On-Site Side Air Bag Investigation
Dynamic Science, Inc. (DSI), Case Number DS10008
2005 Toyota Corolla LE
Arizona
January 2010

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

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

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient Catalog No.
DS10008		

4. Title and Subtitle	5. Report Date
On-Site Side Air Bag Investigation	October 12, 2010
	6. Performing Organization Report No.

7. Author(s)	8. Performing Organization Report No.
Dynamic Science, Inc.	

9. Performing Organization name and Address	10. Work Unit No. (TRAIS)
Dynamic Science, Inc. 299 West Cerritos Avenue Anaheim, CA 92805	11. Contract or Grant no. DTNH22-07-00045

12. Sponsoring Agency Name and Address	13. Type of report and period Covered [Report Month, Year]
U.S. Dept. of Transportation (NVS-411) National Highway Traffic Safety Administration 1200 New Jersey Ave, SE Washington, DC 20590	14. Sponsoring Agency Code

15. Supplemental Notes

16. Abstract

The focus of this investigation was the deployed side air bags in a 2005 Toyota Corolla LE involved in a crash and the serious injuries sustained by the vehicle's front right occupant. The single vehicle crash occurred on an undivided two-lane north/south roadway during January 2010 in the state of Arizona. The Toyota was being driven by a 23-year-old male and was occupied by a 23-year-old female front right passenger. While traveling southbound the driver lost control of the vehicle and it departed the roadway. The Toyota then impacted a raised curb, a metal utility pole, and a masonry wall. The vehicle was equipped with side impact inflatable curtain (IC) air bags and seat-mounted side air bags, and all four side air bags deployed during the crash. The driver of the Toyota sustained minor injuries and was transported to a local hospital where he was treated and released. The front right passenger sustained serious injuries and was transported to a local hospital where she was initially treated and then later transferred by air to a Level 1 Trauma Center.

17. Key Words	18. Distribution Statement
Side air bag, IC air bag injury	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price

Form DOT F 1700.7 (8_72) Reproduction of this form and completed page is authorized

Dynamic Science, Inc.
Crash Investigation
Case Number: DS10008

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Background

The focus of this investigation was the deployed side air bags in a 2005 Toyota Corolla LE (**Figure 1**) involved in a crash and the serious injuries sustained by the vehicle's front right occupant. The single vehicle crash occurred on an undivided two-lane north/south roadway during January 2010 in the state of Arizona. The Toyota was being driven by a 23-year-old male and was occupied by a 23-year-old female front right passenger.

Figure 1. Subject vehicle, 2005 Toyota Corolla LE

While traveling southbound the driver lost control of the vehicle and it departed the roadway. The Toyota then impacted a raised curb, a metal utility pole, and a masonry wall. The vehicle was equipped with side impact inflatable curtain (IC) air bags and seat-mounted side air bags, and all four side air bags deployed during the crash.

The driver of the Toyota sustained minor injuries and was transported to a local hospital where he was treated and released. The front right passenger sustained serious injuries and was transported to a local hospital where she was initially treated and then later transferred by air to a Level 1 Trauma Center.

This on-site side air bag investigation was identified by the National Highway Traffic Safety Administration (NHTSA) during a review of National Automotive Sampling System (NASS) General Estimates System (GES) police reports. On March 15, 2010, the police report was forwarded to Dynamic Science, Inc. (DSI) with instructions to locate the subject vehicle and obtain the necessary cooperation to commence the investigation. The Toyota was located at a police impound facility and permission to inspect the vehicle was obtained from the insurance company. The case was assigned on March 20, 2010 and the vehicle inspection was completed on March 26, 2010. Permission was obtained from the insurance company to remove the Toyota's Event Data Recorder (EDR) and it was removed during the vehicle inspection. The EDR was then sent to the NHTSA for the purpose of submitting it to the manufacturer for imaging of the EDR data. The NHTSA forwarded the Toyota Readout Tool (ROT) file to DSI and it was reported using software version 1.4.1.1. A summary of the EDR data is incorporated in this report.

