Remote, Redesigned Air Bag Special Study

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Dynamic Science, Inc., Case Number (1998-079-802E)

1998 Toyota Corolla

California

August/1998

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16. Abstract

This remote investigation focused on the depowered air bag system deployment of a 1998 Toyota Corolla four-door sedan. This is a two vehicle crash that occurred during the early evening hours in August of 1998. The weather was clear and the level, bituminous roadway surface was dry. This crash occurred at a busy three-leg intersection in a commercial business district. Vehicle 1, a 1984 Chevrolet Camaro Sport two-door coupe driven by a 36-year-old male (restraint use/unknown), was traveling northbound approaching the intersection at an undetermined rate of speed. Vehicle 1 was in lane 2 when the driver initiated a left turn sequence with the intention of heading westbound. Vehicle 2, a 1998 Toyota Corolla four-door sedan was driven by a fully restrained 20-year-old male (178 cm/70 in., 73 kg/161 lbs.), who was traveling southbound in lane 1 and approaching the intersection at an undetermined rate of speed. The front, right seated position was occupied by a fully restrained 23-year-old female (163 cm/64 in., 61 kg/134 lbs.). The driver of Vehicle 2 (case vehicle) detected Vehicle 1 initiating the left turn in front of his path of travel and applied his brakes in an attempt to avoid the impending impact. Vehicle 2 initiated a longitudinal skid pattern as its front bumper (71FYEW2) impacted the front, right bumper location of Vehicle 1 in at an obtuse angle impact. Both the driver and passenger frontal air bags deployed. The case vehicle is also equipped with side air bags that did not deploy as a result of the collision. The involved vehicles engaged in a secondary sideslap as the right quarter-panel area of Vehicle 1 impacted the left rear door of Vehicle 2 (09LPEW1). As the vehicles separated, Vehicle1 departed the roadway coming to rest straddling the southwest intersection quadrant and facing south. Vehicle 2 was deflected in a clockwise direction as it departed the roadway at the northwest intersection quadrant. The case vehicle impacted a curb with its front, right wheel (12 FRWN3) before coming to rest straddling the curbing and facing west. Both drivers departed their respective vehicles. After a brief confrontation, the driver of Vehicle 1 fled the crash scene. The driver of the case vehicle reported that Driver 1 had a strong odor of alcohol on his breath. The driver of Vehicle 1 was holding the right side of his forehead and apparently was injured. The driver of Vehicle 2 sustained anterior forearm abrasions which occurred during the air bag deployment. The front right seated passenger sustained a chest contusion due to her interaction with the deploying air bag. She also sustained bilateral knee contusions due to contacting the knee bolster/ glove compartment door. Both the driver and front, right seated passenger did not require treatment for their injuries.

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Summary

This remote investigation focused on the depowered air bag system deployment of a 1998 Toyota Corolla four-door sedan. This is a two vehicle crash that occurred during the early evening hours in August of 1998. The weather was clear and the level, bituminous roadway surface was dry. This crash occurred at a busy three-leg intersection in a commercial business district. The northbound leg of the intersection is a two-way undivided roadway and is comprised of two northbound travel lanes and two southbound travel lanes. The southbound leg of the intersection consists of two southbound travel lanes and two northbound travel lanes. The westbound leg of the intersection is a two lane undivided roadway. Each leg of the intersection is bordered by curbing and the posted speed limit is 56 km/h (35 mph) for both roadways.

Vehicle 1, a 1984 Chevrolet Camaro Sport two-door coupe driven by a 36-year-old male (restraint use/unknown), was traveling northbound approaching the intersection at an undetermined rate of speed. Vehicle 1 was in lane 2 when the driver initiated a left turn sequence with the intention of heading westbound.

Figure 1. View showing Vehicle 1's Point of Impact & Final Rest Location (curb)

Figure 2. View showing Vehicle 2's (case vehicle) Point of Impact

Vehicle 2, a 1998 Toyota Corolla four-door sedan was driven by a fully restrained 20-year-old male (178 cm/70 in., 73 kg/161 lbs.), who was traveling southbound in lane 1 approaching the intersection at an undetermined rate of speed. The front, right seated position was occupied by a fully restrained 23-year-old female (163 cm/64 in., 61 kg/134 lbs.). The driver of Vehicle 2 (case vehicle) detected Vehicle 1 initiating the left turn in front of his path of travel and applied his brakes in an attempt to avoid the impending impact. Vehicle 2 initiated a longitudinal skid pattern as its front bumper (71FYEW2) impacted the front, right bumper location of Vehicle 1 in an obtuse angle impact. The total delta V for Vehicle 1 was calculated at 23 km/h (14 mph)[1] and the longitudinal delta V was -17 km/h (-11 mph) which was of sufficient force to deploy both the driver and passenger frontal air bags. The case vehicle is also equipped with side air bags that did not deploy as a result of the collision (lateral delta V 15 km/h, 9 mph).

