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ON-SITE ROLLOVER INVESTIGATION

CASE NUMBER - IN07017
LOCATION - TEXAS
VEHICLE - 2002 TOYOTA TUNDRA
CRASH DATE - October 2006

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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

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16. <i>Abstract</i> This report covers an on-site rollover investigation that involved a 2002 Toyota Tundra and a 2006 Dodge Magnum. This crash is of special interest because the Toyota rolled over. The crash occurred on a state highway within a construction zone. The straight four lane roadway had been reduced to one northbound lane and two southbound lanes. The Toyota was traveling north and the Dodge was traveling south in the outside lane. The Toyota's driver stated that the vehicle lurched to the right when she ran over a dip in the roadway. The driver steered left, right and then left again, the Toyota began rotating counterclockwise and entered the southbound lanes. The Toyota's front end impacted the left fender of the Dodge causing the Toyota's driver and front right passenger air bags to deploy. The impact caused the Toyota to roll over onto its right side. The Toyota's unrestrained front right passenger was ejected through the right front window prior to the rollover. The Dodge also rolled over as a result of the crash. Both vehicles and the Toyota's front right passenger came to rest on the west side of roadway. The Toyota's four occupants were transported by ambulance to a hospital. The driver and front right passenger were admitted and the back center and back right passengers were treated and released.			
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This crash was brought to the National Highway Traffic Safety Administration's attention on or before April 4, 2007 by the sampling activities of the National Automotive Sampling System. The crash involved a 2002 Toyota Tundra and a 2006 Dodge Magnum SXT. The crash occurred in October 2006, at 18:32 hours, in Texas and was investigated by the Texas Department of Public Safety. This crash is of special interest because the Toyota rolled over. This contractor inspected the Toyota and scene on June 12 and 13, 2007. The Toyota's driver was interviewed on June 12 and 28, 2007. The Dodge could not be located and was not inspected. This report is based on the police crash report, scene and vehicle inspections, interviews with the Toyota's driver, police on-scene photographs, medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

This crash occurred on a state highway within a construction zone during daylight hours and clear weather conditions. The straight four lane roadway had been reduced to one northbound lane and two southbound lanes due to road construction. The Toyota was traveling north and the Dodge was traveling south in the outside lane. The Toyota's driver stated during the interview that the vehicle lurched to the right when the vehicle ran over a dip in the roadway. The driver steered left, right and then left again, the Toyota began rotating counterclockwise and entered the southbound lanes. The front of the Toyota impacted the left fender of the Dodge causing the Toyota's driver and front right passenger air bags to deploy. The Toyota separated from impact, the unrestrained front right passenger was ejected through the right front window, and the vehicle rolled over one quarter turn onto its right side. The Dodge also rolled over as a result of the crash. Both vehicles and the Toyota's front right passenger came to rest on the west side of roadway with the Toyota heading east and the Dodge heading south.

The Collision Deformation Classifications (CDCs) for the Toyota were **82-FDEW-2** (70 degrees, the 2 o'clock principal direction of force was incremented for frame shift to the left) for the frontal impact and **00-RDAO-2** for the rollover. The WinSMASH reconstruction program, Missing Vehicle algorithm calculated the Toyota's Total, Longitudinal, and Lateral Delta Vs for the front impact as: 38.0 km/h (23.6 mph) -13.0 km/h (-8.1 mph) and -35.7 km/h (-22.2 mph), respectively. The crash fit the reconstruction model and the results were borderline. The rollover severity was minor based on the extent of crush to the right side.

The CDC for the Dodge's impact with the Toyota was estimated from insurance photographs to be **11-LYAW-3** (340 degrees). The CDC for the rollover damage was estimated to be **00-RDAO-2**. The WinSMASH reconstruction program, Missing Vehicle algorithm calculated the Dodge's Total, Longitudinal, and Lateral Delta Vs for the left side impact as: 43.0 km/h (26.7 mph), -40.4 km/h (-25.1 mph) and 14.7 (9.1 mph), respectively. The crash fit the reconstruction model and the results were borderline. The rollover severity was estimated to be minor based on the crush to the right side.