Summary

Crash Site

The crash site was a two-way undivided north/south level roadway composed of asphalt (**Figure 2**). The lanes were not delineated by striping or markers. At 213.4 m (700.0 ft) north of the point of impact (POI), the roadway width measured 14.3 m (47.0 ft). Approaching the POI the roadway narrowed first on the right edge resulting in a roadway width of 11.0 m (36.0 ft) and then on the left edge resulting in a roadway width of 7.4 m (24.2 ft). From 101.2 m (332.0 ft) north of the POI to

the vehicle's final rest position the roadway was straight and measured 7.4 m (24.2 ft) in width.

Figure 2. Crash site, southbound approach

The west roadway edge was bordered by unpaved ground. North of the POI, the elevation of the ground fell to 10.0 cm (3.9 in) to 13.0 cm (5.1 in) below the paved roadway, creating a pronounced drop-off. At 27.4 m (90.0 ft) north of the POI the ground was level with the roadway. The east roadway edge was bordered by a raised concrete curb measuring 14.0 cm (5.5 in) in height, a concrete sidewalk measuring 2.0 m (6.6 ft) in width, a dirt embankment measuring 6.1 m (20.0 ft) in width, and a masonry block wall measuring 1.5 m (5.0 ft) in height. The embankment ascended from the sidewalk to the wall to a height of 61.0 cm (24.0 in) above grade. Breakaway metal luminaire utility poles aligned parallel to the roadway were located 2.3 m (7.5 ft) from the east roadway edge and 0.3 m (1.0 ft) east of the sidewalk edge. The utility poles measured 16.0 cm (6.5 in) in diameter and were attached to metal base plates anchored to concrete bases. The posted speed limit at this location was 56 km/h (35 mph).

Pre-Crash

At the time of the crash conditions were dark with streetlights illuminated, the weather was clear, and the roadway was dry. The Toyota was traveling southbound at a police-estimated speed of 137-153 km/h (85-95 mph) and the right side tires departed the right edge of the roadway at 177.0 m (580.0 ft) north of the POI. The vehicle continued traveling straight with its right side tires off the roadway for 123.5 m (405.2 ft) and then the driver steered left returning the vehicle's right side tires to the roadway at approximately 32.3 m (106.0 ft) north of the POI. The driver overcorrected his steering and the vehicle initiated a counterclockwise yaw, traveling across the northbound lane and departing the roadway on the left edge.

Crash

The crash sequence included six events. The Toyota's right front tire impacted the curb (Event 1) depositing a 76.0 cm (29.9 in) tire mark on the curb and a 2.7 m (9.0 ft) skid mark on the sidewalk. The left front tire impacted the curb (Event 2) depositing a 62.0 cm (24.4 in) tire mark on the curb. The right rear tire impacted the curb (Event 3) depositing a 1.6 m (5.2 ft) tire mark on the curb and a 4.7 m (15.4 ft) skid mark on the sidewalk. The Toyota then traveled in a right side leading yaw for 10.0 m (32.8 ft) on the sidewalk and the then the right side of the vehicle impacted the breakaway luminaire utility pole (Event 4) (**Figure 3**). The impact displaced the pole from its base and fractured it into two sections. The vehicle's seat-mounted side air bags and IC air bags probably deployed during the pole impact.

Following the pole impact the Toyota crossed the dirt embankment and then its right front wheel and fender impacted the masonry wall (Event 5). The vehicle continued rotating counterclockwise and

then its back end impacted the wall (Event 6). According to the police report, the two wall impacts knocked down a section of the wall measuring several feet in length. At the time of the scene inspection the damaged section of wall had been replaced and was not discernible from the undamaged section. Following the second impact with the wall, the vehicle traveled on the embankment for approximately 6.0 m (19.8 ft) and then came to final rest facing southeast on the embankment. The vehicle traveled a total distance of 35.0 m (114.8 ft) from the first curb impact to its final at-rest location.

Figure 3. Area of impact showing tire skid mark in foreground, curb impact in mid-ground, and pole impact in background

For the pole impact (Event 4), the Barrier algorithm of WinSMASH calculated a Total Delta-V of 31.0 km/h (19.3 mph); the longitudinal and lateral components were 0.0 km/h and -31.0 km/h (-19.3 mph), respectively. The program calculated a Barrier Equivalent Speed (BES) of 31.2 km/h (19.4 mph). For this event the vehicle's EDR reported a maximum longitudinal Delta-V of -2.6 km/h (-1.6 mph). The EDR did not capture lateral Delta-V values for the pole impact.

