began at the front right bumper corner and extended 99.0 cm (39.0 in) inboard. The impact deformed the entire front end width, resulting in a combined direct and induced damage length (Field L) of 100.0 cm (39.4 in). Six crush measurements were documented at the level of the reinforcement bar (*bumper fascia separation*): C1= 7.0 cm (2.8 in), C2= 41.0 cm (16.1 in), C3= 60.0 cm (23.6 in), C4= 62.0 cm (24.4 in), C5= 60.0 cm (23.6 in), C6= 48.0 cm (18.9 in). A secondary crush profile was obtained 13.0 cm (5.1 in) above the level of the bumper to capture the underride damage, which resulted in an *averaged profile* of: C1= 7.0 cm (2.8 in), C2= 41.0 cm (16.1 in), C3= 60.0 cm (23.6 in), C4= 62.0 cm (24.4 in), C5= 77.0 cm (30.3 in), C6= 63.0 cm (24.8 in). The Collision Deformation Classification (CDC) for this impact to the Chrysler was 11-FZEW-4 with a principal direction of force of (-)20 degrees. White and gray paint transfers were documented along the direct contact damage. A maximum crush value of 94.0 cm (37.0 in) was identified at the (above bumper/mid-radiator) C5 location, as direct contact damage to the hood from the vehicle underride/override extended rearward towards the base of the windshield. Metal scarring and paint transfers were noted across the hood surface and attributed to the front right area of the Toyota pickup truck. In addition, this damage pattern to the hood resulted in minor penetration of the rear edge through the right lower windshield area. The windshield was also fractured in multiple locations (along the base) from exterior impact forces, and the right mid-windshield area from the (interior) passenger air bag flap. Induced contact damage produced roof buckling along the right side support pillars. The right fender was displaced rearward which restricted the right front wheel/tire. Right side wheelbase reduction measured 28.5 cm (11.2 in) while elongation in the left side wheelbase measured 6.5 cm (2.6 in). The right front door was removed by rescue personnel during post-crash occupant extrication activities, with pry marks surrounding the damaged areas.



Figure 4. Frontal damage to the 2000 Chrysler Concorde Lxi.

Exterior - 2000 Toyota Tundra SR5

The 2000 Toyota Tundra SR5 4x2 pickup truck sustained moderately severe damage as a result of the impact with the Chrysler Concorde (**Figure 5**). The direct contact damage began at the front right bumper corner and extended 70.0 cm (27.6 in) inboard. The impact deformed the entire front end width, resulting in a combined direct and induced damage length (Field L) of 143.0 cm (56.3 in). Six crush measurements were documented at the level of the bumper: C1= 1.0 cm (0.4 in), C2= 1.0 cm (0.4 in), C3= 8.0 cm (3.1 in), C4= 25.0 cm (9.8 in), C5= 41.0 cm (16.1 in), C6= 83.0 cm (32.7 in). The CDC for this impact to the Toyota was 12-FZEW-4 with a principal direction of force of (+)10 degrees. Red paint transfers were documented along the direct contact damage. The hood was deformed up and rearward from the impact force. The right fender was displaced rearward with impact separation damage noted to the right front wheel/tire and axle area. The windshield was fractured along the right lower windshield from exterior impact forces, and the right mid-windshield area from the (interior) passenger air bag deployment. Induced contact damage produced roof buckling along the right B-pillar and C-pillar. Bed to cab contact was noted on both sides. Right side wheelbase reduction measured 34.0 cm (13.4 in) as elongation in the left side wheelbase measured 7.5 cm (3.0 in).



Figure 5. Front right damage to the 2000 Toyota Tundra SR5 pickup truck.

Interior - 2000 Chrysler Concorde Lxi

Interior damage to the Chrysler Concorde was severe and was attributed to occupant contacts, component intrusions, and trunk cargo shift (**Figure 6**). Scuff marks and indentations were documented on the left knee bolster and glove compartment door. The glove compartment door opened during the crash (latch mechanism damaged/inoperative), and was noted to be resting on the seat cushion. A circular indentation was also identified to the right mid-instrument panel area. No steering rim deformation or column compression was identified. The driver seat back was deformed to a rearward mid-range position with a large ice cooler (full of beverages) lodged behind the seat frame. Contact damage to the front right seat back consisted of small indentations and abrasions to the aft aspect. A narrow/deep abrasion was also documented to the right of the (front right) head restraint and attributed to a rear seated occupant bracing posture. Blood pooling and socket tools (*trunk cargo*) were noted in the seat bight and on the floor area.



Figure 6. Interior damage to the 2000 Chrysler Concorde.