The Toyota's driver (21-year-old, female) was restrained by the lap-and-shoulder seat belt. She sustained minor injuries and was transported by ambulance to a hospital and hospitalized for 2 days.

The front right passenger (13-year-old, male) was not restrained by the lap-and-shoulder seat belt. He sustained multiple severe brain injuries and a critical pelvis injury due to contact with the ground and numerous other injuries. He was transported by ambulance to a hospital and was hospitalized for 15 days.

The back center passenger (2-year-old, female) was unrestrained. She sustained minor injuries and was transported by ambulance to a hospital and was treated and released.

The back right passenger (9-month-old, male) was restrained in an Evenflo forward facing child safety seat (CSS). He remained restrained in the CSS throughout the crash sequence. He sustained minor injuries and was transported by ambulance to a hospital and was treated and released.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which both vehicles were traveling was under construction at the time of the crash. The trafficway was originally a straight, four-lane, undivided, state highway, traversing in a north-south direction. At the time of the crash, the roadway consisted of two southbound travel lanes and a single northbound travel lane. The inside northbound travel lane had been closed by a series of construction barrels placed at regular intervals within the lane. Pavement reflectors were used in conjunction with the construction barrels to channel traffic down to a two-lanes north of the crash site. The road work had been completed prior to this contractor's scene inspection; therefore, no physical evidence from the crash was present and it was not possible to document the original roadway physical plant. The police crash report indicated that the speed limit at the time of the crash was 113 km/h (70 mph). A reduced speed limit was probably in effect due to the construction; however, there was no information on the police crash report indicating a reduced speed limit. At the time of the crash, the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry, level bituminous. Traffic density was light, and the site of the crash was rural and undeveloped. Refer to the Crash Diagram at the end of this report.

Pre-Crash: The Toyota was traveling north (**Figure 1**) at a driver estimated speed of 97 km/h (60 mph) and the driver intended to continue northbound. The Dodge was traveling south in the outside lane and the driver intended to continue southbound. The Toyota ran over a dip in the roadway and the vehicle lurched to the right. The driver steered left, right and then left again, the vehicle began to rotate counterclockwise and crossed into the southbound lanes (**Figure 2**). The crash occurred in the outside southbound lane. She stated during the interview that she only steered in an attempt to regain control and did not apply the brakes during the crash sequence.

Crash: The Toyota's counterclockwise yaw increased as it approached impact with the Dodge (Figure 2). The front of the Toyota (Figure 3) impacted the Dodge's left fender (Figure 4) causing the Toyota's driver and front right passenger air bags to deploy. The impact also caused the Dodge's driver and front right passenger air bags to deploy. The impact accelerated the Toyota's counterclockwise rotation, and the unrestrained front right passenger was ejected through the right front window. The vehicle then rolled over onto its right side (Figure 5). The rollover occurred on the roadway as indicated by the pavement scratches on the right front door. The Dodge rotated counterclockwise, departed the west side of the roadway and rolled over with the right side leading three quarter turns. The Toyota came to rest on its right side on the west side of the road (Figure 6) heading east. The Dodge came to rest on its left side on the west side of the road (Figure 6) heading south. The police crash schematic indicated that the Toyota's ejected front right passenger came to rest on the north side of the Toyota near its undercarriage.

Post-Crash: The Toyota's driver attempted to exit the vehicle from the right front window through a gap between the ground and the top of the window, but got stuck. Passers-by tilted the vehicle enough to pull her through the window. A passer-by broke the backlight and removed the back right passenger from the CSS and removed him from the vehicle. The back center passenger climbed out of the vehicle through the backlight without assistance. A passer-by also broke a hole in the windshield in an attempt to assist the occupants. All of the occupants were transported to a hospital by ambulance.



