

Child Safety Seat Fatality/ Vehicle to Object
Dynamic Science, Inc. / Case Number: DS05011
2000 Toyota Celica
California
June 2005

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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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BACKGROUND

This on-site investigation focused on the performance of a rear facing child safety seat (CSS) that was improperly installed in the right rear position of a 2000 Toyota Celica. The Toyota Celica was being driven by a 21-year-old male. The front right seat was occupied by an 18-year-old female. A 4-month-old male was seated in an infant seat that had been placed in the rear seat. The infant seat was designed with a 5-point harness and a stay-in-vehicle base. The vehicle safety belt was routed through the top part of the CSS and not through the stay-in-vehicle base. The lap and shoulder belt was switchable (Emergency Locking Retractor [ELR] to Automatic Locking Retractor [ALR]) with a sliding latch plate. The belt had not been switched to ALR. The child was not restrained by the 5-point harness. The Toyota was traveling on an interstate highway when it was cut off by another vehicle. The Toyota struck a guardrail and eventually overturned. The rear seat child occupant was ejected from the vehicle and fatally injured. The driver and front right occupant sustained minor to moderate injuries and were taken to local hospitals for treatment.



Figure 1. Front left, 2000 Toyota Celica

This child safety seat case was identified by a member of a child safety advocate group through a news article. NHTSA was notified on June 28, 2005. DSI located the vehicle and the child seat on July 1, 2005, and was assigned the case on that same day. The vehicle and seat inspections took place on July 5, 2005.

SUMMARY

Crash Site

This crash occurred on a divided interstate highway. It was dark at the time of the crash and there were no streetlights present. The weather was clear and the concrete roadway was dry. The north/south roadway was configured with three southbound lanes and three northbound lanes divided by a median. The median is comprised of metal guardrails separated by oleander bushes. The southbound travel lanes are separated by dashed white lines. On the west side of the roadway there is an asphalt shoulder followed by a raised asphalt curb. There is a west/east overpass that runs over both the north and southbound lanes. This roadway is supported by concrete



Figure 2. Area of impacts, rollover, and final rest (looking south)—lane 1 to left of image

pillars in the median and on the west/east roadsides. The speed limit is 105 km/h (65 mph).

Pre-Crash

This single vehicle crash occurred in June, 2005 at 2141 hours. The case vehicle is a 2000 Toyota Celica driven by 21-year-old male. The front right seat was occupied by an 18-year-old female. A 4-month-old male was seated in a Graco Snug Ride infant seat that had been placed in the rear seat. The child had a crown-to-heel length of 63.5 (25.0 in) and crown-to-rump length of 46.4 (18.3 in). His head, chest and abdominal circumferences measured 42.5 cm (16.8 in), 42.5 cm (16.8 in), and 43.2 cm (17.0 in), respectively. The infant seat was designed with a 5-point harness and a stay-in-vehicle base. The child was not wearing the 5-point harness. The Toyota Celica was traveling southbound at an unknown speed. According to the police, a non-contact vehicle (dark colored BMW) was in the area.

Crash

The BMW reportedly cut in front of the Celica causing the driver to brake and swerve hard to the left. The driver of the Celica lost control of his vehicle as it veered to the left. The Celica struck the metal guardrail with its front end (12FLEE4). Both frontal air bags in the Celica likely deployed at this time. The Celica was redirected back to the right to some degree, but the damage to the front left wheel caused the vehicle to begin a counterclockwise rotation. The Celica again struck the guardrail and continued its rotation. It appears that the Celica had rotated approximately 90 degrees before it tripped and began overturning with its right side leading (00TDD02). The Celica rolled at least four quarter turns. Prior to coming to final rest the Celica contacted one of the overpass support beams. At some point during the rollover sequence the infant in the Celica was ejected through the backlight.

Post-Crash

There are some discrepancies with regard to the final rest orientation of the Celica. Police have indicated that it was up on its wheels, but the tow truck driver has indicated that it was on its left side near the support structure.

Both front occupants of the Celica sustained minor to moderate injuries. Both were transported to hospitals for treatment. It is not known if the driver was hospitalized. The front right occupant sustained a large right temporal parietal scalp hematoma with a 9 mm hemorrhagic contusion in the right parietal lobe. She also sustained a right orbital contusion and multiple scattered abrasions. She arrived at the emergency room with a Glasgow Coma Scale (GCS) score of 14/15. Her long term memory was intact. She did demonstrate both retrograde and anterograde amnesia. She was admitted to the hospital and was discharged home the following day.