For the first wall impact (Event 5), the program calculated a Total Delta-V of 21.0 km/h (13.0 mph); the longitudinal and lateral components were 3.6 km/h (2.2 mph) and -20.7 km/h (-12.9 mph), respectively. The BES was 20.7 km/h (12.9 mph).

For the second wall impact (Event 6), the program calculated a Total Delta-V of 12.0 km/h (7.5 mph); the longitudinal and lateral components were 11.8 km/h (7.3 mph) and -2.1 km/h (-1.3 mph), respectively. The BES was 12.1 km/h (7.5 mph).

Based on the yielding nature of the impacted objects, the WinSMASH results for Events 4-6 were considered borderline.

Post-Crash

After the vehicle came to rest, the driver unbuckled his safety belt and exited the vehicle under his own power through the front row left side door. He walked to the right side of the vehicle to assist the front right occupant, who had lost consciousness during the crash. The police reported a crash time of 2350 hours. Emergency Medical Services (EMS) was dispatched at 0006 hours, arrived on-scene at 0015 hours, and transported the driver at 0027 hours. The driver arrived at a local hospital at 0043 hours with a Glasgow Coma Score (GCS) of 14. He sustained left hand abrasions and complained of neck and back pain. He tested positive for alcohol and drugs but the test results were not reported. The driver was treated for his injuries and discharged at 0509 hours. He did not miss any days of work due to his injuries.

The front right occupant remained seated and restrained by the vehicle's lap and shoulder belt. She

was unconscious following the crash and the front row right side door was jammed shut. EMS was dispatched at 2357 hours and arrived on-scene at 0001 hours. The occupant was removed from the vehicle while unresponsive and transported to a local hospital at 0020 hours. She arrived at a local hospital at 0034 hours with a Glasgow Coma Score (GCS) of 5. Initially she did not respond to commands or questions and her eyes were bilaterally deviated to the left. Her critical care time in the emergency department was 90 minutes. The occupant sustained serious injuries to the skull, brain, lumbar spine, liver, spleen, and lungs. Additionally, the Emergency Medical Services (EMS) and hospital records confirmed a loss of consciousness but did not specify a length of time. At 0712 hours the occupant was transported by air to a Level 1 Trauma Center in another city. The occupant's medical records from the hospital and the trauma center were obtained. She was hospitalized for a total of 29 days: 15 days were spent in an intensive care facility and 14 days were spent in a rehabilitation facility. She missed approximately 40 days from work due to her injuries.

The Toyota was towed due to damage and impounded by police for evidentiary reasons.

Vehicle Data - 2005 Toyota Corolla

The Toyota was identified by the Vehicle Identification Number (VIN): 1NXBR30E35Zxxxxxx and it was manufactured in July 2004. The vehicle's electronic odometer was inoperable at the time of the vehicle inspection and the last recorded odometer reading was 83,848 km (52,102 mi) on February 9, 2009, which was 11 months prior to the crash. The vehicle was equipped with a 1.8-liter, 4-cylinder engine, automatic transmission, front-wheel drive, and power steering with tilt column functionality.

The vehicle manufacturer recommended P195/65R15 tires for the front and rear with a cold tire pressure of 207 kPa (30 psi). The vehicle was equipped with Kumho Power Star tires of the recommended size on the front and Geostar Radial NST tires of the recommended size on the rear. The Kumho tires were manufactured in week 7 of 2007 and the Geostar tires date of manufacture was unknown. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire flat	7 mm (9/32 in)	No	De-beaded
LR	193 kPa (28 psi)	6 mm (7/32 in)	No	None
RR	Tire flat	5 mm (6/32 in)	No	De-beaded
RF	Tire flat	8 mm (10/32 in)	Yes	De-beaded

The Toyota's interior was equipped with fabric-covered seating for five occupants. The front row seating consisted of outboard bucket seats with adjustable head restraints and the second row seating consisted of a split bench seat with folding backs and adjustable head restraints.

Vehicle Damage - 2005 Toyota Corolla

Exterior Damage

The Toyota sustained direct and induced damage to the tires during the curb impacts (Events 1-3), direct and induced damage to the right side and roof during the pole impact (Event 4); and direct and induced damage to the back end, left side, and right side during the wall impacts (Events 5-6).

