Child Safety Seat Fatality Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS06004
2000 Toyota Camry
California
January 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.

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16. Abstract

The focus of this on site investigation was on two child safety seats installed in the rear seat of a 2000 Toyota Camry. The Camry was occupied by a 35-year-old male driver, a 33-year-old female front right seat passenger, a 3-year-old male second row left passenger who was seated in a forward facing child safety seat, and a 6-month-old second row female right passenger who was seated in a rear facing infant safety seat. Both child seats were anchored to the vehicle using the manual 3-point lap and shoulder belts. The Camry was struck on the left side by a 1997 Ford F150 pickup. The front air bags in both vehicles deployed at this time. The left door, left rear tire, and the left quarter panel on the Camry were essentially torn away. Debris from the crash apparently struck and damaged a third vehicle, a 2004 Chrysler PT Cruiser. The Camry and Ford pickup went into rotation and left the roadway. The driver of the Toyota Camry was seriously injured. He sustained multiple facial fractures, a concussion, and a subdural hematoma. The front right occupant sustained minor injuries, including contusions to her hips and right shoulder. She was transported to a local hospital where she was treated and released. The 6-month-old second row right occupant was transported by ground ambulance to a local hospital. She was examined, found to have no injuries and was released. The 3-year-old second row left occupant was fatally injured. He sustained massive crushing and extruding injuries to his skull and brain. He was declared dead at the scene.

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BACKGROUND

Figure 1. 2000 Toyota Camry

The focus of this on site investigation was on two child safety seats installed in the rear seat of a 2000 Toyota Camry (see Figure 1). The Camry was occupied by a 35-year-old male driver, a 33-year-old female front right seat passenger, a 3-year-old male second row left passenger who was seated in a forward facing child safety seat, and a 6-month-old second row female right passenger who was seated in a rear facing infant safety seat. Both child seats were anchored to the vehicle using the manual 3-point lap and shoulder belts. The Camry was struck on the left side by a 1997 Ford F150 pickup. The front air bags in both vehicles deployed at this time. The left door, left rear tire, and the left quarter panel on the Camry were essentially torn away. Debris from the crash apparently struck and damaged a third vehicle, a 2004 Chrysler PT Cruiser. The Camry and Ford pickup went into rotation and left the roadway. The driver of the Toyota Camry was seriously injured. He was transported by air to a Level 1 trauma center. He sustained three facial fractures; one to the left zygomatic arch and two to the left orbit. He also sustained a 10.1 cm (4.0 cm) laceration to the left arm, a left black eye, and multiple facial abrasions. According to statements from his doctor to the interviewee, he also sustained a subdural hematoma and a concussion with a loss of consciousness for approximately one-half hour. He was hospitalized for three days and was unable to return to work for three weeks. The front right occupant sustained minor injuries, including contusions to her hips and right shoulder. She was transported to a local hospital where she was treated and released. The 6-month-old second row right occupant was transported by ground ambulance to a local hospital. She was examined, found to have no injuries and was released. The 3-year-old second row left side occupant was fatally injured. He sustained massive crushing and extruding injuries to his skull and brain. He was declared dead at the scene.

This case was identified by NHTSA from an on-line news article and was forwarded to DSI on January 19, 2006 with instructions to locate both the case vehicle and the child seats. The child seats and vehicle were located on January 20, 2006. DSI obtained cooperation to inspect the vehicle on that same day. The vehicle and child seat inspections took place January 24, 2006. Members of the major accident investigation team for the state were present during the inspections.

SUMMARY

Crash Site

This three vehicle crash occurred on a two-lane, undivided state highway in January, 2006. At the time of the crash, there were no adverse weather conditions and the asphalt roadway surface was dry. The east/west roadway was configured with one lane in each direction separated by a double-yellow painted centerline. There is a slight west to east downgrade. For westbound travel, the approaching roadway was straight with a right hand curve near the area of impact. The posted speed limit is 89 km/h (55 mph).