Figure 3. Exterior, left front of Vehicle 2

The involved vehicles engaged in a secondary side-slap as the right quarter-panel area of Vehicle 1 impacted the left rear door of Vehicle 2 (09LPEW1).

[1] Calculated using the Missing Vehicle Algorithm of the WinSmash 1.2.1 program

As the vehicles separated, Vehicle 1 departed the roadway coming to rest straddling the southwest intersection quadrant an facing south. Vehicle 2 was deflected in a clockwise direction as it departed the roadway at the northwest intersection quadrant. The case vehicle impacted a curb with its front, right wheel (12FRWN3) before coming to rest straddling the curbing and facing west.

Figure 4. Left side view of Vehicle 2 showing side slap impact

Both drivers departed their respective vehicles. After a brief confrontation, the driver of Vehicle 1 fled the crash scene. The driver of the case vehicle reported that Driver 1 had a strong odor of alcohol on his breath. The driver of Vehicle 1 was holding the right side of his forehead and apparently was injured. The driver of Vehicle 2 sustained anterior forearm abrasions which occurred during the air bag deployment. The front right seated passenger sustained a chest contusion due to her interaction with the deploying air bag. She also sustained bilateral knee contusions due to contacting the knee bolster/glove compartment door. Both the driver and front, right seated passenger did not require treatment for their injuries.

Table 1. Delta V

	Case Vehicle		Other Vehicle	
	km/h	mph	km/h	mph
Total	23	14.3	20	12.4
Longitudinal	-17	-10.6	-19	-11.8
Lateral	15	9.3	-7	-4.3

Exterior of Case Vehicle

Table 2. Vehicle Information

Model year, make and model	1998 Toyota Corolla
VIN	1NXBR18E8WZ
CDC	71FYEW2 (Primary)- 09LPEW1 (Secondary Sideslap)- 12FRWN3 (Secondary)

Table 2. Crush Measurements

Plane of Impact	Field L cm/in.	C1 cm/in.	C2 cm/in.	C3 cm/in.	C4 cm/in.	C5 cm/in.	C6 cm/in.
Front Bumper	137	24	24	27	24	17	13
	53.9	9.4	9.4	10.6	9.4	6.7	5.1

Figure 5. Exterior, left side view

Figure 6. Exterior, front view

Interior of Case Vehicle

Damage to the interior of the 1998 Toyota Corolla consisted of windshield glazing damage due to the passenger side air bag contacting the windshield during deployment. The front, right passenger's left knee contacted the center instrument panel resulting in a permanent residual scuff mark. The front, right passenger also contacted the passenger air bag with her face as evidenced by a lip stick transfer to the air bag fabric. There were no intruding components to the case vehicle.

Figure 7. Driver's seated position

The vehicle is equipped with front bucket seats with adjustable head restraints-which were not damaged. Both front seats were adjusted at the middle track positions and the seat backs were slightly reclined prior to the collision.

Case Vehicle Occupant Protection Systems

The Toyota Corolla four-door sedan was equipped with a redesigned air bag systems which consisted of a crash sensor diagnostic control module, air bag warning lamp, front left and front right air bag modules which housed the air bags and inflator units. The front bucket seats are equipped with active three-point lap and shoulder restraints with adjustable anchorage adjustments that were both adjusted to their full upward position. The front shoulder belts were equipped with pretensioners.

Figure 8. Deployed driver's air bag

The case vehicle is also equipped with side air bag modules which are housed in the lateral portion of the front seat back (adjacent to the door). There are two side crash sensors located in the fender and quarter-panel areas. There is a separate diagnostic module sensor located in the center console area. The crash did not activate the sensors and the side air bags did not deploy.

The front left air bag was housed in the steering wheel hub and was concealed by asymmetrical double horizontal module cover flaps. The circular air bag was tethered by four separate tether straps and was equipped with two vent ports. The lower instrument panel is equipped with a rigid plastic knee bolster. There was no discernible residual contact damage to the knee bolster, air bag, or module cover flaps.

Figure 9. Deployed passenger's air bag

The front right passenger air bag was located on the instrument panel, top surface plane. The module cover flap is rectangular in design and the air bag broke the laminated windshield glazing upon deployment. The air bag was not tethered and was equipped with two vent port holes. There was a documented residual scuff mark located to the glove compartment door/ knee bolster and a lipstick transfer to the air bag fabric. There were no indications of damage to either of the air bags and their respective module covers.

