Driver Air Bag Fatality Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: 2003-082-086B
1997 Toyota Camry
Washington
July, 2003

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

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

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16. Abstract

This remote investigation focused on the air bag induced fatal injuries sustained by the driver of a 1997 Toyota Camry. This two vehicle crash occurred in July, 2003 in the state of Washington at 0709 hours. The crash occurred just beyond a traffic signal controlled four-leg intersection. The posted speed limit is 48 km/h (30 mph). The northwest corner of the intersection is occupied by a drive-thru espresso stand. There are drive lanes on the north and south sides of the stands. The case vehicle is a 1997 Toyota Camry being driven by a 59-year-old male. This vehicle was equipped with dual front air bags. The other vehicle is a 2001 Dodge Dakota being driven by a restrained 42-year-old male. The front right seat was occupied by a restrained 42-year-old male. The Toyota Camry was traveling westbound on a five-lane undivided roadway at an unknown speed. The Dodge Dakota was at a complete stop, with its engine running, facing east in an espresso stand drive-thru lane. The Camry traveled through the intersection and departed the roadway to the right. The front of the Camry struck the front of the Dodge Dakota. Both front air bags deployed at this time. The Camry traveled over the curb surrounding the stand and the front of the Camry hit the espresso stand. The case vehicle came to final rest, facing north, in the private way. The driver of the Camry was fatally injured.

17. Key Words	18. Distribution Statement
Air bag, deployment, injury, crash, fatality	

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Dynamic Science, Inc.
Crash Investigation
Case Number: 2003-082-086B

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BACKGROUND:

Description:	This Driver's Air Bag Related Adult Fatality case was identified by the local National Automotive Sampling System (NASS), Primary Sampling Unit. The case was reported to DSI on March 16, 2004. This was an SCI/NASS combination case.
Investigation Type:	Driver Air Bag Fatality
Crash Location:	Washington
Crash Date:	July, 2003
Notification Date:	March 16, 2004
Field Work Completed:	NA, remote case

SUMMARY

Crash Site

This two vehicle crash occurred in July, 2003 in the state of Washington at 0709 hours. The crash occurred just beyond a traffic signal controlled four-leg intersection. The westbound approach to the intersection is comprised of two westbound travel lanes, a left turn lane, and two eastbound travel lanes. The weather was clear and dry. The concrete roadway was straight, level, and dry. The posted speed limit is 48 km/h (30 mph).

The northwest corner of the intersection is occupied by a drive-thru espresso stand. There are drive lanes on the north and south sides of the stands.

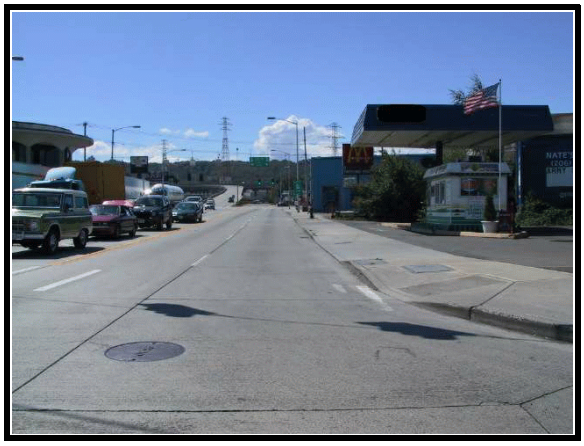

Figure 1. Approach to area of impact near espresso stand (west)

Pre-Crash

The case vehicle is a 1997 Toyota Camry being driven by a 59-year-old male (165 cm/65 in, 71 kg/156 lbs). This vehicle was equipped with dual front air bags. The other vehicle is a 2001 Dodge Dakota being driven by a restrained 42-year-old male. The front right seat was occupied by a restrained 42-year-old male.

The Toyota Camry was traveling westbound on a five-lane undivided roadway at an unknown speed. The Dodge Dakota was at a complete stop, with its engine running, facing east in an espresso stand drive-thru lane. The driver of the Camry appears to have sustained a heart attack with a loss of consciousness. The Camry traveled through the intersection and departed the roadway to the right. According to the owner of the espresso stand, on the day of the crash, there was a construction crew working in the center of the intersection. Someone warned them

that there was a vehicle that was out of control and heading their way. The crew cleared the intersection but did not warn this witness. There is a small window that looks out towards the intersection. This witness saw the Camry "barreling" towards him at around 89 km/h (55 mph). There was no indication that the Camry was going to slow down, so this witness ducked down and covered his head. The Camry continued on into the private way.