Excessive cargo shift in the trunk area deformed the fixed rear right and center seat backs with an associated anchorage failure at the upper frame retainer clips (**Figure 7**). The fixed seat back design utilizes a 6.4 mm (1/4 in) thin gauge metal wire to provide frame support, and act as a barrier between the two vehicle compartments. The seat back is then affixed to the vehicle frame through the use of three “U” channel retaining clips located at the upper left, center, and right seating positions. Although deformed sections of the wire seat back frame were removed by the medical examiner’s office for further analysis, forward displacement of the retaining clips were identified during the SCI vehicle inspection as a source of the seat back failure, and spacings (*gaps*) which measured 2.6 cm (1.0 in), and 3.0 cm (1.2 in), respectively. Cargo stowed in the trunk consisted of books, tools, clothing bags, coconuts and home video equipment. The items were removed from the trunk area and weighed for a total of 29.9 kg (66.0 lb), as the heaviest items (*books and tools*) were then singled out for a total weight of 11.3 kg (25.0 lb). The multitude of socket tools found in the rear right seat bight suggested the heaviest concentration of loading forces in this occupant space. Longitudinal component intrusions into the passenger compartment included 14.0 cm (5.5 in) of right toepan, 7.0 cm (2.8 in) of right instrument panel, 10.0 cm (3.9 in) of external hood, and 12.0 cm (4.7 in) of rear seat back intrusion.

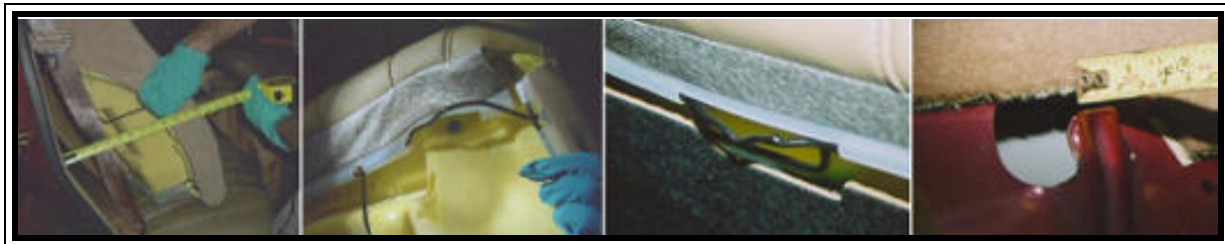


Figure 7. Rear seat back damage and associated anchorage failure in the 2000 Chrysler Concorde.

Interior- 2000 Toyota Tundra SR5

Interior damage to the Toyota Tundra pickup truck was minimal and was attributed to occupant contacts, component intrusions, and bed cargo shift (**Figure 8**). Friction marks were documented on the outboard aspect of the driver seat cushion, and attributed to interaction with the lap portion of the 3-point manual restraint. No steering rim deformation or column compression was identified. The glove compartment door opened during the crash (latch mechanism damaged/inoperative) and was noted to be displaced slightly to the right. A small indentation and scratch mark were documented on the aft aspect of the front right head restraint. Light scuff marks and cloth abrasions were documented on the aft aspect of the front right seat back. The left portion of the backlight glazing was disintegrated, and attributed to cargo shift stowed in the bed area. Component intrusions into the front right passenger space involved 15.0 cm (5.9 in) of longitudinal toepan, and 8.0 cm (3.1 in) of vertical floorpan intrusion.



Figure 8. Interior view of the 2000 Toyota Tundra SR5.

MANUAL RESTRAINT SYSTEMS

2000 Chrysler Concorde Lxi

The interior of the Chrysler Concorde consisted of a five passenger seating configuration with front bucket and rear bench seats. The outboard seating positions were equipped with 3-point manual lap and shoulder belt systems, which consisted of a continuous loop belt webbing with a sliding latchplate and a dual mode retractor (inertial lock/belt sensitive). The rear center seating position was equipped with a 2-point manual lap belt with a locking latchplate. Extensive loading evidence was documented on the front restraint systems. Evidence included deep abrasions to the D-ring and latchplate webbing sleeve, with associated transfers embedded into the webbing (**Figure 9**).

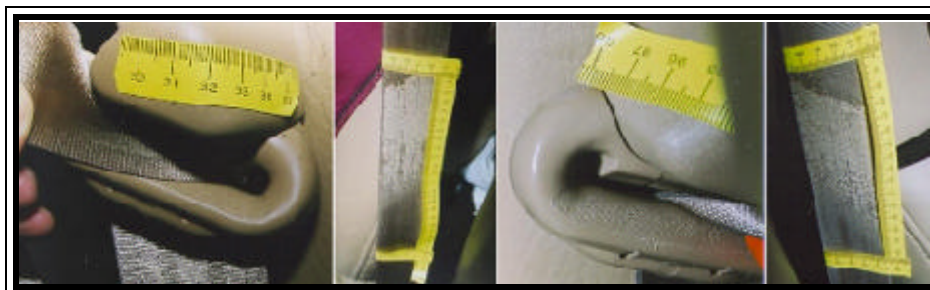


Figure 9. Loading evidence to the front left and right 3-point restraint systems (D-ring/shoulder webbing).