The impact for Event 1 de-beaded and flattened the right front tire and fractured the rim and the Collision Deformation Classification (CDC) was 03RFWN1. The impact for Event 2 de-beaded and flattened the left front tire and the CDC was 03RFWN8. The impact for Event 3 flattened and de-beaded the right rear tire and scuffed the rim and the CDC was 03RBWN1.

Figure 4. Right side crush profile for pole impact (Event 4)

Event 4 was a pole impact to the vehicle's right side passenger sector and direct damage began 75.0 cm (29.5 in) forward of the rear axle and extended forward 26 cm (10.2 in). The Field L began 30.0 cm (11.8 in) aft of the rear axle, extended 276.0 cm (108.7 in) forward, and ended 23.0 cm (9.1 in) aft of the front axle (**Figure 4**). Vertically, the deformation extended from the sill to the roof. Six crush measurements were taken at mid-door level as follows: C_1 = 7.0 cm (2.8 in), C_2 = 4.0 cm (1.6 in), C_3 = 41.0 cm (16.1 in), C_4 = 0 cm, C_5 = 1.0 cm (0.4 in), C_6 = 11.0 cm (4.3 in). Maximum crush was located 96.0 cm (37.8 in) forward of the rear axle between C_3 and C_4 and measured 46.0 cm (18.1 in). The CDC for Event 4 was 03RPAN3.

Event 5 was a wall impact to the Toyota's right side front sector and the direct damage began 218.0 cm (85.8) forward of the rear axle and extended 112.0 cm (44.1 in) forward to the right front bumper corner. The Field L location was identical to the direct damage location. Six crush measurements were taken at mid-door level as follows: C_1 = 4.0 cm (1.6 in), C_2 = 8.0 cm (3.2 in), C_3 = 19.0 cm (7.5 in), C_4 = 25.0 cm (9.8 in), C_5 = 30.0 cm (11.8 in), C_6 = 25.0 cm (9.8 in). Maximum crush was located at C_5 and the CDC for Event 5 was 03RFEW3.

Event 6 was a wall impact to the vehicle's back end and the direct damage was distributed from the back left bumper corner to the back right bumper corner and measured 147.0 cm (57.9 in) in length. The Toyota sustained additional damage to the trunk and sides from displaced masonry blocks. Six crush measurements were taken at bumper level as follows: C_1 = 1.0 cm (0.1 in), C_2 = 1.0 cm (6 .4 in), C_3 = 2.0 cm (0.8 in), C_4 = 3.0 cm (1.2 in), C_5 = 2.0 cm (0.8 in), C_6 = 2.0 cm (0.8 in). Maximum crush was located at C_4 and the CDC for Event 6 was 06BDEW1.

Interior Damage - 2005 Toyota Corolla

The Toyota sustained moderate interior damage resulting from intrusion, occupant loading, occupant contacts, and post-crash extrication activities. The windshield was fractured and holed and the side glass and backlight were disintegrated. The right side doors were jammed shut and the right front door would not close due to deformation. The passenger compartment sustained lateral intrusion of the left front, right front, and right rear door panels, the right A-pillar, B-pillar, and C-pillar, the right sill, and right roof side rail. The roof and right floor pan intruded vertically. The steering wheel, front right door panel, right B-pillar, and shift control lever showed occupant contacts. The left IC air bag was torn on the outboard side and showed scuff marks on the inboard side. The right IC air bag was cut at the roof side rail during extrication efforts and the right seat-mounted side air bag was torn on the inboard side.

Manual Restraints - 2005 Toyota Corolla

The vehicle's front row seating was equipped with continuous loop 3-point manual lap and shoulder safety belts with sliding latch plates, adjustable D-ring anchorages, and retractor pretensioners. The driver's safety belt was equipped with an Emergency Locking Retractor (ELR) and the front right passenger's safety had a switchable ELR/Automatic Locking Retractor (ALR). The vehicle's retractor pretensioners did not actuate during the crash. The pretensioners were probably controlled by the same frontal crash sensors as were the frontal air bags, which did not deploy.

Figure 5. Front right occupant's safety belt webbing showing load marks

The driver's safety belt D-ring anchorage was in the full-down position and the latch plate was scratched indicating historical usage. The safety belt webbing was stretched in a 12.0 cm (4.7 in) sector beginning 20.0 cm (7.9 in) above the stop button and the latch plate and D-ring were scuffed. Based on the vehicle inspection it was determined that the front left safety belt was used to restrain the driver during the crash.