Figure 1: Police photo showing Toyota's northbound approach to the crash; arrows show Toyota's yaw marks on the east shoulder and in the northbound lane

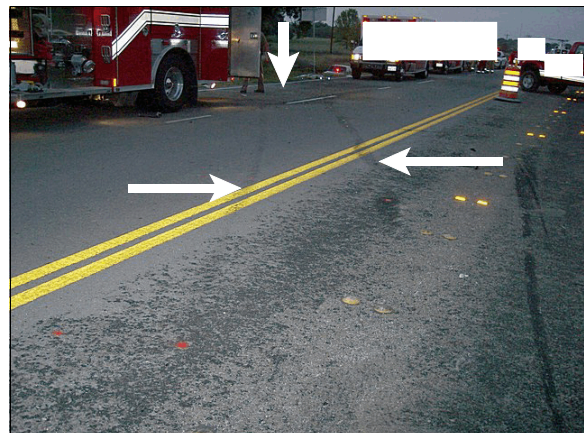


Figure 2: Police photo showing yaw marks (horizontal arrows) from Toyota entering the outside southbound lane; vertical arrow shows area of impact in outside southbound lane



Figure 3: Damage to front of case vehicle due to impact with the Dodge, holed windshield is not related to crash

The 2002 Toyota Tundra was a rear wheel drive, four-door pickup truck (VIN: 5TBRT38132S-----) equipped with a 4-speed automatic transmission and 4 wheel anti-lock disc brakes. The front row was equipped with bucket seats with adjustable head restraints, driver and front right passenger redesigned frontal air bags and lap-and-shoulder seat belts with pretensioners. The second row was equipped with a bench seat with a folding back, adjustable head restraints, lap-and-shoulder seat belts in the outboard seat positions, and a lap belt in the middle seat position. The Toyota's specified wheelbase was 326 centimeters (128.3 inches). The odometer reading at the time of the vehicle inspection could not be determined because the Toyota was equipped with an electronic odometer. The Toyota's driver did not know the vehicle's approximate mileage.

CASE VEHICLE DAMAGE

Exterior Damage: The Toyota's impact with the Dodge involved the front end and right fender. The front bumper, grille, hood, turn signal/headlamp assemblies, and right fender were directly damaged. The front frame members were shifted left 13 centimeters (5.1 inches). The direct damage began at the front right bumper corner and extended 130 centimeters (51.2 inches) across the front end. The front bumper was broken off of the Toyota, so the crush measurements were taken at the level of the lower radiator support. The residual maximum crush was measured as 36 centimeters (14.2 inches) occurring at C₁. The table below shows the Toyota's front crush profile.



Figure 4: Insurance photo showing damage to the Dodge due to the impact with the Toyota



Figure 5: Pavement scratches to right side of Toyota's cab due to the rollover



Figure 6: Police on-scene photo showing final rest positions of Toyota and Dodge

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	130	36	122	36	35	29	27	24	28	0	0
in		51.2	14.2	48.0	14.2	13.8	11.4	10.6	9.4	11.0	0.0	0.0

The Toyota's left side wheelbase was shortened 13 centimeters (5.1 inches) and the right side wheelbase was shortened 22 centimeters (8.7 inches). Induced damage from the front impact involved the hood, left fender and left and right front doors.

The rollover damage involved the right side of the Toyota and consisted of scratches and induced damage folds on the side of the truck bed. Pavement scratches were present on the right front door and sill (**Figure 5**) as well as other scratches at the top of the right front window frame and on the right side of the truck bed. The induced damage folds were located aft of the right rear axle (**Figure 7**). Grass was embedded in the bead of the right front and right rear tires, as well as in the door seam at the front of the right front door and around the right side view mirror. The direct damage began 119 centimeters (46.9 inches) rear of the right rear axle and extended forward 396 centimeters (155.9 inches) along the right side. The maximum lateral crush was 12 centimeters (4.7 inches).



Figure 7: Overview of rollover damage to right side of Toyota and induced damage folds aft of right rear wheel due to rollover

Damage Classification: The CDCs for the Toyota were **82-FDEW-2** (70 degrees, the 2 o'clock principal direction of force was incremented due to the frame shift to the left) for the front impact and **00-RDAO-2** for the rollover. The WinSMASH reconstruction program, Missing Vehicle algorithm, was used to reconstruct the Delta Vs for the front impact. The Total, Longitudinal, and Lateral Delta Vs were 38.0 km/h (23.6 mph) -13.0 km/h (-8.1 mph) and -35.7 km/h (-22.2 mph), respectively. The crash fit the reconstruction model and the results were borderline. The rollover severity was minor based on the extent of crush to the right side. The Toyota was towed due to damage.