Extensive loading evidence was also documented on the webbing of the rear right restraint (**Figure 10**). Although a 0.9 meter (3.0 feet) section was removed by the medical examiner's office post-crash for further analysis, the webbing exhibited distinct curling characteristics with inner folds resembling a "W" pattern. This folding mechanism may have produced razor blade like injuries, as the width of the webbing was reduced which allowed laceration into the soft abdominal tissue of the rear right passenger. Blue fabric transfers were embedded deep into the lap portion (forward side), with skin tissue and blood transfers embedded into the aft side. Abrasions were identified on the D-ring and latchplate.



Figure 10. Loading evidence and fabric transfers to the rear right 3-point manual restraint.

2000 Toyota Tundra SR5

The interior of the Toyota Tundra pickup truck consisted of a five passenger seating configuration with front bucket and rear (split) bench seats. The outboard seating positions were equipped with 3-point manual lap and shoulder belt systems which consisted of a continuous loop belt webbing with a sliding latchplate and a dual mode retractor (inertial lock/belt sensitive). The rear center seating position was equipped with a 2-point manual lap belt with a semi-locking latchplate. Loading evidence documented on the front restraint systems consisted of abrasions to the D-ring (**Figure 11**) and latchplate. “Dimpling” of the shoulder belt webbing was also noted. Loading evidence documented on the rear right restraint included distinct markings on the shoulder webbing, and attributed to the child safety seat locking clip. Black fabric and light plastic transfers were also embedded into the shoulder webbing of the rear right restraint, and attributed to the child safety seat (plastic shell and cloth liner) in use at the time of the crash.

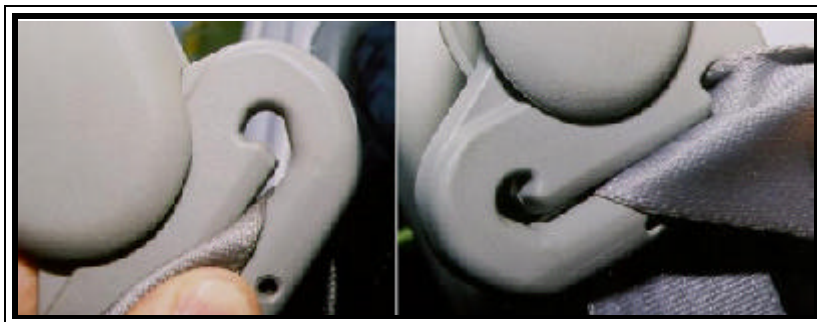


Figure 11. Loading evidence on the driver and front right passenger restraint D-rings (respectively).

SUPPLEMENTAL RESTRAINT SYSTEMS

2000 Chrysler Concorde Lxi

The 2000 Chrysler Concorde Lxi was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of the crash (**Figure 12**). The driver air bag was identified by the part number: *P120545-82H* with a bar coded lot number of: *TMK3448G1396* and housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The upper flap was trapezoidal in shape and measured 11.3 cm (4.4 in) in width along the top portion, 13.4 cm (5.3 in) in width along the flap tear seam, and 9.0 cm (3.5 in) in height. The

lower flap was rectangular in shape and measured 13.4 cm (5.3 in) in width and 5.4 cm (2.1 in) in height. No contact evidence was identified on the exterior surface of the module cover flaps. Although the surface of the air bag seemed lightly abraded from occupant interaction, blood spattering across the face of the membrane masked any obvious contact evidence. The diameter of the driver air bag measured 51.4 cm (20.2 in) in its deflated state. No vent ports or internal tether straps were present. Air bag excursion measured 21.0 cm (8.3 in) from the steering wheel hub.



Figure 12. 2000 Chrysler Concorde deployed redesigned frontal air bags.

The front right passenger air bag deployed from the right top instrument panel area, with a single cover module cover flap design hinged at the forward aspect. The flap was rectangular in shape and measured 35.0 cm (13.8 in) in width and 18.2 cm (7.2 in) in height. The aft edge of the module cover flap was slightly abraded from engagement against the windshield. No contact evidence was identified on the exterior surface of the module cover flap, however, a circular indentation was documented on the right mid-instrument panel area just below the module location. Makeup transfers were identified at the right upper quadrant of the air bag face, along with blue fabric transfers to the lower right quadrant. The passenger air bag measured 49.0 cm (19.3 in) in width and 56.5 cm (22.2 in) in height in its deflated state. The bag was tethered by two internal straps, and vented by two 6.0 cm (2.4 in) diameter ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag. Air bag excursion measured 58.0 cm (22.8 in) from the aft portion of the mid-instrument panel.

2000 Toyota Tundra SR5

The 2000 Toyota Tundra pickup truck was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of the crash (**Figure 13**). The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The flaps were nearly symmetrical in shape, as the upper flap measured 16.2 cm (6.4 in) in width and 4.7 cm (1.9 in) in height; while the lower flap measured 16.2 cm (6.4 in) in width and 7.6 cm (3.0 in) in height. No contact evidence was identified on the exterior surface of the module cover flaps, however, light abrading was documented across the face of the air bag membrane. The diameter of the driver air bag measured 58.2 cm (22.9 in) in its deflated state. The bag was tethered by four internal straps, and vented by two 2.0 cm (0.8 in) diameter ports located at the 10 o'clock and 2 o'clock sectors on the rear aspect of the air bag. Air bag excursion measured 38.5 cm (15.2 in) from the steering wheel hub.