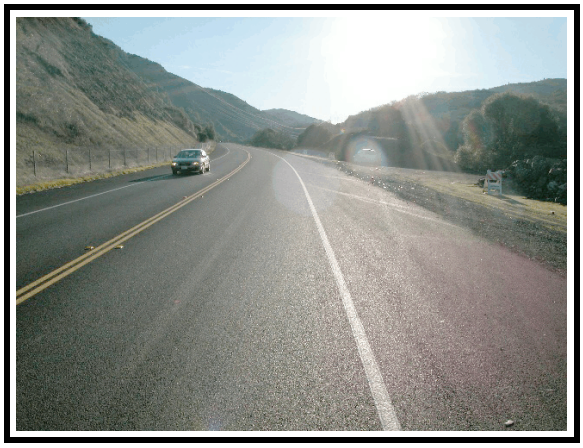

Figure 2. Path of case vehicle, eastbound

Pre-Crash

The 2000 Toyota Camry was traveling eastbound (see Figure 2). The Camry was occupied by a 35-year-old male driver, a 33-year-old female front right seat passenger, a 3-year-old male second row left passenger who was seated in a forward facing child safety seat, and a 6-month-old second row right passenger who was seated in a rear facing infant safety seat. The 1997 Ford F150 pickup was being driven by an 19-year-old male and was traveling westbound (see Figure 3). The third vehicle in this crash was a 2004 Chrysler PT Cruiser. This vehicle was traveling eastbound behind the Toyota Camry.

Figure 3. Path of other vehicle, westbound

Crash

The 1997 Ford pickup was traveling on the straight portion of the roadway and had begun to enter the right hand curve area. The Ford pickup drifted across the center line of the highway and struck the driver's side of the Toyota in a sideswiping type motion. The Ford's left bumper continued to engage the left side of the Toyota until penetrating the left rear door area and snagging the left rear wheel assembly. The front air bags in both vehicles deployed at impact. After impact, the Toyota began a counterclockwise rotation and left the roadway on the south side. The Toyota traveled approximately 10.9 m (36.0 ft) and came to rest facing west. The Ford also began a counterclockwise rotation and left the roadway on the south side. The Ford traveled approximately 17.9 m (59.0 ft) and came to rest facing east. Debris from the impact between the Toyota and Ford struck the front of the Chrysler causing some minor damage.

Post-Crash

The driver of the Toyota Camry was seriously injured. He was transported by air to a Level 1 trauma center. He sustained three facial fractures; one to the left zygomatic arch and two to the left orbit. He also sustained a 10.1 cm (4.0 in) laceration to the left arm, a left black eye, and multiple facial abrasions. According to statements from his doctor to the interviewee, he also sustained a subdural hematoma and a concussion with a loss of consciousness for approximately one-half hour. He was hospitalized for three days and was unable to return to work for three weeks.

The front right occupant sustained minor injuries, including contusions to her hips and right shoulder. She was transported to a local hospital where she was treated and released.

The 6-month-old second row right occupant was transported by ground ambulance to a local hospital. She was examined, found to have no injuries and was released.

The 3-year-old second row left side occupant was fatally injured. He sustained massive crushing and extruding injuries to his skull and brain. This child occupant was declared dead at the scene.

The Toyota and Ford were towed from the scene due to damage and placed on a police hold. The Chrysler was apparently driven from the scene.

VEHICLE DATA -2000 Toyota Camry

The 2000 Toyota Camry was identified by the Vehicle Identification Number (VIN): JTZBG22K8Y0xxxxxx. The vehicle's odometer could not be read since there was no power to the instrument panel. The Toyota Camry SE four-door sedan was equipped with a 2.2 liter, four cylinder engine, an automatic four-speed transmission, front wheel drive, cruise control, disc brakes with ABS, power steering, and a tilt steering wheel. The Camry was configured with Michelin Hi Energy MXV4 Plus P205/65R15 tires. The tire manufacturer's recommended cold tire pressure was 303 kPa (44 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Flat	8 mm (10/32 in)	Yes	Holed
LR	Flat	8 mm (10/32 in)	NA - wheel assembly torn from vehicle	Holed
RR	172 kPa (25 psi)	7 mm (9/32 in)	No	No
RF	193 kPa (28 psi)	7 mm (9/32 in)	No	No

The seating in the 2000 Toyota Camry was configured with cloth covered front bucket seats with adjustable head restraints and a rear bench seat with a folding back with adjustable head restraints for the outboard seat positions.