The manufacturer's recommended tire size was P265/70R16. The Toyota was equipped with LT265/75R16 size tires. The Toyota's tire data are shown in the table below (note: the manufacturer's recommended pressure for the rear tires as shown below was different than the front tires based on the vehicle's tire placard).

Tire	Measured Pressure		Vehicle Manufacturer's Recommended Pressure		Tread Depth		Damage	Restricted	Deflated
	kPa	psi	kPa	psi	milli-meters	32 nd of an inch			
LF	Flat	Flat	179	26	11	14	Cannot determine	Yes	Yes
LR	234	34	179	26	10	13	None	No	No
RR	207	30	200	29	10	13	None	No	No
RF	159	23	200	29	11	14	None	Yes	No

Vehicle Interior: Inspection of the Toyota's interior (**Figure 8**) revealed an occupant contact scuff mark on the driver's knee bolster (**Figure 9**), and the upper half of the steering wheel rim (**Figure 10**) was deformed forward 4 centimeters (1.6 inches). The contacts indicated the driver's left knee had contacted the knee bolster and she had ridden down the air bag and loaded the steering wheel with her chest. There was an occupant contact scuff mark on the glove box door (**Figure 11**), the right front door panel was slightly deformed outward, and the door panel control housing was displaced. These contact marks indicated that one of the front right passenger's knees had contacted the glove box door and his torso had loaded the right front door and window sill.



Figure 8: Overview of Toyota's front seating area

The passenger compartment intrusion involved the left and right toe pan, the driver's and front right passenger seat cushions, and the center console. The most severe intrusion occurred to the driver's toe pan, which intruded longitudinally 13 centimeters (5.1 inches).



Figure 9: Occupant contact scuff on driver's knee bolster

AUTOMATIC RESTRAINT SYSTEM

The Toyota Tundra was equipped with redesigned driver and front right passenger air bags, which deployed due to the front impact with the Dodge. The driver's air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of

damage to the air bag or the cover flaps due to the deployment. The driver's air bag was designed with two tether straps and had two vent ports located on the back of the air bag at the 11 and 1 clock positions. The deployed driver's air bag was round with a diameter of 67 centimeters (26.4 inches). Inspection of the air bag revealed a few blood stains on the air bag, but no occupant scuff marks or transfers were observed. The driver's retractor-mounted pretensioner actuated.

The front right passenger air bag was located in the top of the instrument panel. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of damage to the air bag or the cover flaps due to the deployment. The front right passenger air bag was designed without tethers and had two vent ports located at the 9 and 3 clock positions. The deployed air bag was rectangular and was 60 centimeters (23.6 inches) in height and 68 centimeters (26.7 inches) in width. A few blood stains were on the air bag, but no occupant scuff marks or transfers were observed. It is not known if the front right retractor-mounted pretensioner actuated because the seat belt was jammed between the seat back and the B-pillar due to the displacement of the seat.



Figure 10: Left side view of deformation of top half of Toyota's steering wheel



Figure 11: Orange dots show contact scuff on glove box door from front right passenger

CHILD SAFETY SEAT

The second row right passenger was seated in an Evenflo forward facing CSS with a 5-point harness. The CSS was not inspected. The driver stated during the interview that she had discarded it.

CASE VEHICLE DRIVER KINEMATICS

The Toyota's driver [21-year-old, female; 165 centimeters and 91 kilograms (65 inches, 200 pounds)] stated during the interview that she was seated in an upright posture with both hands on the steering wheel and her back against the seat back. Her left foot was on the floor and her right foot was over the accelerator pedal. The seat track was adjusted to the middle position, the seat back was slightly reclined, and the tilt steering column was adjusted to its center position. The driver was not wearing glasses or contact lenses.

The Toyota's driver was restrained by the lap-and-shoulder seat belt. Inspection of the seat belt assembly revealed that the shoulder belt was jammed in the corner of the D-ring (**Figure 12**) and there were load abrasions on the belt. The driver also reported seat belt contusions on her left shoulder, chest and hips.