Figure 2. Front right, Dodge Dakota

Crash

The front of the Camry (12FZEW3) struck the front of the Dodge Dakota (12FZEW2).

The total velocity change for the Toyota Camry as calculated by the missing vehicle algorithm of WinSmash collision model was 34.0 km/h (21.1 mph). The longitudinal and lateral delta V components were -34.0 km/h (-21.1 mph) and 0 km/h (0 mph), respectively. Both the driver and passenger front air bags in the Camry deployed during the vehicle to vehicle impact. Both front air bags in the Dodge Dakota also deployed.

The Dakota was pushed into the espresso stand and the curb surrounding it. The Dodge Dakota came to rest on the private way still facing east. The Camry traveled over the curb surrounding the stand and the front of the Camry hit the espresso stand (12FDLW1[1]). The case vehicle came to final rest, facing north, in the private way.

Post-Crash

The driver of the Camry was found unconscious in his vehicle with his head rolled back and blood on his face or head. Witnesses reported that he was sitting up, straight in his seat, but with his head tipped back. He was transported to a local trauma center. He arrived in a pulseless electrical activity (PEA) state. Cardiopulmonary resuscitation (CPR) had been initiated before arrival and continued on after arrival. He was shocked three times over the course of his treatment. CPR was continued until 0802 hours at which point an ultrasound was performed which showed no signs of pericardial effusion or surgically repairable cause for his PEA arrest. Another shock was performed at 0802 with no result and he was declared deceased–approximately one hour post crash.

An autopsy was conducted for the driver of the Camry and revealed the following injuries:

- Rib fractures, left 4th through 6th, anteriorly
- Rib fractures, right 4th through 7th, anteriorly
- Sternal fracture, at the level of second intercostal space
- Thoracic vertebral body fracture, 7th, with hemorrhage in surrounding soft tissues

[1]SCI change to extent zone

and mild softening of underlying spinal cord
- Ankle fracture, right, compound
- Ecchymosis, 10 x 10 cm (4 x 4 in), over central face including nose, upper lip, bilateral cheeks, and bilateral periorbital regions.
- Ecchymosis, 5 x 3 cm (2 x 1 in), anterior aspect of upper left arm
- Abrasion, 1.9 cm (0.75 in), tip of nose

The report also indicated that the spinal cord was mild edematous.

The cause of death was given as:

- rib, vertebral, and sternal fractures
- blunt force injury of chest

Arteriosclerotic cardiovascular disease was given as an additional significant condition. The coronary arteries showed moderate to severe atherosclerosis with multi-focal 75% occlusion of all three main coronary arteries.

There were two occupants in Dodge Dakota. Both occupants were reported to be wearing their manual lap and shoulder belts. The driver and passenger front air bags deployed on impact. The nature of the driver's injuries was reported to be a sore neck and sore shoulders. The front right passenger was reported having a sore back and sore legs.

VEHICLE DATA - 1997 Toyota Camry

The 1997 Toyota Camry four-door, five-passenger sedan was equipped with an automatic transmission, front wheel drive, front disc/rear drum brakes, air conditioning, and tilt steering wheel.

VIN:	4T1BG22K1VUxxxxxx
Odometer:	Unknown
Engine:	2.2 L, 4 cylinder
Reported Defects:	None related
Cargo:	None, per vehicle inspection

The 1997 Toyota Camry was equipped with Akuret P195/70R14 tires. The specific tire data is as follows:

Tire	Tread	Pressure	Cold Tire Pressure
LF	5 mm (0.2 in)	200 kPa (29 psi)	207 kPa (30 psi)
LR	5 mm (0.2 in)	214 kPa (31 psi)	207 kPa (30 psi)
RF	5 mm (0.2 in)	Flat	207 kPa (30 psi)
RR	5 mm (0.2 in)	221 kPa (32 psi)	207 kPa (30 psi)

The front seating positions in the 1997 Toyota Camry were configured with cloth covered bucket seats with adjustable front head restraints. The rear seating positions were configured with 60-40 folding rear bench seats with adjustable rear head restraints for the outboard positions.