The front row passenger's safety belt D-ring was in the full-up position and the latch plate was scratched indicating historical usage. The safety belt webbing was cut during extrication activities at 90.0 cm (35.4 in) above the lower anchorage. The webbing showed scuff marks in a 10.0 cm (3.9 in) sector beginning 46.0 cm (18.1 in) above the lower anchorage and stretch marks in a 10.0 cm (3.9 in) sector (**Figure 5**) beginning 72.0 cm (28.3 in) above the lower anchorage. The latch plate was found inserted in the buckle and it showed scuff marks where the webbing was routed. The D-ring also showed scuff marks where the webbing was routed. Based on the vehicle inspection it was determined that the front right safety belt was used to restrain the occupant during the crash.

Supplemental Restraint System - 2005 Toyota Corolla

The vehicle's Supplemental Restraint System (SRS) included an air bag control module (ACM), driver and passenger frontal air bags, side impact IC air bags, and safety belt retractor pretensioners for the front row. Based on the interview and a vehicle history report, the air bags were original to the vehicle and had not been serviced.

The Toyota was a Certified Advanced 208-Compliant (CAC) vehicle. A CAC vehicle is certified by the manufacturer to be compliant with the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Toyota's advanced dual-stage frontal air bags were designed to deploy according to impact severity. The frontal air bags did not deploy during the crash.

Figure 6. Left IC air bag and seat-mounted side air bag

The left IC air bag deployed from the left roof side rail over the front (**Figure 6**) and second rows. The IC air bag measured 160.0 cm (63.0 in) in length and 42.0 cm (16.5 in) in height. The deployed air bag covered the vehicle's left rear side glass in its entirety and the left front side glass beginning 15.0 cm (5.9 in) aft of the forward aspect. The IC air bag was configured with an exterior tether measuring 26.0 cm (10.2 in) in length that connected the air bag's forward aspect to the A-pillar.

The left IC air bag's inboard panel showed skin oil transfers and scuff marks located within an area measuring 15.0 cm (5.9 in) square at the forward lower aspect. Based on the driver's kinematics and medical records, it was determined the transfers and scuff marks were possibly deposited by the driver's forearm and left hand, which sustained abrasion injuries.

The air bag's outboard panel showed a tear measuring 18.0 cm (7.1 in) in length and a brown-colored scuff mark that was located 34.0 cm (13.4 in) aft of the leading edge and 17.0 cm (6.7 in) above the bottom edge. Based on the type of damage to the air bag and the color of the scuff mark it was determined the outboard panel of the left IC air bag was contacted by masonry blocks during the second wall impact (Event 6).

The left seat-mounted side air bag deployed from the outboard aspect of the driver's seat back. The air bag was oval in shape measuring 42.0 cm (16.5 in) in height and 28.0 cm (11.0 in) in width. It covered the door panel's rear upper quadrant including the armrest. The seat-mounted side air bag showed no damage or load marks and was unremarkable.

The right IC air bag deployed from the right roof side rail and showed damage resulting from occupant loading and extrication activities. The air bag including the tether was cut at the upper aspect beginning at the leading edge and ending at the B-pillar. The air bag showed a scuff mark on the inboard panel measuring 2.0 cm (0.8 in) and located 23.0 cm (9.1 in) from the top and 43.0 cm

(16.9 in) aft of the leading edge. A second scuff mark measuring 1.0 x 2.0 cm (0.4 x 0.8 in) was located at the bottom edge and 10.0 cm (3.9 in) aft of the leading edge. The outboard panel of the right IC air bag showed dirt deposits and was otherwise unremarkable.

Figure 7. Right seat-mounted side air bag and right IC air bag

The right seat-mounted side air bag deployed from the front left seat back and showed damage on the inboard panel. A tear and two scuff marks each measuring 2.0 cm (0.8 in) in length were located beginning 3.0 cm (1.2 in) from the bottom edge. The source of the damage was determined to be occupant loading by the right hip of the front right occupant. **Figure 7** shows the deployed right seat-mounted side air bag and right IC air bag in their post-inflated state with occupant loading evidence highlighted.