Figure 10. Front right passenger area

Case Vehicle Occupant Demographics

	Occupant 1	Occupant 2
Age/Sex:	19/Male	23/Female
Seated Position:	Front Left	Front Right
Seat Type:	Bucket-cloth covered	Bucket-cloth covered
Height (cm/in:):	178 70.08	163 64.17
Weight (kg/lbs).:	73 160.9	61 134.5
Pre-existing Medical Condition:	None Reported	None Reported
Body Posture:	Normal/Upright	Normal/Upright
Hand Position:	Unknown	Unknown
Foot Position:	Right foot likely depressing the brake pedal	Both feet likely on the floor pan
Restraint Usage:	Active three-point lap and shoulder belt reportedly applied properly	Active three-point lap and shoulder belt reportedly applied properly
Air bag:	Driver air bag, deployed as a result of the primary frontal impact	Passenger air bag, deployed as a result of the primary frontal impact

Occupant Injuries

Table 3. Injuries

Injury	Injury Severity (AIS)	Injury Mechanism
Right Forearm Abrasion (Driver)	1	Air Bag Interaction
Left Forearm Abrasion (Driver)	1	Air Bag Interaction
Chest Contusion (Passenger)	1	Air Bag Interaction
Left Knee Contusion (Passenger)	1	Glove Compartment Door/ Knee Bolster

Occupant Kinematics

The 19 year old male driver of the Toyota Corolla was situated in the font, left position in an upright and normal driving posture. He was fully restrained by the available three-point manual lap and shoulder belt. He was wearing the manual restraint system in a normal fashion with the shoulder belt across the anterior of his chest and upper torso.

Figure 11. Passenger air bag (note contact at bottom left)

He responded to the 320 degree principle direction of force by moving forward and to his left. He loaded the lower lap belt webbing with sufficient force to prohibit further forward motion of his lower torso. His chest loaded the shoulder belt webbing which restricted further forward motion of his upper torso. Both hands were positioned on the steering wheel rim, however, the exact location is unknown. Both of his forearms (anterior aspect) were contacted by the deploying air bag resulting in abrasions (AIS-1).

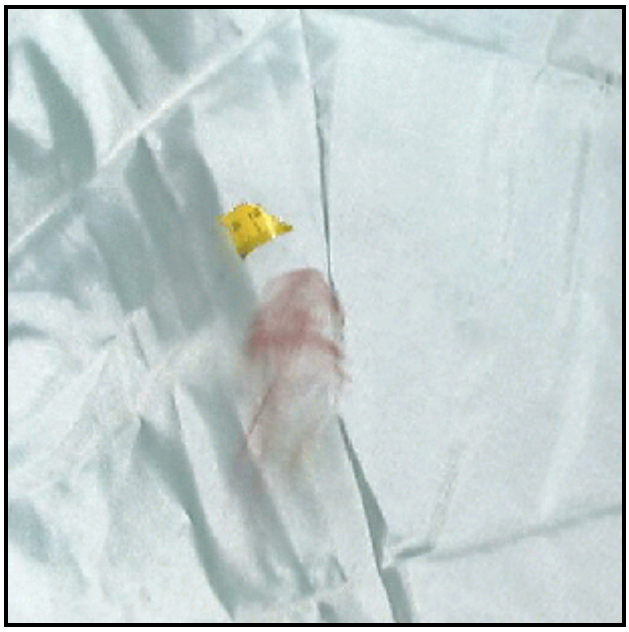

Figure 12. Close up of air bag contact

The secondary sideslap impact probably displaced the driver laterally to his left. His upper torso and flank probably contacted the interior door surface, however, this did not result in injury or leave residual contact evidence. The front right wheel impact with the curb (third event) was not of sufficient force to displace the driver from his seated position. The driver exited the vehicle unassisted after the case vehicle came to rest.

The front right seat was occupied by a fully restrained 23 year old female. She responded to the 11 o'clock direction of force (320 degrees) by moving forward and to her left. She loaded the lap and shoulder belt webbing which prohibited extended forward motion, however, there was a submarining element to her movement. Her left knee contacted the glove compartment door/ knee bolster as evidenced by a documented scuff mark and a left knee contusion (AIS-1), Her chest came into contact with the deploying air bag resulting in a chest contusion (AIS-1). Her face contacted the air bag fabric as evidenced by a lip stick transfer. Although her face contacted the deploying air bag, she did not sustain any reported facial injuries.

Scene Diagram