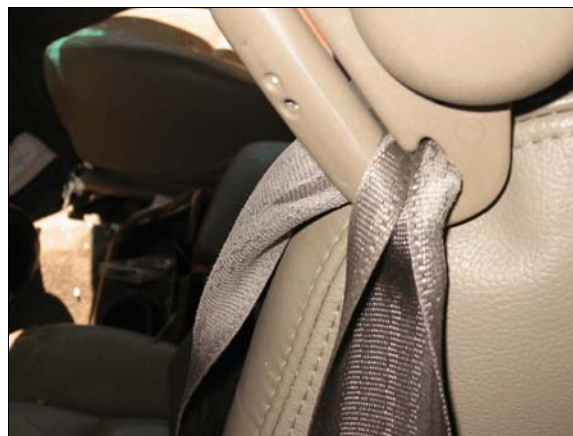


Figure 12: Toyota driver's shoulder belt jammed in corner of D-ring

The driver stated that her upper torso was displaced to the right and left within the seat belt as a result of the pre-crash steering maneuvers. The front impact with the Dodge displaced the driver forward and to the right opposite the Toyota's 70 degree direction of principal force.

The driver loaded the seat belt and her left knee contacted and scuffed the knee bolster (**Figure 9**). Her face and chest contacted the deployed air bag, she rode down the air bag and loaded the steering wheel. She continued to load the seat belt as the Toyota rolled over and she remained restrained in the seat.

CASE VEHICLE DRIVER INJURIES

The driver sustained minor injuries and was hospitalized 2 days for observation. She received no follow-up treatment and lost 14 work days as a result of the crash. This contractor was unable to acquire the driver's medical records because the treating hospital had no record of treatment for the driver. The table below shows the driver's injuries and injury sources based on the interview.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Contusion {bruising} left shoulder, not further specified	minor 790402.1,2	Torso portion of safety belt system	Certain	Interviewee (same person)
2	Contusion {bruising} across chest, not further specified	minor 490402.1,4	Torso portion of safety belt system	Certain	Interviewee (same person)
3	Contusion {bruising} across hips, not further specified	minor 590402.1,8	Lap portion of safety belt system	Certain	Interviewee (same person)

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The Toyota's front right passenger [13-year-old, male; 155 centimeters and 50 kilograms (61 inches, 110 pounds)] was seated slumped down in the seat with both feet on the floor and both hands in his lap. The seat track was adjusted to the middle position and the seat back was slightly reclined. He was not wearing glasses or contact lenses.

The front right passenger was not restrained by the lap and shoulder seat belt. Inspection of the seat belt assembly showed no evidence of loading. The driver also stated that the passenger was not restrained.

Due to the driver's pre-crash steering maneuvers, the front right passenger's position and posture just prior to the impact with the Dodge was not known. The impact displaced him forward and to the right opposite the 70 degree direction of principal force. One of his knees contacted the glove box door and his right upper torso loaded the right front door including the arm rest, window sill, and right front window glazing, which disintegrated. Although there was no evidence on the front right air bag, he also probably contacted the air bag. The contact with the right front window sill caused multiple right rib and thoracic vertebrae fractures, a diaphragm laceration, and a laceration and contusions of the liver. The passenger was ejected out of the right front window as the vehicle rotated counterclockwise and began to rollover. He landed on the ground, and sustained fractures of the left femoral neck, left and right sacral ala, multiple lumbar vertebrae, and bilateral pulmonary contusions with pneumomediastinum. His head also contacted the ground causing an intraventricular hemorrhage, subdural hematoma and subarachnoid hemorrhage.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger sustained critical injuries and was hospitalized for 15 days. He received follow-up treatment for his injuries and no additional injuries were diagnosed. The table below shows the front right passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
	Nonanatomic brain injury with loss of consciousness and seizures at scene; unconscious on arrival; GCS=8 at scene	not coded	Ground	Probable	Hospitalization records
1 2	Hemorrhage, small, intraventricular, posterior horns of lateral ventricles, especially left	severe 140678.4,1 140678.4,2	Ground	Probable	Hospitalization records
3	Hematoma, small, subdural, posterior falx ¹	severe 140442.4,6	Ground	Probable	Hospitalization records