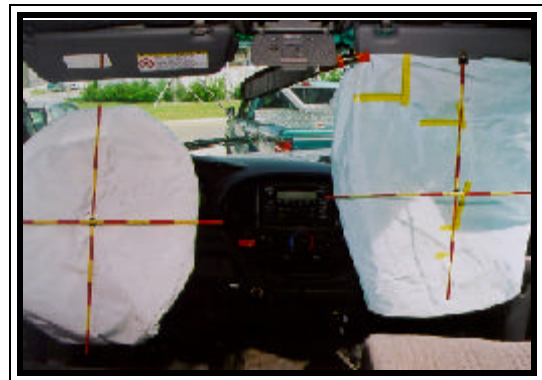


Figure 13. 2000 Toyota Tundra SR5 deployed redesigned frontal air bags.

The front right passenger air bag deployed from the right top instrument panel area with a horizontally oriented flap tear seam (H-configuration). The flaps were symmetrical/rectangular in shape, and measured 23.5 cm (9.3 in) in width and 6.0 cm (2.4 in) in height. No contact evidence was identified on the exterior surface of the module cover flaps. Light colored fabric transfers were documented on

the right lower quadrant of the air bag face, along with light abrading and blood spattering to the left upper quadrant. The top portion of the air bag membrane was also slightly abraded from engagement against the (fractured) right mid-windshield. The passenger air bag measured 71.0 cm (28.0 in) in width and 73.0 cm (28.7 in) in height in its deflated state. The bag was vented by two 5.0 cm (2.0 in) diameter ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag. Air bag excursion measured 44.0 cm (17.3 in) from the aft portion of the mid-instrument panel.

DRIVER DEMOGRAPHICS - 2000 Chrysler Concorde Lxi

Age/Sex: 75 year old male
 Height: 170 cm (67 in)
 Weight: 73 kg (160 lb)
 Seat Track Position: Mid-to-rear position
 Manual Restraint Use: 3-point lap and shoulder belt system
 Usage Source: Vehicle inspection, police report, driver interview
 Eyeware: None
 Type of Medical Treatment: Transported to a nearby trauma center and admitted (3 days)

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Fracture right femur (mid-shaft: displaced/comminuted)	Serious (851814.3,1)	Left knee bolster
*Fracture right calcaneus (displaced)	Moderate (851400.2,1)	Brake pedal
+Contusion right lateral shin (above ankle)	Minor (890402.1,1)	Accelerator pedal
+Contusion left posterior hand	Minor (790402.1,2)	Left instrument panel

Sources: radiology report*/driver interview+

Driver Kinematics

The 75 year old male driver of the 2000 Chrysler Concorde Lxi was restrained by the available 3-point manual lap and shoulder belt system, and seated in an upright posture with his hands placed at the 4 o'clock and 8 o'clock positions on the steering wheel rim. Belt usage was determined by the extensive loading evidence identified on the latchplate, D-ring, and webbing of the front left restraint.

At impact, the driver initiated a forward and slightly lateral trajectory in response to the 11 o'clock impact force and loaded the manual restraint, knee bolster, and deployed redesigned driver air bag. Loading of the knee bolster resulted in a comminuted and displaced fracture of the right femur as evidenced by the scuff marks and indentations documented on this component (**Figure 14**). Contact to the deployed driver air bag was confirmed by the abrasion pattern identified across the face of the air bag. His (posterior) left hand struck the vent louvers which resulted in a small contusion, evidenced by the scuff marks identified to the mid-instrument panel area. He also sustained a contusion to the (inside) ankle,



Figure 14. Interior view of the driver space.

and fracture of the right heel from brake pedal loading, as evidenced by the location of the injury relative to the driver's stated placement of the right foot on the brake pedal during pre-crash avoidance maneuvers. The driver rebounded into the front left seat back, confirmed by the deformation documented to this component and pre-crash placement of the (lodged) ice cooler. The driver reported no resulting injury. Following the crash, the driver was removed from the vehicle by rescue personnel due to perceived serious injury, and transported by ambulance to a nearby hospital and admitted for three days. Treatment included placement of an intra medullary rod to repair the right femur. The redesigned driver air bag provided additional protection against further contact to the steering wheel hub/rim, and potential serious injury.