The rear seat infant occupant was transported from the scene to a local emergency room where he was declared dead at 2228 hours, less than one hour post-crash. According to the autopsy report he sustained multiple skull fractures, scalp hemorrhages, subdural and subarachnoid hemorrhages, multiple brain lacerations, and multiple abrasions to the head, torso and extremities. The cause of death was given as “blunt force injuries of the head (minutes)”.

The BMW fled the scene. The Celica was towed from the scene due to damage and placed on a police hold.

VEHICLE DATA - 2000 Toyota Celica

The 2000 Toyota Celica GT coupe was identified by the Vehicle Identification Number (VIN): JTDDR32T9Y0xxxxxx. The vehicle’s odometer could not be read, as there was no power to the instrument panel. The Toyota was a three-door hatchback that was equipped with a 1.8 liter, four cylinder engine, an automatic transmission, front disc/rear drum brakes, hydraulic power-assist rack and pinion steering, and a tilt steering wheel. The Toyota was configured with Sumitomo SR1X04 P19560/R15 tires. The manufacturer’s recommended cold tire pressure was 352 kPa (51 psi). The specific tire information is as follows:

Tire	Tread	Measured pressure	Manufacturer recommended pressure	Restricted	Damage
LF	6 mm (7/32 in)	Flat	241 kPa (35 psi)	No	Torn
LR	6 mm (7/32 in)	186 kPa (27 psi)	241 kPa (35 psi)	No	None
RR	7 mm (8/32 in)	214 kPa (31 psi)	241 kPa (35 psi)	No	None
RF	6 mm (7/32 in)	Flat	241 kPa (35 psi)	No	Torn

The seating in the Toyota Celica was configured with front bucket seats with integral head restraints and a rear 50-50 folding forward bench seat. The fabric covered 6-way adjustable driver seat was adjusted to between the middle and rear most track positions. The seat back angle was 53 degrees and the seat bottom angle was 20 degrees. The seat was not damaged. The fabric covered 4-way adjustable front right seat was adjusted to the forward most track position. The seat back angle was 70 degrees and the seat bottom angle was 20 degrees. The seat was not damaged.

VEHICLE DAMAGE

Exterior Damage - 2000 Toyota Celica

The 2000 Toyota Celica sustained moderate front/left side damage from the impacts with the guardrail and moderate roof damage from the rollover. The direct frontal damage began at the left bumper corner and extended laterally 21.0 cm (8.3 in). Direct damage extended down the left side for 85.0 cm (33.5 in). The left front tire was knocked off and the left wheelbase was shortened by 8.0 cm (3.1 in). The front left rim was abraded and the wheel was flat. There was direct contact damage along the left side of the hood that extended rearward and included the A pillar and the left roof rail and roof area. The mirrors on both sides were broken off. There was direct road surface contact along the right front fender. The front right tire rim was abraded and the tire was flat. Both front doors and the hatch remained closed and operational. The windshield was fractured during the rollover. The right rear window and the backlight glazing disintegrated. The roof glass was cracked and out of place.

CDC:	Impact 1: 12FLEE4	
	Impact 2: Unknown frontal CDC	
	Impact 3: 00TDDO2	
	Impact 4: Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown



Figure 3. Initial contact area to front left bumper corner



Figure 4. Guardrail damage down left side

Interior Damage - 2000 Toyota Celica

The 2000 Toyota Celica sustained minor interior damage as a result of passenger compartment intrusion and occupant contacts. There was a small amount of vertical intrusion to the left A pillar and left roof rail. The driver's knee bolster exhibited scuff marks on the left aspect from the driver's left knee. The rear view mirror was off.

MANUAL RESTRAINT SYSTEMS - 2000 Toyota Celica

The 2000 Toyota Celica was configured with manual 3-point lap and shoulder belts for each of the four seating positions. The driver's safety belt was configured with a sliding latch plate and an emergency locking retractor (ELR). The other three safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR).

The driver's belt showed signs of past usage and there were also indications of webbing loading at the latch plate area from this crash. The remaining safety belts also showed signs of historical usage.

The front right seat safety belt was being used by the female occupant in that position. The safety belt was found in the extended position at the time of the inspection.

The rear right seat safety belt was used to anchor a Graco Snug Ride infant safety seat. There were no indications that the seat belt had been switched to the ALR mode.