¹ The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

falx (falcs) pl. *fal'ces*: a sickle-shaped organ or structure; used as a general term in anatomical nomenclature to designate such a structure.

f. cerebelli, f. of cerebellum: the small fold of dura mater in the midline of the posterior cranial fossa, projecting forward toward the vermis of the cerebellum [i.e., partitions the right and left cerebellar hemispheres; anchored to occipital crest (from the book: HUMAN ANATOMY, THIRD EDITION, by Van De Graaff, Kent M., William C. Brown Publishers)].

vermis (var'mis): 1. a worm or worm-like structure. 2. *v. cerebelli*

v. cerebelli: the narrow median part of the cerebellum, between the two lateral hemispheres.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
4	Hemorrhage, small, subarachnoid in interpeduncular fossa ²	serious 140684.3,9	Ground	Probable	Hospitalization records
5	Contusions, pulmonary, bilateral with bilateral pneumothoraces, left larger than right	severe 441410.4,3	Ground	Probable	Hospitalization records
6	Laceration {tear} pericardium, not further specified	moderate 441602.2,4	Ground	Possible	Hospitalization records
7	Pneumomediastinum, not further specified	serious 442204.3,9	Ground	Possible	Hospitalization records
8	Laceration {rupture} diaphragm from right triangular ligament across central tendon with herniation of liver and respiratory failure	severe 440606.4,8	Right front window sill	Possible	Hospitalization records
9	Laceration liver, not further specified	moderate 541820.2,1	Right front window sill	Possible	Hospitalization records
10	Contusions liver, not further specified	moderate 541810.2,1	Right front window sill	Possible	Hospitalization records
11	Injury (not further specified) left kidney	moderate 541699.2,2	Ground	Possible	Hospitalization records
12	Fractured teeth, several, not further specified	minor 251404.1,8	Ground	Probable	Hospitalization records
13	Avulsed teeth, multiple, not further specified	minor 251406.1,8	Ground	Probable	Hospitalization records
14	Fractured right ribs: 4 th , 5 th , and 8 th laterally and 10 th and 11 th posteriorly	serious 450230.3,1	Right front window sill	Possible	Hospitalization records
15 16 17	Fracture T ₇ to T ₉ , right transverse process	moderate 650420.2,7 650420.2,7 650420.2,7	Right front window sill	Possible	Hospitalization records
18 19 20 21 22	Fracture L ₁ to L ₅ , transverse process fractures; specifically: left L ₁ , right L ₂ , bilateral L ₃ , left L ₄ , and left L ₅	moderate 650620.2,8 650620.2,8 650620.2,8 650620.2,8 650620.2,8	Ground	Possible	Hospitalization records

² The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

fossa (*fos'a*) [*L.J.*]: a trench, channel, or hollow place.

fossa interpeduncularis, *interpeduncular fossa*: a depression between the two cerebral peduncles, the floor of which is the posterior perforated substance; called also *Tarin f.*

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
23	Fracture right scapular body from lateral margin medially	moderate 753000.2,1	Ground	Probable	Hospitalization records
24	Fracture right inferior pubic ramus, not further specified	moderate 852600.2,5	Right side interior hardware and/or armrest	Probable	Hospitalization records
25	Fracture, comminuted left and right sacral ala, not further specified, with unstable pelvis and massive (2 liters) blood loss and included a large left retroperitoneal hematoma, near sigmoid colon	critical 852610.5,0	Ground	Possible	Hospitalization records
26	Fracture, closed, left femoral neck ³ , possibly intertrochanteric, with 8 mm of displacement of fragments	serious 851812.3,2	Ground	Probable	Hospitalization records
27	Contusion {hematoma}, large, to head, not further specified; however, swelling right parietal scalp	minor 190402.1,9	Ground	Probable	Hospitalization records
28	Abrasion, large, right forehead, not further specified	minor 290202.1,7	Ground	Probable	Hospitalization records
29	Avulsive laceration right forehead, not further specified	minor 290800.1,7	Ground	Probable	Hospitalization records
30 31	Abrasions face, left greater than right, not further specified	minor 290202.1,1 290202.1,2	Air bag, front right passenger's	Possible	Hospitalization records

³ Complications included the onset of avascular necrosis with loss of motion and articular collapse and Perthes disease. The following terms are defined in Dorland's Illustrated Medical Dictionary as follows:

disease (dī-zēz'): any deviation from or interruption of the normal structure or function of a part, organ, or system of the body as manifested by characteristic symptoms and signs; the etiology, pathology, and prognosis may be known or unknown.