FRONT RIGHT PASSENGER DEMOGRAPHICS - 2000 Chrysler Concorde Lxi

Age/Sex: 50 year old female
 Height: 168 cm (66 in)
 Weight: 73 kg (160 lb)
 Seat Track Position: Full rearward position
 Manual Restraint Use: 3-point lap and shoulder belt system
 Usage Source: Vehicle inspection, police report, passenger interview
 Eyewear: Prescription glasses (*type of lenses/frames unknown*)
 Type of Medical Treatment: Transported to a nearby trauma center and admitted (2 days)

Front Right Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Fracture right distal radius	Moderate (752802.2,1)	Right mid-instrument panel
*Fracture right 4 th metacarpal neck (displaced)	Moderate (752002.2,1)	Right mid-instrument panel
*Fracture/dislocation left 2 nd metatarsal shaft	Moderate (852200.2,2)	Right toepan
*Fracture/dislocation left 3 rd metatarsal shaft	Moderate (852200.2,2)	Right toepan
#Contusion right knee and upper shin	Minor (890402.1,1)	Glove compartment door
#Laceration over left knee	Minor (890602.1,2)	Glove compartment door
+Contusion right chest (follows ribs)	Minor (490402.1,1)	Shoulder harness
+Contusion bridge of nose	Minor (290402.1,4)	Eyeglasses (air bag related injury)
+Epitaxis ("nosebleed")	Minor (251090.1,4)	Eyeglasses (air bag related injury)

Sources: radiology report/emergency room records#/passenger interview+*

Front Right Passenger Kinematics

The 50 year old female front right passenger of the 2000 Chrysler Concorde Lxi was restrained by the available 3-point manual lap and shoulder belt system. She was seated out-of-position and leaned forward in a bracing posture, with her right arm extended forward against the right mid-instrument panel

area. Belt usage was determined by the extensive loading evidence identified on the latchplate, D-ring, and webbing of the front right restraint. It should be noted that the passenger was wearing prescription glasses at the time of the collision.

At impact, she initiated a forward and slightly lateral trajectory in response to the 11 o'clock impact force and loaded the manual restraint, right instrument panel, toe pan, and deployed redesigned front right passenger air bag. Loading of the manual restraint resulted in contusions to the right chest. Bracing against the instrument panel resulted in fractures of the right 4th metacarpal neck (hand) and distal radius fracture. This injury mechanism was evidenced by the scuff marks and distinct indentation identified just above the glove compartment door (**Figure 15**). Her knees struck the glove compartment door, which resulted in bilateral soft tissue injury to the lower extremities as evidenced by the deformation documented

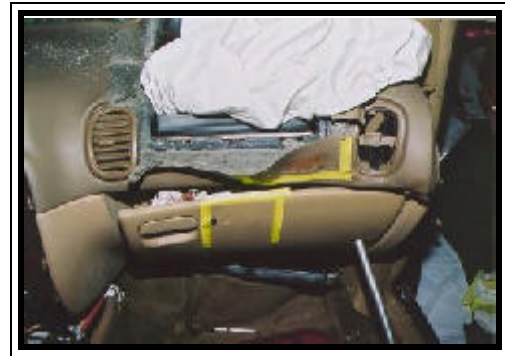


Figure 15. Contact evidence to the right mid-instrument panel and glove compartment door.

to this component. She also sustained fractures of the right 2nd and 3rd metatarsal shaft (foot) from loading to the *intruded* toe pan, evidenced by the location of the injury in conjunction with the passenger's stated placement of the feet on the toe pan during pre-crash brace posturing. Contact to the deployed redesigned passenger air bag compressed the eyeglasses into the nose, resulting in a small contusion on the bridge of the nose and a rupture of the mucosal vessels ("nosebleed"). This injury mechanism was evidenced by the makeup and fabric transfers documented on the right aspect of the air bag face. The front right passenger stated during the SCI interview that her glasses were "broke in half" at the bridge due to air bag interaction. Although not entrapped by intruded components, she also stated the (open) glove compartment door partially restricted movement of her right lower extremity during extrication procedures post-crash. Following the crash, the passenger was removed from the vehicle by rescue personnel due to perceived serious injury, and transported by ambulance to a nearby hospital. After initial evaluation by emergency room personnel, she was transferred to a nearby trauma center for specialized treatment of her extremity fractures. On hospitalization day eight, she was transferred back to the initial hospital facility for the remainder of her 28 day admit. The redesigned passenger air bag provided additional protection against further contact to frontal components, and potential serious injury.

REAR RIGHT PASSENGER DEMOGRAPHICS - 2000 Chrysler Concorde Lxi

Age/Sex:	73 year old female
Height:	155 cm (61 in)
Weight:	75 kg (165 lb)
Seat Track Position:	Fixed
Manual Restraint Use:	3-point lap and shoulder belt system (<i>improper usage</i>)
Usage Source:	Vehicle inspection, police/autopsy report, driver interview
Eyewear:	None
Type of Medical Treatment:	Pronounced deceased at the scene