Figure 5. Loading to webbing of driver's seat belt



Figure 6. Front right passenger seat belt



Figure 7. Rear right seat belt—used with infant seat

FRONTAL AIR BAG SYSTEM - 2000 Toyota Celica

The 2000 Toyota Celica was equipped with dual front air bags. The air bags deployed as a result of the first impact with the guardrail.

The driver's air bag deployed from the center of the steering wheel hub through Y configuration module cover flaps. The top flap measured 15.0 cm (5.9 in) wide by 8.0 cm (3.1 in) high. The bottom flap measured 15.0 cm (5.9 in) wide by 6.0 cm (2.4 in) high. The deployed driver's air bag 60.0 cm (23.6 in) wide in its deflated state. The air bag was tethered by a single internal tether that was stitched in the center of the air bag face. Two circular vents were located at the 11 and 1 o'clock aspects on the back of the air bag. There was no damage or indication of occupant contact to the air bag.



Figure 8. Driver's air bag

The front right passenger's air bag deployed from a top mount module with rectangular H configuration cover flaps. The top module cover flap measured 21.0 cm (8.3 in) wide by 6.0 cm (2.4 in) high. The bottom module cover flap measured 21.0 cm (8.3 in) wide by 8.0 cm (3.1 in) high. The deployed front right passenger air bag measured 41.0 cm (16.1 in) in width and 38.0 cm (15.0 in) in height. Two circular vent ports were located at the 3 and 9 o'clock aspects of each side panel of the air bag. There was no damage or indication of occupant contact to the air bag.



Figure 9. Deployed front right passenger's air bag

CHILD SAFETY SEAT - Graco Snug Ride

A Graco Snug Ride infant seat was positioned in the rear right seat of the Toyota Celica. The model number was 7330D04, the serial number JU1130044529, and the manufacturing date was November 30, 2004. The infant seat was equipped with a 5-point harness, a plastic carrying handle, a stay-in-car base, a canopy, and an infant head rest. The seat is designed to be used rear-facing only and is for infants up to 9.0 kg (20.0 lbs) and less than 66.0 cm (26.0 in) tall. The seat is designed to be used with or without the stay-in-vehicle base. At the time of the crash, the 5-point harness was routed through the top slots and the harness clip was positioned low near the harness latch. The carrying handle was in the up position and the base was used. The latch tongues were examined and show light signs of historical usage. The latches were fastened and unfastened and found to operate correctly.

Infant Seat Installation

The infant seat was installed in a rear facing configuration using the stay-in-vehicle base. The seat was improperly installed. The Toyota's manual 3-point lap and shoulder belt was routed through the infant seat's vehicle belt hooks that are intended to be used when the seat is installed without the base. When using the stay-in-vehicle base, it is the base that is anchored to the vehicle using the vehicle belt system. The vehicle was equipped with a lap and shoulder belt that was switchable ELR to ALR and had a sliding latch plate. The investigating officer indicated that the belt had not been switched to ALR and a locking clip was not being used.



Figure 10. Graco Snug Ride child safety seat



Figure 11. Graco Snug Ride child safety seat

Infant Seat Damage

There was no damage to the seat. There were no indications of stress or loading to the vehicle's seat belt. There were faint scuff marks found on the left portion of the harness webbing near the upper left slot.



Figure 12. Child safety seat latch tongue



Figure 13. Scuff located on bottom of left side webbing

Occupants Demographics

<u>Case vehicle</u>	Driver	Occupant 2	Occupant 3
Age/Sex:	21/Male	18/Female	4 month/Male
Seated Position:	Front left	Front right	Second row, right
Seat Type:	Fabric covered bucket seat, adjusted to between middle and rear most track position	Fabric covered bucket seat, adjusted to forward most track position	Fabric covered
Height:	173 cm (68 in)	Unknown	63.5 cm (25.0 in) ¹
Weight:	75 kg (165 lbs)	Unknown	Unknown
Occupation:	Unknown	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted	None
Alcohol/Drug Involvement:	Unknown	NA	NA
Driving Experience:	Unknown	NA	NA
Body Posture:	Upright	Upright	Lying in child seat
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used	Lap and shoulder belt used incorrectly with infant safety seat

¹The child had a crown-to-heel length of 63.5 (25.0 in) and crown-to-rump length of 46.4 (18.3 in). His head, chest and abdominal circumferences measured 42.5 cm (16.8 in), 42.5 cm (16.8 in), and 43.2 cm (17.0 in), respectively.