VEHICLE DAMAGE

Exterior Damage - 1997 Toyota Camry

Damage Description:	Moderate front end damage. Right front tire flattened and restricted. Vehicle towed from the scene due to damage.	
CDC:	Impact 1: 12FZEW3 Impact 2: 12FDLW1	
Delta V (impact 1):	Total	34.0 km/h (21.1 mph)
	Longitudinal	-34.0 km/h (-21.1 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	69,419 joules (51,200 ft-lbs)

The direct damage to the Toyota Camry from the impact with the Dodge Dakota began at the right front corner and extended to the left 52.0 cm (20.5 in). There was damage to the bumper, grille, right fender, and hood. The bumper fascia was knocked off. The direct and induced damaged involved the entire front width of this vehicle. The right wheelbase was shortened by 7.0 cm (2.7 in). The right front tire was restricted. Six crush measurements were taken along the bumper and were averaged with above bumper measurements as follows: C1=0 cm (0 in), C2=12.0 cm (4.7 in), C3=29.0 cm (11.4 in), C4=37.0 cm (14.6 in), C5=30.0 cm (11.8 in), C6=25.0 cm (9.8 in).

Figure 3. Front, Toyota Camry

There was slight contact damage to the front left bumper corner from the impact to the espresso stand base.

Interior Damage - 1997 Toyota Camry

Interior damage to the Camry was minor and was attributed to vehicle intrusion and occupant contacts. There was minor center instrument panel intrusion. All the doors remained closed and operational. There was no integrity loss. The upper rim of the steering wheel rim had 2.0 cm (0.8 in) of deformation. The windshield was cracked from the air bag and impact forces. There was no occupant glazing contacts or damage. The left and center instrument panel was scuffed and scratched by occupant contact. The gas pedal was deformed to the right.

Figure 4. Overview of driver's seated area, Toyota Camry

MANUAL RESTRAINT SYSTEMS - 1997 Toyota Camry

The front seats were equipped with 3-point manual lap and shoulder belts. Both front seat belts were configured with adjustable shoulder belt anchorages. The driver's anchorage was adjusted to the mid position and the front right passenger's was adjusted to the full up position. All three rear seat locations were equipped with 3-point manual lap and shoulder belts.

FRONTAL AIR BAG SYSTEM - 1997 Toyota Camry

The driver's air bag was mounted in the steering wheel hub. The driver's air bag was circular and measured 60.0 cm (23.6 in.) in diameter. The air bag was equipped with two tethers and two vent ports. The vent ports were located at the 11 and 1 o'clock positions. There were smudges found on the top right and bottom right of the air bag face. The face of the air bag exhibited 12 horizontal and 8 vertical folds. The dual module cover flaps opened in an "H" type configuration. The top flap measured 16.0 cm (6.3 in) wide by 6.0 cm (2.4 in). The bottom flap measured 16.0 cm (6.3 in) wide by 8.0 cm (3.1 in) high. There were no indications of any damage to the module cover flaps.

Figure 5. Driver's air bag, top is at the bottom of the picture

The front right passenger air bag was mounted in the top of the instrument panel. The air bag was generally rectangular in shape and measured 60.0 cm (23.6 in) high by 45.0 cm (17.7 in) wide. It was equipped with two internal tethers and there were no vent ports. There were no contacts or damage to the air bag face. The module cover was vaguely in an "H" configuration. The top flap was 22.0 cm (8.7 in) wide by 3.0 cm (1.2 in) high on the left and 5.0 cm (1.9 in) on the right. The bottom flap was 22.0 cm (8.7 in) wide by 7.0 cm (2.8 in) high on the right and 9.0 cm (3.5 in) high on the left. There were no contacts or damage to the module covers.

Figure 6. Driver's air bag module cover

Figure 7. Front right passenger's air bag

VEHICLE DATA - 2001 Dodge Dakota

Description:	2001 Dodge Dakota pickup	
VIN:	1B7GG22N81Sxxxxxx	
Odometer:	Unknown	
Engine:	4.7 L, 8 cylinder	
Reported Defects:	None noted	
Cargo:	5 kg, per vehicle inspection	
Damage Description:	Moderate front end damage. Front right tire restricted. Vehicle towed due damage.	
CDC:	12FZEW2	
Delta V:	Total	25.0 km/h (15.5 mph)
	Longitudinal	-25 km/h (-15.5 mph)
	Latitudinal	-4.0 km/h (-2.5 mph)
	Energy	57,270 joules (42,240 ft-lbs)