VEHICLE DAMAGE

Exterior Damage - 2000 Toyota Camry

The 2000 Toyota Camry sustained major left side damage from the impact with the Ford pickup. The direct damage began 77.0 cm (30.3 in) forward of the front axle and extended down the entire left side of the vehicle. There was a height mismatch between the Toyota and the Ford pickup. The left front tire of the Toyota was pushed into the wheel well and holed. The driver's door was jammed shut. The rear portion of the left rear door, left rear quarter panel, left rear tire and suspension, and the trunk were all torn from the vehicle. The damage began as a sideswiping type motion at the front, but as the pickup truck's bumper engaged the left rear door area there was

Figure 4. Overview of Toyota Camry as seen from above looking forward

penetration and a snagging motion began. The damage toward the front of the vehicle was largely a product of contact with the truck's front left tire while the remaining damage was above the sill and more related to the pickup truck's left bumper corner.

Due to the nature of the damage no crush profile was obtained. The Collision Deformation Classification (CDC) for the impact with the pickup was 11LDAW4. The A pillar on the left and the A/B/C pillars on the right were cut while the roof was being removed during extrication.

Figure 5. Second row, left seat belt buckle

Interior Damage - 2000 Toyota Camry

The 2000 Toyota Camry sustained substantial interior damage as a result of passenger compartment intrusion. There was lateral intrusion to the driver's seated area from the left front door and the B pillar. There was an unknown amount of lateral intrusion to the second row left seat position from the door. There was also, according to police, vertical intrusion to the second row left seat position from the roof/roof side rail. The seat back for the second row left seat position failed and separated from the rest of the seat. The left rear door remained attached at the hinges, but the locking mechanism at the C pillar was torn away.

Figure 6. Loading to second row right seat belt

Manual restraints - 2000 Toyota Camry

The 2000 Toyota Camry was configured with manual 3-point lap and shoulder belts for each of the five seating positions. The driver's belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). There were indications of historic belt usage and the belt was used during the crash (see Figures 6-7). The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The front left passenger's seat belt had indications of historic usage and was used during the crash.

Figure 7. Retractor support structure

Figure 8. Pulling striation along belt

The second row left safety belt was used to secure a forward facing child safety seat. The seat belt failed at two points during the crash sequence. First, the buckle failed and the sliding latch came out of the buckle. Second, the supporting structure that secured the seat belt retractor was pulled from the vehicle. The failures do not appear to be related to any loading from the child safety seat. It appears more likely that as the rear structures of the vehicle were being torn away by the Ford pickup, the retractor support was torn away and began to pull on the seat belt. This movement caused over tension on the belt and the buckle gave way.

The second row right safety belt was used to secure a rear facing infant safety seat. At the time of the vehicle inspection, the safety belt was still anchoring the infant seat. The belt was found to be in the ELR mode and not switched to the ALR mode for use with the infant seat. There was loading to the belt that began 63.0 cm (24.8 in) from belt stop button.

Figure 9. Driver's air bag

Supplemental Restraint System - 2000 Toyota Camry

The 2000 Toyota Camry was equipped with dual-stage frontal air bags. Both frontal air bags deployed as a result of the longitudinal deceleration of the Camry during the impact with the Ford pickup.

The driver's air bag deployed from the center of the steering wheel hub through symmetrical H-configuration module cover flaps (see Figure 9). Each flap measured 4.0 cm (1.6 in) in height and 16.0 cm (6.3 in) in width. The deployed driver's air bag measured 62.0 cm (24.4 in) in diameter in its deflated state. There was a single internal tether and two circular vent ports. The vent ports were located at the 11 and 1 o'clock positions.

Figure 10. Front right passenger's air bag

The front right passenger's air bag deployed through top mount H-configuration module cover flaps (see Figure 10). Each flap measured 22.0 cm (8.7 in) in width and 7.0 cm (2.8 in) in height. The deployed front right passenger's air bag measured 39.0 cm (15.3 in) seam to seam in its deflated state. There were circular vent ports at the 9 and 3 o'clock positions.