OCCUPANT INJURIES - 2000 Toyota Celica

Driver: Injuries obtained from police report.

<u>Injury</u>	<u>OIC CODE</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Minor injuries of an unknown nature			

Front right occupant (Occupant 2): Injuries obtained from CT scans.

<u>Injury</u>	<u>OIC CODE</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusion, right parietal lobe (9 mm), associated with parietal scalp hematoma	140606.3,1	Door panel	Possible
Large right temporal parietal scalp hematoma	190402.1,1	Door panel	Possible
Right orbital contusion	297402.1,1	Door panel	Possible
Multiple abrasions	990200.1,O	Unknown	Unknown

Second row right passenger (Occupant 3): Injuries obtained from Autopsy Report

<u>Injury</u>	<u>OIC CODE</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Extensive lacerations of the right and left cerebellar hemispheres that penetrate into the white matter up to 2.0 - 3.0 cm (0.75 - 1.25 in.)	140688.4,1 140688.4,2	Ground	Probable
Subdural and subarachnoid hemorrhages	140684.3,1 140684.3,2	Ground	Probable
Displaced skull fracture that visibly up lifts the overlying scalp. This is a closed fracture that runs in a coronal plane between the right and left posterior parietal bones. Small island of fractured bone within the previously described fracture and a branch off of this that involves the posterior right parietal region.	150403.3,1 150403.3,2	Ground	Probable

Directional abrasions involving the posterior left lower jaw and adjacent cheek area w/a directional orientation of slightly diagonal of horizontal that measure up to 4.4 cm (1.75 in) in width	290202.1,2	Ground	Probable
Abrasion, posterior right cheek that is up to 1.9 cm (0.75 in) wide	290202.1,1	Ground	Probable
Abrasions of the right and left forehead that measure up to 1.9 cm (0.75 in)	290202.1,7	Ground	Probable
Irregular abrasion, right tip of the nose that measures up to 1.6 cm (0.6 in)	290202.1,4	Ground	Probable
Large abrasion from the medial right parietal scalp across the dome down over the left side of the scalp to behind the left ear and into the junction area of the left frontal parietal region and the junction region of the parietal occipital region on the right and left. Covers an area up to 19.6 cm (7.4 in) in the coronal plane and is up to 13.3 cm (5.3 in) in the sagittal plane.	190202.1,0	Ground	Probable
Extensive red abrasions, anterior left ear up to 4.4 cm (1.75 in)	190202.1,2	Ground	Probable
Abrasions scattered on the posterior right ear up to its superior aspect covering an area up to 4.1 cm (1.6 in) wide	190202.1,1	Ground	Probable
Abrasions of the distal lateral right arm, wrist and proximal hand that cover an area up to 7.0 cm (2.75 in) wide	790202.1,1	Ground	Probable
Abrasions are located on the posterior proximal right second and the distal and proximal posterior phalanges of the first digit of the right hand that measure up to 1.0 cm (0.4 in)	790202.1,1	Ground	Probable
Abrasion from the proximal lateral left shoulder down over the lateral left arm, elbow and length of the posterior left forearm and then continues as punctuate red abrasions over the posterior left hand and second digit	790202.1,2	Ground	Probable

Contusion, posterior left hand and the posterior second through fourth proximal digits.	790402.1,2	Unknown	Unknown
Abrasion, left shoulder, continues over the length of the lateral left back of the chest and inferior back on to the upper left buttock.	790202.1,1 690202.1,2	Ground	Probable
Abrasion, 1.3 cm (0.5 in), lateral left knee	890202.1,2	Ground	Probable
Area of red scratches (laceration) in an area that is 5.0 cm (2.0 in) wide on the distal lateral left leg	890602.1,2	Backlight glass	Possible
Abrasions scattered over the distal and lateral aspect of the dorsum of the left foot that are continuous, with some noted of the dorsum of the left first through fifth toes. These measure up to 1.6 cm (0.4 in) in width	890202.1,2	Ground	Probable
Abrasions, 5.0 cm (2.0 in) area, plantar surface of the proximal half of the right foot	890202.1,1	Ground	Probable
Abrasions (2), mid anterior chest	490202.1,4	Ground	Probable