Figure 8. Front right bumper corner

Figure 9. Interior view of Dodge Dakota, showing deployed frontal air bags

OCCUPANT DEMOGRAPHICS - 1997 Toyota Camry

	Driver
Age/Sex:	59/Male
Seated Position:	Front left
Seat Type:	Fabric covered bucket seat. Seat adjusted to between middle and rear most track position. Seat back slightly reclined.
Height:	165 cm (65 in)
Weight:	71 kg (156 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	Arteriosclerotic cardiovascular disease with with multi-focal 75% occlusion of all three main coronary arteries.
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be greater than 20 years.
Body Posture:	Forward facing, possibly leaning forward to some degree
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Three point lap and shoulder belt available, used.
Air bag:	Steering wheel mounted air bag available, deployed.

OCCUPANT DEMOGRAPHICS - 2001 Dodge Dakota

	Driver	Front right occupant
Age/Sex:	42/Male	42/Male
Seated Position:	Front left	Front right
Seat Type:	Bucket seat	Bucket seat
Height:	178 cm (70 in)	Unknown
Weight:	84 kg (185 lbs)	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	Unknown	Unknown
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used per police report	Lap and shoulder belt available, used per police report
Air bag:	Steering wheel mounted air bag available, deployed.	Instrument panel mounted air bag available, deployed.

OCCUPANT INJURIES -1997 Toyota Camry

Driver: Injuries obtained from autopsy report.

Injury	OIC Code	Injury Mechanism	Confidence Level
Rib fractures, left 4th through 6th anteriorly, right 4th through 7th anteriorly	450230.3,3	Driver's air bag	Probable, EDCS indicates Certain
Thoracic vertebral body fracture, 7th, with hemorrhage in surrounding soft tissues and mild softening of underlying spinal cord	650430.2,7	Resuscitation efforts[2]	Possible, EDCS indicates Certain
Sternal fracture, at the level of the second intercostal space	450804.2,4	Driver's air bag	Probable, EDCS indicates Certain
Ankle fracture, right, compound	852002.2,1	Gas pedal[3]	Certain
Ecchymosis, 10 x 10 cm (4 x 4 in), over central face including nose, upper lip, bilateral cheeks, and bilateral periorbital regions[4].	290402.1,0	Driver's air bag	Certain
Abrasion, 1.9 cm (0.75 in), tip of nose	290202.1,4	Driver's air bag	Certain
Eyelid contusion, right	297402.1,1	Driver's air bag	Certain
Eyelid contusion, left	297402.1,2	Driver's air bag	Certain
Ecchymosis, 5 x 3 cm (2 x 1 in), anterior aspect of upper left arm	790402.1,2	Driver's air bag	Certain

[2]SCI change

[3]Coded to floor in EDCS

[4]Not coded in EDCS

OCCUPANT INJURIES - 2001 Dodge Dakota

	Injury	OIC Code	Injury Mechanism	Confidence Level
Driver:	Sore neck/shoulder			
Front right occupant:	Sore back/legs			

OCCUPANT KINEMATICS - 1997 Toyota Camry

It appears that the 59-year-old driver of the Toyota Camry was seated in a forward facing position. He was possibly leaning forward to some degree. He was wearing the available lap and shoulder belt. The seat belt shoulder anchorage was adjusted to the mid position. The driver was seated in fabric covered bucket seat that had been adjusted to between the middle and rear most track position. The seat back was slightly reclined. The seat was equipped with an adjustable head restraint that was not damaged. The driver was wearing glasses at the time of the crash. His right foot was on the accelerator. He was likely unconscious and may have sustained a heart attack. As the Camry approached the other vehicle there were no indications of braking or evasive maneuvers. At impact, the frontal air bag system deployed and the driver initiated a forward trajectory. The driver impacted the left side of the knee bolster with his left knee–scuffing the instrument panel. His right ankle engaged and deformed the accelerator pedal–causing the compound ankle fracture. His torso continued in a forward direction and he began loading the torso belt. There were no indications of seat belt related abrasions or contusions. At some point his torso engaged the deploying air bag–causing the bilateral rib fractures. The blunt force chest trauma was due to the deploying air bag. His head pitched forward and his face engaged the deployed air bag–causing the centrally located facial contusions and abrasions. He rebounded rearward and came to rest generally in an upright position with his head tipped back.