Child Safety Seat

Cosco Alpha Omega Child Safety Seat

The Cosco Alpha Omega child safety seat was positioned in the second row left seat of the Toyota Camry. The seat can be used with an internal harness system to secure a child up to 40 pounds and then, with the removal of the internal harness, is used as a high back belt positioning booster (BPB) seat. The model number was 22-269 CRK. The date of manufacture is not known. This car seat was configured with a five-point harness system and a two-piece, locking harness retainer clip. The manufacturer recommends that the seat be used in a forward facing fashion. When used with the harness, the seat is designed to be used for children weighing 10-18 kg (20-40 lbs). When used without the harness, the seat is designed to be used for children weighing 13.6-36.3 kg (30-80 lbs) and up to 132 cm (52 in) in height.

The seat was being used with the harness. The child's weight (approximately 21 kg/47 lbs) exceeded the manufacturer's recommended weight.

At the time of the child seat inspection, the harness straps were routed through the top set of harness slots.

Figure 11. Cosco Alpha Omega child safety seat

The child safety seat was installed in a forward facing orientation and was anchored to the vehicle using the manual 3-point lap and shoulder belt. The belt was routed through the forward facing belt path. It is unknown if the switchable retractor was engaged. The vehicle was equipped with three tether anchors on the rear deck. The child seat was configured with a tether strap and lower anchor attachments that were not in used during the crash.

The child safety seat sustained minor damage as a result of the crash. There were loading and door panel transfers to the left arm of the child seat. There was blood/hair/tissue found on the left upper portion of the seat back (see Figure 12). The upper harness guides were pulled forward. There were indications of loading along the vehicle belt path, particularly on the right side (see Figure 13). The child seat shell remained intact.

Figure 12. Close up of blood/tissue found on left side of child seat back

Figure 13. Loading marks to right side of child seat along belt path

Graco Snug Ride Infant Safety Seat

A rear-facing Graco SnugRide infant safety seat was positioned in the second row right seat of the Toyota Camry (see Figure 14). The model number was 8652 NPB2. The manufacture date was April 15, 2005. The infant seat was configured with a stay in vehicle base, an adjustable canopy, and a five-point harness system. The manufacturer recommends that the SnugRide infant car seat be used rear-facing only and for infants who weigh 2-10 kg (5-22 lbs) and who are less than 74.0 cm (29.0 in) tall. The child in this seat location met both the height and weight recommendations.

Figure 14. Graco SnugRide as found in vehicle

The infant seat was installed in a rear facing orientation and was anchored to the vehicle using the manual 3-point lap and shoulder belt. The seat was connected to the stay in vehicle base. The vehicle seat belt was routed through the rear facing belt path in the stay in vehicle base. The switchable retractor was not engaged. The seat was not tightly anchored. At the time of the inspection, the seat was able to be moved both forward and to the side. The seat was found tilted slightly to the left at the time of the inspection. The vehicle was equipped with three tether anchors on the rear deck. A child seat tether was attached to the vehicle tether anchor, but the tether was not connected to the infant seat. The infant seat was configured with LATCH belts that were not in use at the time of the crash.

The infant seat did not sustain any damage. Brain tissue from the left rear seat occupant was found just below the crotch strap and on the front of the seat (see Figure 15).

Figure 15. Graco SnugRide infant safety seat

VEHICLE DATA - 1997 Ford F150 pickup

Description:	1997 Ford F150 XLT pickup	
VIN:	1FTDF1861VKxxxxxx	
Odometer:	Unknown	
Engine:	4.6 liter, V8	
Reported Defects:	None	
Cargo:	Metal toolbox	
CDC:	12FLEW3	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Exterior Damage - 1997 Ford F150 pickup

The 1997 Ford F150 pickup sustained moderate frontal damage from the impact with the Toyota Camry. The vehicle was partially inspected (pictures, limited measurements) due to time constraints for the investigating police officers. The direct damage began at the left front bumper corner and extended 62.0 cm (24.4 in) across the front bumper. The maximum crush was at C1 and measured approximately 87.0 cm (34.3 in). A section of sheet metal from the Toyota's door/left rear quarter panel was embedded in the bumper. The left wheelbase was shortened by 28.0 cm (11.0 in). The left front tire was holed.