Rear Right Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
#Laceration to mesentery	Severe (542026.4,8)	Lap belt webbing
#Laceration to colon (large bowel) - NFS	Severe (540826.4,8)	Lap belt webbing
#Laceration to ileum (small bowel) - NFS	Severe (541426.4,8)	Lap belt webbing
#Abdominal laceration (large/deep/elongated)	Serious (590606.3,1)	Lap belt webbing
#Fracture right distal ulna (open)	Serious (753206.3,1)	Front right seat back (bracing injury)
#Cervical spine fracture at C1 - NFS	Moderate (650216.2,6)	Non-contact injury (flexion-acceleration injury)
#Laceration/avulsion flexor muscle right wrist	Moderate (740400.2,1)	Front right seat back
#Abrasion anterior neck (patterned)	Minor (390202.1,5)	Lap belt webbing
#Contusion left chest	Minor (490402.1,2)	Shoulder belt webbing
#Abrasion left chest (patterned)	Minor (490202.1,2)	Shoulder belt webbing
#Contusion anterior right wrist	Minor (790402.1,1)	Front right seat back (bracing injury)
#Contusions across entire abdomen (horizontal)	Minor (590402.1,0)	Lap belt webbing
#Abrasions across entire abdomen (horizontal)	Minor (590202.1,0)	Lap belt webbing
#Contusion right knee	Minor (890402.1,1)	Front right seat back
#Contusion left anterior foot/lower leg and bilateral feet/ankles	Minor (890402.1,3)	Front right seat back / cushion frame

Source: autopsy report#

Rear Right Passenger Kinematics

The 73 year old female rear right passenger of the 2000 Chrysler Concorde Lxi was restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with her right arm extended forward in a bracing position (**Figure 16**). Belt usage was confirmed by the extensive loading evidence identified on the latchplate, D-ring and webbing of the rear right restraint. Injury patterns sustained indicated improper belt use by the occupant as the shoulder portion was positioned high across the chest, and the lap portion high over the abdomen. The occupant's large girth along her mid-section folded the lap belt webbing over into a pinched "W" pattern. It should be noted that clothing worn included a plaid short-sleeve blue, tan and white blouse, and blue pants.



Figure 16. Interior view of the rear right seating area.

At impact, the rear right passenger initiated a forward and slightly lateral trajectory in response to the 11 o'clock impact force, and loaded the manual restraint and rear aspect of the front right seat back. The passenger initially sustained a cervical spine fracture (at C1), which was a result of the sudden forward movement of the head as the body loaded the belt system. Loading of the manual restraint resulted in distinct patterned abrasions to the anterior neck and left torso, with contusions extending to the left breast and left lateral torso. The unique pattern of these soft tissue injuries was indicative of improper shoulder harness placement high across the chest. Her right arm/hand struck the front right seat back which resulted in a contusion to the posterior aspect of the wrist, an underlying avulsion of the flexor muscle, and an open fracture of the distal ulna. These extremity injuries were evidenced by the abrasions and scuff marks identified to the right of the front right head restraint, and further confirmed the passenger's pre-impact bracing posture. Her right knee struck the front right seat back, as both feet/ankles slid under and loaded the seat cushion frame, resulting in multiple contusions as evidenced by the scuff marks and indentations documented along the mid-to-lower aspects of this component.

At this point, the cargo stowed in the trunk area shifted forward and impacted the fixed rear seat back. The retainer clips failed which allowed excessive loading forces against the restrained occupant. This "vise" mechanism combined with the abnormal folding characteristic of the lap portion of the restraint into a "W" pattern acted as a razor blade (*sharp edge under tension*) along the abdominal belt path. Folding of the restraint webbing reduced the width which lacerated into the soft tissue resulting in extensive abdominal soft tissue and underlying internal laceration/avulsive type trauma. This very large, deep, and "gaping" laceration extended from the lateral aspect of the right side, slightly downward and oblique (well below the umbilicus) toward the midline to the pubic symphysis. The laceration extended to, but did not involve, the spinal column or other internal organs. Underlying abdominal avulsive and trauma was sustained to the bowel (colon/ileum), which eviscerated (protruded) through the wide laceration. Following the crash, the rear right passenger came to rest slumped to the right against the door panel, evidenced by the extensive blood pooling noted in the passenger space. She was removed from the vehicle through the right rear door by rescue personnel, and subsequently pronounced deceased at the scene.

DRIVER DEMOGRAPHICS - 2000 Toyota Tundra SR5

Age/Sex:	42 year old male
Height:	175 cm (69 in)
Weight:	86 kg (190 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection, police report, driver interview
Eyewear:	None
Type of Medical Treatment:	Refused on-scene treatment

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
+Contusion left shoulder	Minor (790402.1,2)	Shoulder belt harness
+Contusion center chest	Minor (490402.1,4)	Shoulder belt harness
+Contusion abdomen	Minor (590402.1,0)	Lap belt harness
+Abrasion posterior right wrist	Minor (790602.1,1)	Deployed redesigned front right passenger air bag
+Contusion left knee/shin	Minor (890402.1,2)	Left knee bolster