Event Data Recorder - 2005 Toyota Corolla

The Toyota's EDR recorded three events. It was this investigator's opinion that the latest recorded event was the pole impact and the air bag deployment event. The two prior recorded events were curb impacts. The recorded data was summarized in the following tables.

Data Table	
Recorded Ama Side	NonSide
Deployment Judgement Side	NonSide
Deployment Enabled	OFF
New Page	1 Page
Freeze Signal	Freeze
Deployment Time	129 milliseconds (ms)
Deployment Stage Driver	Not Fired
Deployment Stage Passenger	Not Fired

Graph Data	
Latest/Frozen[1]	Bank 1
Freeze Signal	Freeze
Record Status	Recorded
Individual Data	
Time From Previous Event	5120 ms
Time From Last Pre-Crash Data	(N/A)
Seat Position Driver	RW[2]
Belt Switch Status Driver	Belted
Belt Switch Status Passenger	Belted
Occupant Detection Passenger	AM50[3]
PAB-Manual Cut Off (N/A)	(N/A)
Ignition Cycles	0 times
Lamp On Term	0 minutes
Event Counter	2
Writing Flag	Finished Writing

Graph Data	
Next Most Recent	Bank 0
Record Status	Recorded
Individual Data	
Time From Previous Event	5120 ms
Time From Last Previous Data (N/A)	(N/A)
Shift Position (N/A)	(N/A)

[1] Latest recorded event was the pole impact and side air bag deployment event

[2] Assumed to indicated Rearward

[3] Assumed to indicate Adult Male 50th Percentile Weight

Seat Position Driver	RW
Belt Switch Status Driver	Belted
Belt Switch Status Passenger	Unbelted
Occupant Detection Passenger	Unoccupied
PAB-Manual Cut Off (N/A)	(N/A)
Ignition Cycles	0 times
Lamp On Term	0 minutes
Event Counter	1
Writing Flag	Finished Writing

Graph Data	
Past Max. Delta-V	Bank 2
Record Status	Initial State
Individual Data	
Time From Previous Event	5222 ms
Time From Last Previous Data (N/A)	(N/A)
Shift Position (N/A)	(N/A)
Seat Position Driver	Undetermined
Belt Switch Status Driver	Not Implemented
Belt Switch Status Passenger	Not Implemented
Occupant Detection Passenger	Invalid
PAB-Manual Cut Off (N/A)	(N/A)
Ignition Cycles	2047 times
Lamp On Term	31442 minutes
Event Counter	0
Writing Flag	Not Recorded

Occupant Demographics - 2005 Toyota Corolla

Driver

Age/Sex:	23 years/Male
Height:	168 cm (66 in)
Weight:	82 kg (181 lb)
Seat type:	Bucket with adjustable head restraint
Seat track position:	Middle-track
Manual restraint usage:	Lap and shoulder belt
Usage source:	Vehicle inspection
Air bags:	Frontal air bag, not deployed; IC air bag, seat-mounted side air bag, deployed
Alcohol, drug involvement:	Positive for alcohol, BAC not reported; positive for drugs, type and level of concentration not reported
Type of medical treatment:	Transported, treated and released

Front Right Occupant

Age/Sex:	23 years/Female
Height:	157 cm (62 in)
Weight:	139 kg (307 lb)
Seat type:	Bucket with adjustable head restraint
Seat track position:	Rearmost track
Manual restraint usage:	Lap and shoulder belt
Usage source:	Vehicle inspection
Air bags:	Frontal air bag, not deployed; IC air bag, seat-mounted side air bag, deployed
Type of medical treatment:	Transported, admitted, transferred to Level 1 Trauma Center

Occupant Kinematics - 2005 Toyota Corolla

Driver

The 23-year-old male driver was seated in an unknown posture and was restrained by the vehicle's lap and shoulder belt. He was actively steering the vehicle and his right foot was on the accelerator. The driver's seat track was adjusted to the middle seat track position and his seat back was reclined slightly. His seat was equipped with an aftermarket seat cover for the cushion, back, and head restraint. The driver was not wearing contact lenses or eyeglasses.

The roadway narrowed on the right edge and the vehicle's right side tires departed the roadway. In response to the partial roadway departure, the driver steered left in an attempt to return the right side tires to the roadway. The driver overcorrected his steering and after the vehicle returned to the roadway it initiated a counterclockwise yaw. The vehicle's right front tire impacted the curb as the vehicle departed the roadway with its heading angle oriented approximately -90 degrees lateral to its trajectory path. The vehicle's rotational movement resulted in right side impacts to the tires. The driver was displaced to the right in response to the direction of force.