Figure 16. Front, 1997 Ford F150 pickup

VEHICLE DATA - 2004 Chrysler PT Cruiser

Description:	2004 Chrysler PT Cruiser	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Minor frontal damage from debris	
CDC:	Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

OCCUPANT DEMOGRAPHICS - 2000 Toyota Camry

	Driver	Occupant 2
Age/Sex:	35/Male	33/Female
Seated Position:	Front left	Front right
Seat Type:	Fabric covered bucket seat	Fabric covered bucket seat
Height:	188 cm (74 in)	168 cm (66 in)
Weight:	86 kg (190 lbs)	64 kg (140 lbs)
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	Unknown	Unknown
Body Posture:	Upright	Upright
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used
Air bag:	Steering wheel mounted frontal air bag available, deployed	Instrument panel mounted frontal air bag available, deployed

OCCUPANT DEMOGRAPHICS - 2000 Toyota Camry

	Occupant 3	Occupant 4
Age/Sex:	3 year old, 4 months/Male	6 months/Female
Seated Position:	Second row left	Second row right
Seat Type:	Bench with folding back	Bench with folding back
Height:	99 cm (39 in)	66 cm (26 in)
Weight:	21 kg (47 lbs) - between 45 and 50 lbs, per necropsy report	7 kg (16 lbs)
Occupation:	NA	NA
Pre-existing Medical Condition:	None	None noted
Alcohol/Drug Involvement:	NA	NA
Driving Experience:	NA	NA
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used with child safety seat	Lap and shoulder belt used with child safety seat

OCCUPANT DEMOGRAPHICS - 1997 Ford F150

	Driver
Age/Sex:	19/Male
Seated Position:	Front left
Seat Type:	Fabric covered bucket seat
Height:	175 cm (69 in)
Weight:	70 kg (155 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Upright
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt available, used
Air bag:	Steering wheel mounted frontal air bag available, deployed

OCCUPANT DEMOGRAPHICS - 2004 Chrysler PT Cruiser

	Driver
Age/Sex:	40/Male
Seated Position:	Front left
Seat Type:	Fabric covered bucket seat
Height:	191 cm (75 in)
Weight:	98 kg (215 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Upright
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt available, used
Air bag:	Steering wheel mounted frontal air bag available, did not deploy

OCCUPANT INJURIES - 2000 Toyota Camry

Driver: Injuries obtained from interviewee.

Injury	OIC Code	Injury Mechanism	Confidence Level
Concussion with a loss of consciousness for approximately one-half hour[1]	Not codeable		
Left zygomatic arch fracture	251800.2,2	Exterior, other vehicle	Probable
Left orbit fracture (x 2)[2]	251204.3,2	Exterior, other vehicle	Probable
10.1 cm (4.0 in) laceration, left arm	790600.1,2	Exterior, other vehicle	Probable
Left black eye	297402.1,2	Exterior, other vehicle	Probable
Multiple facial abrasions	290202.1,0	Unknown	Unknown

Front right occupant: Injuries obtained from interviewee.

Injury	OIC Code	Injury Mechanism	Confidence Level
Bilateral hip contusions	890402.1,3	Seat belt webbing	Certain
Right shoulder contusion	790402.1,1	Seat belt webbing	Certain

[1]Anatomical lesion has higher AIS than the non-anatomical lesion

[2]Coded as comminuted

Second row left occupant: Injuries obtained from a necropsy report obtained from the office of the coroner.

Injury	OIC Code	Injury Mechanism	Confidence Level
Crushed skull with destruction of both skull and brain	113000.6,0	Roof	Probable
Abrasion, left shoulder	790202.1,2	Child safety seat webbing	Probable
Lacerations, minor, right hand	790602.1,1	Flying glass	Probable

Second row right occupant: Injury information obtained from interviewee. This occupant was transported by ground ambulance to a local hospital. She was examined, found to have no injuries and was released

OCCUPANT KINEMATICS - 2000 Toyota Camry

Driver Kinematics

The 35-year-old male driver of the Toyota Camry was seated in a upright posture and was restrained by the manual 3-point lap and shoulder belt. The shoulder belt anchorage was adjusted to the mid position. The fabric covered bucket seat was adjusted to the rear most track position. He was wearing prescription glasses. At impact, this occupant initiated a forward and slightly left trajectory in response to the 11 o'clock direction of force. As the impact continued, the exterior of the Ford pickup penetrated and over-rode the left side of the Camry and struck the left side of the driver's face, causing the facial fractures and brain injury. The driver was unconscious immediately after the crash. The front right occupant supported his head and neck until bystanders began to render aid. The driver was transported by air to a Level 1 trauma center. He was hospitalized for three days and was unable to return to work for three weeks.