OCCUPANT KINEMATICS - 2000 Toyota Celica

Driver Kinematics

The 21-year-old male driver of the Toyota Celica was seated in an upright position in the fabric covered bucket seat. The seat track was adjusted to between the middle and rear most track position. The seat back was adjusted to a 53 degree angle at the time of inspection, but it was likely moved after the crash. The seat bottom angle was 20 degrees from horizontal. The driver was wearing the available 3-point lap and shoulder belt. Just prior to the crash, a non-contact vehicle cut in front of the Celica. The driver braked and swerved to the left. The vehicle entered the left shoulder and struck the guardrail. This impact likely deployed the driver's air bag. The driver pitched forward in response to the 12 o'clock direction of force and engaged the deployed air bag and loaded the lap and shoulder belt to some degree. The vehicle was redirected to the right. The damage to the left front tire caused drag and the vehicle was pulled back into the guardrail a second time. This was likely a light swiping type impact. The vehicle continued its rotation until had rotated approximately 90 degrees before it tripped and began overturning with its right side leading. The driver pitched side to side during the rollover but was generally held in place by the lap and shoulder belt as the vehicle overturned four quarter turns prior to coming to rest.

Front Right Occupant Kinematics

The 18-year-old female front right occupant of the Toyota Celica was seated in an upright position in the fabric covered bucket seat. The seat track was adjusted to the forward most position. The seat back was adjusted to a 70 degree angle at the time of inspection. This occupant was wearing the available 3-point lap and shoulder belt. Just prior to the crash, a non-contact vehicle cut in front of the Celica. The driver braked and swerved to the left. The vehicle entered the left shoulder and struck the guardrail. This impact likely deployed the front right passenger's air bag. This occupant pitched forward in response to the 12 o'clock direction of force and engaged the deployed air bag and loaded the lap and shoulder belt to some degree. The vehicle was redirected to the right. The damage to the left front tire caused drag and the vehicle was pulled back into the guardrail a second time. This was likely a light swiping type impact. The vehicle continued its rotation until had rotated approximately 90 degrees before it tripped and began overturning with its right side leading. The front right occupant pitched side to side during the rollover but was generally held in place by the lap and shoulder belt as the vehicle overturned four quarter turns prior to coming to rest. She likely contacted the door side panel with the right side of her face/head. She sustained a large right temporal parietal scalp hematoma with a hemorrhagic contusion in the right parietal lobe. She also sustained a right orbital contusion and multiple scattered abrasions. She was admitted to the hospital and was discharged home the following day.

Second Row Right Occupant Kinematics

The 4-month-old second row right occupant was reclined in a rear facing Graco Snug Ride infant seat. The infant seat was installed in a rear facing configuration using the stay-in-vehicle base. The Toyota's manual 3-point lap and shoulder belt was routed through the infant seat's vehicle belt hooks that are intended to be used when the seat is installed without the base. When using the stay-in-vehicle base, it is the base that is anchored to the vehicle using the vehicle belt system. The vehicle was equipped with a lap and shoulder belt with switchable retractor and a sliding latch plate. The investigating officer indicated that the belt had not been switched to the ALR mode and a locking clip was not being used. It appears that the child may



Figure 14. Overview showing child seat in relation to rear window

not have been wearing the infant seat's internal 5-point harness or the harness unbuckled at some point. There were no harness loading type injuries. While the parents indicated that the harness was buckled, first responders to the scene found that it was not buckled. As the driver lost control of the vehicle, it entered the left shoulder and struck the guardrail. This rear seat occupant translated forward in response to the 12 o'clock direction of force and began loading the child seat back. The vehicle was redirected to the right. The damage to the left front tire caused drag and the vehicle was pulled back into the guardrail a second time. This was likely a light swiping type impact. The vehicle continued its rotation until had rotated approximately 90 degrees before it tripped and began overturning with its right side leading. As the vehicle completed the first two quarter turns, this occupant was ejected through the backlight. The slope of the rear window and its positioning above the rear seat offers a fairly straight path of egress from the vehicle as the vehicle went over on its roof. The infant seat remained anchored to the vehicle. There were no indications that the child might have slipped out of the harness straps. The child occupant was transported from the scene to a local emergency room where he was declared dead at 2228 hours, less than one hour post-crash. According to the autopsy report he sustained multiple skull fractures, scalp hemorrhages, subdural and subarachnoid hemorrhages, multiple brain lacerations, and multiple abrasions to the head, torso and extremities. The infant seat remained anchored to the vehicle.

Attachment 1. Scene Diagram