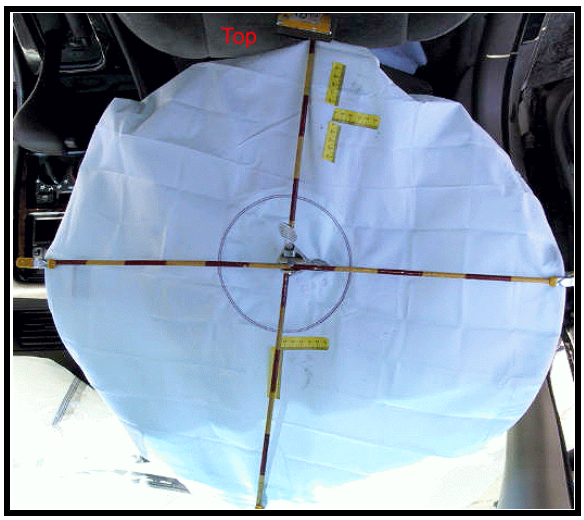

Figure 10. Driver's air bag–image rotated so that top of air bag is at top of picture–Toyota Camry

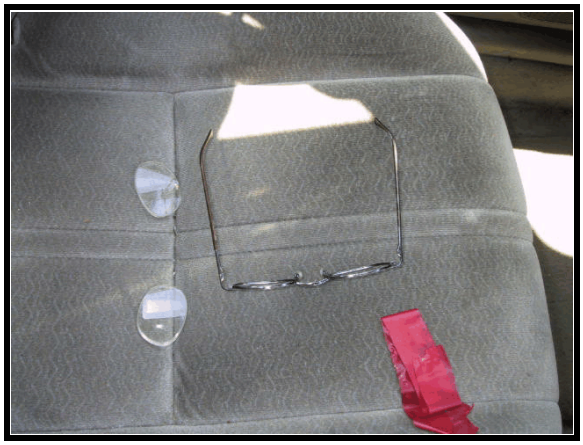

Figure 11. Glasses and lenses for driver of case vehicle

As stated earlier, this occupant underwent CPR both on-scene, en route, and upon arrival at the trauma center. It appears likely that the rib and sternal fractures may have been exacerbated by the CPR activity. The most common resuscitation-related injuries include rib fracture, collapsed lung, ruptured stomach, and broken teeth. Little information is available about the incidence of resuscitation-related injuries, but one study of 63 survivors of cardiopulmonary arrest found such injuries in over 25 percent of the patients[5]. Elderly patients, because they are more likely to

[5]Bjork, R.J., Snyder, B.D., Campion, B.C., et al., "Medical Complications of Cardiopulmonary Arrest," Archives of Internal Medicine 142(3):500-503, 1982.

have osteoporosis (brittle bones), are at an increased risk of fractures, but no age-specific data are available to indicate whether such injuries are more common in elderly survivors of resuscitation than younger ones[6]. The autopsy did not indicate that this occupant had osteoporosis or any other bone related infirmity.

Figure 12. Displaced gas pedal, left knee contact to left instrument panel

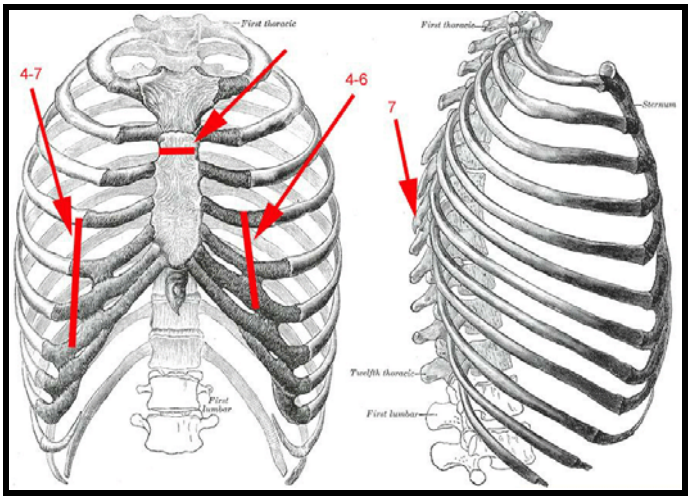

Figure 13. Overview of rib fracture vertical locations

[6]Cassel, C. K., Silverstein, M.D., LaPuma, J., et al., "Cardiopulmonary Resuscitation in the Elderly," prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, November 1985.

Attachment 1. Scene Diagram