Following the curb impacts, the vehicle's right side impacted the breakaway utility pole and the left seat-mounted side air bags and IC air bags deployed. The driver was further displaced to the right and loaded the vehicle's lap and shoulder safety belt, resulting in stretch marks to the webbing and scuff marks to the D-ring and latch plate.

Following the pole impact, the Toyota's right side impacted the wall displacing the driver to the right in response to the direction of force. His arms contacted the steering wheel rim, depositing scuff marks in the left, lower, and right quadrants. His right knee possibly contacted the center console displacing a part of the shift lever assembly.

Following the wall impact, the vehicle rotated counterclockwise and its back end impacted the wall. The driver loaded the seat back and was held in place in his seat by the lap and shoulder safety belt. His left hand and forearm loaded the left IC air bag depositing skin oil transfers and scuff marks in its forward lower aspect. After the vehicle came to rest**,** the driver exited the vehicle under his own power and was ambulatory upon arrival of on-scene responders.

Front Right Occupant

The 23-year-old female front right occupant was seated in an unknown posture and was restrained by the vehicle's lap and shoulder belt. The occupant's seat track was adjusted to the full-rear seat track position and her seat back was completely upright. Her seat was equipped with an aftermarket seat cover for the cushion, back, and head restraint. She was not wearing contact lenses or eyeglasses.

At impact with the curb the occupant was displaced to the right and was held in her seat by her safety belt. The remaining tires subsequently impacted the curb and the occupant was further displaced to the right. At impact with the pole the right seat-mounted side air bag and IC air bag deployed.

Additionally, the right B-pillar and rear upper quadrant of the right side door intruded laterally into the passenger compartment. The front right occupant's head loaded the IC air bag and the air bag subsequently loaded the B-pillar and safety belt D-ring anchorage, resulting in a basilar skull fracture, loss of consciousness, and petechia cerebral hemorrhages on the occupant's frontal lobes. Her right hip and flank loaded the seat-mounted side air bag and the air bag subsequently loaded the rear upper quadrant of the right door panel and B-pillar resulting in displaced transverse process fractures from L1 to L5 vertebrae, lacerations to the liver and spleen, and contusions to the lungs. The trim piece to the lower B-pillar was fractured and displaced, the rearward aspect of the right armrest was fractured and the padding was displaced, and the air bag was torn at its lower aspect. Additionally, the occupant loaded the safety belt webbing resulting in abrasions to the abdomen. The occupant's seat back was deformed inboard 18.0 cm (7.1 in) by the intruded B-pillar and the left floor pan intruded vertically 7.0 cm (2.7 in).

During the first wall impact the occupant was again displaced to the right. The vehicle's back end then impacted the wall and the driver loaded her seat back. At final rest, the occupant was unconscious. She remained restrained and seated in the vehicle until the arrival of on-scene responders and was extricated from the vehicle approximately 30 minutes post-crash.

Occupant Injuries

Driver

Injury data obtained from occupant's medical records and the interview.

Injury	Injury Severity AIS 05/Update 08	Injury Mechanism	Confidence Level
Abrasions, left hand	710202.1,2	Left IC air bag	Possible

Front Right Occupant

Injuries obtained from occupant's medical records and the interview.

Injury	Injury Severity AIS 05/Update 08	Injury Mechanism	Confidence Level
Abrasion, right abdomen	510202.1,1	Safety belt webbing	Probable
Fracture NFS, basilar, occipital	150200.3,8	Safety belt D-ring	Probable
Petechia hemorrhages, right frontal lobe	140642.2,1	Safety belt D-ring	Probable

Contusions NFS, lungs, bilateral	441410.3,3	Door panel armrest/hardware rear upper quadrant	Probable
Lacerations NFS, liver	541820.2,1	Door panel armrest/hardware rear upper quadrant	Probable
Lacerations NFS, spleen	544220.2,2	Door panel armrest/hardware rear upper quadrant	Probable
Fractures, transverse process, displaced, L1-L5	650620.2,8	Door panel armrest/hardware rear upper quadrant	Probable

Attachment 1. Scene Diagram