Source: driver interview+

Driver Kinematics

The 42 year old male driver of the 2000 Toyota Tundra SR5 pickup truck was restrained by the available 3-point manual lap and shoulder belt system, and seated out-of-position leaned to the right with his arm extended laterally outward in a bracing posture. Belt usage was determined by the loading evidence identified on the latchplate and D-ring of the front left restraint. At impact, the driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster, and deployed redesigned driver air bag. Loading of the manual restraint resulted in contusions to the left shoulder, chest, and abdomen. He struck the knee bolster which resulted in a contusion to the left knee/shin. Although no contact damage was identified on the left knee bolster, this injury mechanism was evidenced by the location of the injury relative to the occupant kinematic response pattern. Contact to the deployed driver air bag was confirmed by the abrasion pattern identified across the face of the air bag membrane. Driver bracing of the front right child passenger (along with subsequent passenger air bag interaction), resulted in an abrasion to the posterior aspect of the right wrist. This injury mechanism was evidenced by the aspect of the injury, relative to the driver's stated pre-impact posture, and light abrading documented on the left upper quadrant of the *passenger air bag face*. Following the crash, the driver exited the vehicle under his own power through the left front door, and attended to the child passengers until police/rescue arrived on-scene within 20 minutes of the crash. The driver refused on-scene treatment for his injuries. The redesigned driver air bag provided additional protection against further contact to the steering wheel hub/rim, and potential serious injury.

FRONT RIGHT PASSENGER DEMOGRAPHICS - 2000 Toyota Tundra SR5

Age/Sex:	7 year old male
Height:	122 cm (48 in)
Weight:	36 kg (80 lb)
Seat Track Position:	Full rearward position (<i>seat back reclined</i>)
Manual Restraint Use:	3-point lap and shoulder belt system (<i>improper usage</i>)
Usage Source:	Vehicle inspection, police report, driver interview
Eyeware:	None
Type of Medical Treatment:	Transported to a nearby trauma center and admitted (overnight)

Front Right Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Mild anterior subluxation (C3/C4, C4/C5)	Moderate (650204.2,6)	Non-contact injury
*Closed head injury - NFS	Unknown (115099.7,0)	Non-contact injury
*Loss of consciousness - unknown duration (awake upon initial observation)	Minor (160499.1,0)	Non-contact injury
#Contusion left chest and flank areas	Minor (490402.1,2)	Driver's right arm/hand
#Abrasion left chest	Minor (490202.1,2)	Driver's right arm/hand
#Contusion bilateral lower abdomen	Minor (590402.1,3)	Lap belt harness
+Contusion bilateral anterior lower legs	Minor (890402.1,3)	Glove compartment door

Sources: radiology report/emergency room records#/driver interview+*

Front Right Passenger Kinematics

The 7 year old male front right passenger of the 2000 Toyota Tundra pickup truck was asleep in the supine position, with the seat track adjusted to the full rearward position and the seat back reclined beyond a rearward mid-range position. He was improperly restrained by the available 3-point manual lap and shoulder belt system with the lap harness high across the stomach. Belt usage was determined by the nature of the injuries sustained, in conjunction with the loading evidence identified on the latchplate, D-ring, and webbing of the front right restraint. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, and deployed redesigned front right passenger air bag. He submarined the lap belt which produced contusions bilaterally across the abdomen, and allowed the lower extremities to slide forward and strike the glove compartment door, resulting in additional soft tissue injury. The lower extremity injury mechanisms were evidenced by the displacement documented to the glove compartment door, in conjunction with the occupant kinematic response pattern. Contact to the deployed passenger air bag was confirmed by the fabric transfers documented on the right lower quadrant of the air bag face. The child passenger also complained of pain on the back of the neck/lower back, however, no specific injury was identified. Following the crash, the passenger was removed from the vehicle by the driver through the left front door, and transported by ambulance to a nearby trauma center and admitted overnight for observation. Physicians recommended that he be admitted to the hospital because of the mechanism of his injury and his blunt abdominal trauma. The redesigned passenger air bag provided additional protection against further contact to frontal components, and potential serious injury.

REAR RIGHT PASSENGER DEMOGRAPHICS - 2000 Toyota Tundra SR5

Age/Sex: 3 year old male
 Height: 99 cm (39 in)
 Weight: 12 kg (27 lb)
 Seat Track Position: Fixed
 Child Safety Seat
 Make/Model: Cosco 02-442-WAL @ 9/22/2000 (30-80 lb)
 Manual Restraint Use: 3-point lap and shoulder belt system
 Usage Source: Vehicle inspection, police report, driver interview
 Eyeware: None
 Type of Medical
 Treatment: Transported to a local hospital and released

Rear Right Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Pulmonary contusion and edema - bilateral	Severe (441410.4,3)	CSS harness
#Contusion left eye	Minor (297402.1,2)	Front right head restraint
#Abrasions face - NFS	Minor (290202.1,9)	Front right head restraint
#Laceration left outer upper lip	Minor (290602.1,8)	Front right head restraint (indirect contact injury)
#Avulsion front upper tooth	Minor (251406.1,8)	Front right head restraint
#Contusion posterior right hand	Minor (790402.1,1)	Front right seat back