Figure 17. Overview, driver seated position

Front Row Right Occupant Kinematics

The 33-year-old female front right seat occupant was seated in a upright posture and was restrained by the manual 3-point lap and shoulder belt. The shoulder belt anchorage was adjusted an unknown position. The fabric covered bucket seat was adjusted to the rear most track position. At impact, this occupant initiated a forward and slightly left trajectory in

response to the 11 o'clock direction of force. She loaded the lap and shoulder belt causing bilateral hip contusions and a right shoulder contusion. She was transported to a local hospital where she was treated and released.

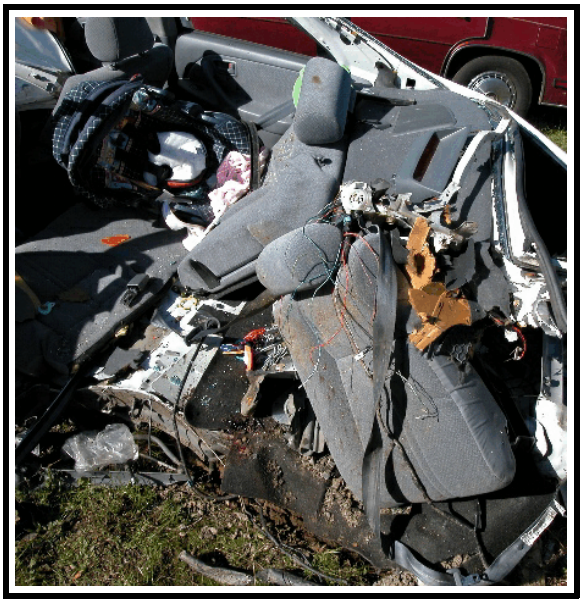

Figure 18. Overview of second row seating

Second Row Left Occupant Kinematics

The 3-year-old male second row left occupant was seated in a Cosco Alpha Omega child safety seat. The child seat was being used with the internal 5-point harness. At the time of the child seat inspection, the harness straps were routed through the top set of harness slots. The child's weight (approximately 21 kg/47 lbs) exceeded the manufacturer's recommended weight. The child safety seat was installed in a forward facing orientation and was anchored to the vehicle using the manual 3-point lap and shoulder belt. The belt was properly routed through the forward facing belt path. It is unknown if the switchable retractor was engaged. At impact, this occupant initiated a forward and slightly left trajectory in response to the 11 o'clock direction of force. He loaded the child safety seat webbing to some degree. As the impact continued, the exterior of the Ford pickup penetrated and over-rode the left side of the Camry. The roof and possibly the exterior of the Ford struck the top of this occupant's head, essentially tearing away the top of the skull from front to back and from left to right at the hairline level. The child was fatally injured. The child safety seat sustained minor damage as a result of the crash. There were loading and door panel transfers to the left arm of the child seat. There was blood/hair/tissue found on the left upper portion of the seat back. The grommets for the upper slots of the harness path were pulled forward. There were indications of loading along the vehicle belt path, particularly on the right side. The child seat shell remained intact.

Second Row Right Occupant Kinematics

The 6-month-old female second row right occupant was seated in a Graco SnugRide infant safety seat. The infant seat was installed in a rear facing orientation and was anchored to the vehicle using the manual 3-point lap and shoulder belt. The seat was properly connected to the stay in vehicle base. The seat was not tightly anchored. At the time of the inspection, the seat was able to be moved both forward and to the side. The seat was found tilted slightly to the left at the time of the inspection. At impact, this occupant initiated a forward and slightly left trajectory in response to the 11 o'clock direction of force. She likely loaded the safety seat back, but there were no resultant injuries. She was transported by ground ambulance to a local hospital where she was examined and released.

Attachment 1. Scene Diagram