Legg-Calvé-Perthes disease, Legg-Calvé-Waldenström disease: osteochondrosis of the capitular epiphysis of the femur.

necrosis (nā-kro'sis) pl. *necro'ses*: the sum of the morphological changes indicative of cell death and caused by the progressive degradative action of enzymes; it may affect groups of cells or part of a structure or an organ.

avascular necrosis: *coagulation n.*

avascular necrosis of bone: *osteonecrosis.*

coagulation necrosis, coagulative necrosis: necrosis in which tissue becomes a dry, opaque, eosinophilic mass containing the outlines of anucleated cells, resulting from the denaturation of proteins following hypoxic injury, such as that caused by ischemia in infarction. Called also *avascular n.* and *ischemic n.*

osteochondrosis (os'te-o-kon-dro'sis): a disease of the growth or ossification centers in children that begins as degeneration or necrosis and is followed by regeneration or recalcification. Called also *epiphyseal ischemic necrosis*. It can occur in any of numerous bones: in the capitular head of the femur it is called *Legg-Calvé-Perthes*, *Perthes*, or *Waldenström disease* and *coxa plana*.

osteonecrosis (oste-o-nā-kro'sis): necrosis of bone due to obstruction of its blood supply. Called also *avascular n.* or *ischemic necrosis of bone*.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
32	Contusion {ecchymosis} face, not further specified	minor 290402.1,9	Air bag, front right passenger's	Possible	Hospitalization records
33	Lacerations, multiple, face, not further specified, including laceration right cheek	minor 290600.1,0	Noncontact injury: flying glass, right front glazing	Possible	Hospitalization records
34	Contusion {ecchymosis} chest, not further specified but sketched centrally	minor 490402.1,4	Ground	Possible	Hospitalization records
35	Abrasion {wound}, large, right hip/flank/abdomen	minor 590202.1,1	Right side interior hardware and/or armrest	Probable	Hospitalization records
36	Contusion {ecchymosis} right hip/flank	minor 590402.1,1	Right side interior hardware and/or armrest	Probable	Hospitalization records
37	Contusion {hematoma} right lumbosacral back including seroma ⁴ on back	minor 690402.1,8	Ground	Probable	Hospitalization records
38	Laceration left knee, not further specified	minor 890600.1,2	Glove compartment door	Probable	Emergency room records

CASE VEHICLE SECOND ROW CENTER PASSENGER KINEMATICS

The Toyota's second row center passenger [2-year-old, female; 89 centimeters and 15 kilograms (35 inches, 32 pounds)] was kneeling on the seat, facing rearward and playing with some toys. There was no CSS available for this passenger.

The driver stated that the second row center passenger had been restrained by the two point lap belt at the beginning of the trip. However, the passenger had gotten out of the restraint and was unrestrained at the time of the crash.

As a result of the driver's pre-crash steering maneuvers, the passenger's position just prior to the impact is not known. No occupant contact evidence related to this passenger was found in the vehicle.

⁴ The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

seroma (se-ro'ma): a tumorlike collection of serum in the tissues.

serum (ser'em): 1. the clear portion of any body fluid; the clear fluid moistening serous membranes. 2. blood serum; the clear liquid that separates from blood on clotting.

CASE VEHICLE SECOND ROW CENTER PASSENGER INJURIES

IN07017

The second row center passenger sustained minor injuries and was treated and released. The table below shows her injuries.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Abrasion, superficial, above right eye, not further specified	minor 290202.1,7	Unknown contact source	Unknown	Emergency room records
2	Contusion between eye, not further specified	minor 290402.1,7	Unknown contact source	Unknown	Emergency room records

CASE VEHICLE SECOND ROW RIGHT PASSENGER KINEMATICS

The Toyota's second row right passenger [9-month-old, male; unknown height and 10 kilograms (22 pounds)] was seated in a forward facing CSS in a reclined position with his hands and feet within the CSS.