Sources: radiology report*/emergency room records#

Rear Right Passenger Kinematics

The 3 year old male rear right passenger of the 2000 Toyota Tundra pickup truck was upright and restrained within the forward facing child safety seat, which was loosely secured by the vehicle’s available 3-point manual lap and shoulder belt system. Belt usage was confirmed by the loading evidence identified on the shoulder webbing of the rear right restraint (**Figure 17**). At impact, the child passenger initiated a forward trajectory in response to the 12 o’clock impact force as the child safety seat’s improper installation allowed the seat to flip forward. The child struck the rear aspect of the front right seat back and head restraint, which resulted in multiple soft tissue injury to the face and an avulsion of a front upper tooth. These injury mechanisms were evidenced by the abrasions and indentations identified on these components. He also sustained a *through and through* upper lip laceration which was an indirect result of the tooth trauma (“*bit lip*”). Following the crash, the child passenger was removed from the vehicle by the driver through the left front door, and subsequently transported by ambulance to a local trauma center for treatment and released.



Figure 17. Loading evidence on the rear right shoulder harness.

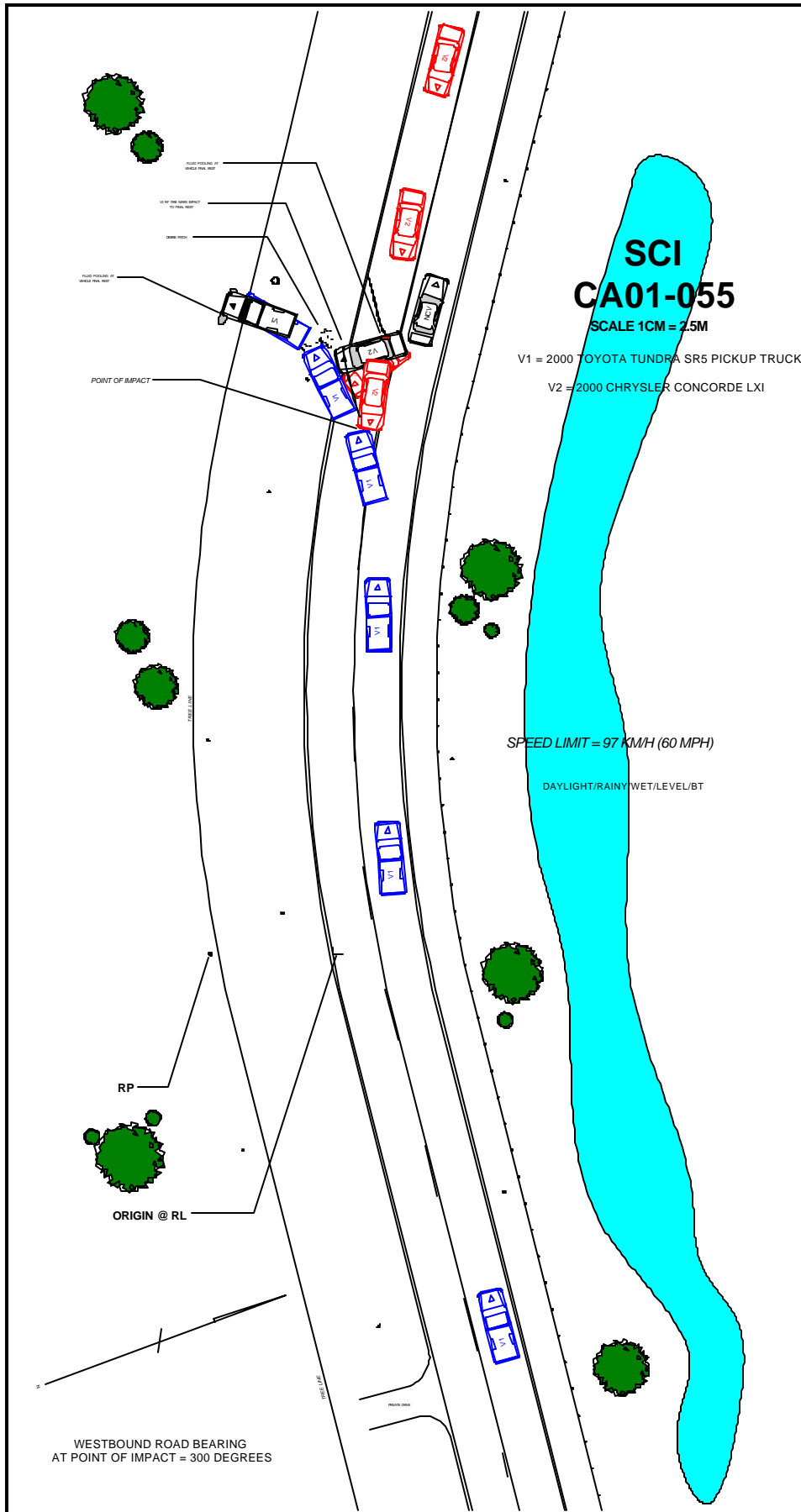


Figure 18. Scene Diagram.