Based on the driver interview, the second row right passenger was restrained in the CSS by the five-point harness, and the CSS was secured in the vehicle by the lap-and-shoulder seat belt. The seat belt usage could not be independently determined during the vehicle inspection because there was no evidence of loading on the seat belt and the CSS had been discarded.

The passenger remained restrained in the CSS during the crash sequence. He sustained several facial abrasions and a contusion to the right side of his forehead. Based on SCI experience and occupant kinematics principles, the abrasions were probably due to contact with flying glass and the contusion was probably due to contact with the side of the CSS.

CASE VEHICLE SECOND ROW RIGHT PASSENGER INJURIES

The second row right passenger sustained minor injuries. The table below shows the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Abrasion above right forehead/ scalp, not further specified	minor 190202.1,1	Noncontact injury: flying glass, unknown source	Possible	Emergency room records
2	Abrasion above right eye, not further specified	minor 290202.1,7	Noncontact injury: flying glass, unknown source	Possible	Emergency room records
3	Contusion right side forehead, not further specified	minor 290402.1,7	Child safety seat's right side surface	Possible	Emergency room records

The 2006 Dodge Magnum was a rear wheel drive, 5-door station wagon (VIN: 2D4FV47V56H-----) equipped with a 3.5L, V6 engine and a 4-speed automatic transmission. The vehicle was also equipped with driver and front right passenger dual stage air bags and 4-wheel disc brakes. Anti-lock brakes were an option, but it is not known if the vehicle was so equipped. The air bag system in the Dodge is certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

Exterior Damage: The Dodge's impact with the Toyota involved the left side (**Figure 13**). The left corner of the front bumper, fender, left front wheel, hood, left front door and A-pillar were directly damaged. The area of maximum crush occurred in the left front wheel area. Induced damage involved the left rear door and roof. The rollover damage appeared to involve primarily the right side of the Dodge (**Figure 14**). The right fender and quarter panel were dented, the right rear window was broken, and there were scratches along the right front door and right roof side rail.

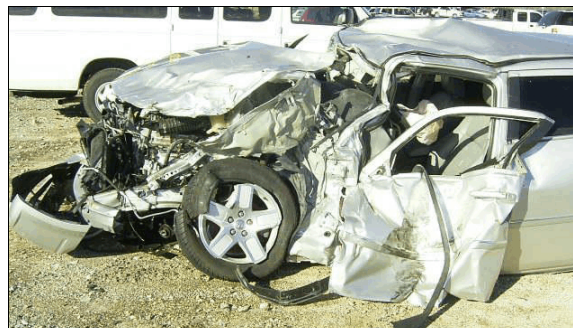


Figure 13: Insurance photo showing damage to left side of Dodge from impact with front of Toyota

Damage Classification: Based on insurance photographs of the Dodge, the CDC for the left side impact with the Toyota was estimated to be **11-LYAW-3 (340 degrees)**. The CDC for the rollover damage was estimated to be **00-RDAO-2**. The WinSMASH reconstruction program, Missing Vehicle algorithm was used to reconstruct the Dodge's Delta Vs for the left side impact. The Total, Longitudinal, and Lateral Delta Vs were 43.0 km/h (26.7 mph), -40.4 km/h (-25.1 mph) and 14.7 (9.1 mph), respectively. The crash fit the reconstruction model and the results were borderline. The severity of the rollover was estimated to be minor based on the damage to the side. The Dodge was towed due to damage.



Figure 14: Insurance photo showing damage from rollover (arrows) to right side of Dodge

Dodge's Driver: According to the police crash report, the Dodge's driver [37-year-old, male] was restrained by the lap-and-shoulder seat belt. The driver was fatally injured in the crash.

Dodge's Front Right Passenger: The Dodge's front right passenger (39-year-old, female) was restrained by the lap-and-shoulder seat belt. She sustained a B (non-incapacitating) injury and was transported by ambulance to a hospital.

