On Site Side Air Bag Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS02021
2002 Kia Optima
California
October, 2002

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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 side air bag involved crash occurred in an urban area of southern California in October, 2002 at 2151 hours. This was a two vehicle angle/broadside type crash which occurred within the confines of a four leg intersection. The intersection was controlled by tri-colored traffic signals. The case vehicle is a 2002 Kia Optima 4-door sedan that was driven by an unrestrained 19-year-old male. The other vehicle was a 1996 Toyota Camry that was driven by a restrained 49-year-old female.

The Kia Optima was initially stopped at the intersection with a red light. He was talking on a cell phone. The Toyota Camry was traveling westbound and entered the intersection with a green light. The driver of the Kia was apparently distracted by the phone call and entered the intersection. He did not see the other vehicle or take any evasive actions. The front of the Toyota struck the left side of the case vehicle. At impact, the driver's seat mounted side air bag deployed in the case vehicle. After impact, the Kia Optima rotated clockwise and crossed through the intersection. The front of the case vehicle struck the traffic signal pole on the south-west corner of the intersection with its front. The collision did not exceed the front air bag deployment threshold and neither the driver's nor the front right passenger's air bags deployed.

There were no injuries to any parties in this crash.

17. Key Words	18. Distribution Statement
Air bag, deployment, side air bag, non injury	

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Dynamic Science, Inc.
Crash Investigation
Case Number: DS02021

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BACKGROUND:

Description:	This seat mounted side air bag case was identified by DSI through insurance contacts. The case was reported to the NHTSA on October 29, 2002. The case was assigned to DSI on October 30, 2002. An on-site investigation was conducted and all field work was completed on November 4, 2002.
Investigation Type:	On Site Side Air Bag
Crash Location:	California
Crash Date:	October, 2002
Notification Date:	October 30, 2002
Field Work Completed:	November 4, 2002

SUMMARY

Crash Site

Figure 1. Case vehicle stopped at intersection.

The side air bag involved crash occurred in an urban area of southern California in October, 2002 at 2151 hours. This was a two vehicle angle/broadside type crash which occurred within the confines of a four leg intersection. The north-south roadway is a two-way, undivided asphalt street. The southbound roadway consists of two through lanes, and a left turn lane. The roadway is bordered by raised concrete curbs. T he speed limit for southbound traffic is 40 km/h (25 mph). The east-west roadway is a two-way, undivided asphalt street. The westbound roadway consists of two through lanes, and a left turn lane. The roadway is bordered by raised concrete curbs. The speed limit for southbound traffic is 56 km/h (35 mph). The intersection is controlled by tri-colored traffic signals.

Pre-Crash

The case vehicle is a 2002 Kia Optima 4-door sedan that was driven by an unrestrained 19-year-old male (178 cm/70 in, 66 kg/145 lbs). The other vehicle was a 1996 Toyota Camry that was driven by a restrained 49-year-old female.

The Kia Optima was initially stopped at the intersection with a red light. He was talking on a cell phone. The Toyota Camry was traveling westbound and entered the intersection with a green light. The driver of the Kia was apparently distracted by the phone call and entered the intersection. He did

not see the other vehicle or take any evasive actions. Assuming a typical acceleration rate of 1.2 m/sec/sec (4 ft/sec/sec), the Kia would have been traveling approximately 21 km/h (13 mph) by the time the vehicle had traveled 13 m (43 ft) into the intersection.

Figure 2. Impact 2 (pole)

Crash

The front of the Toyota struck the left side of the case vehicle (10LYEW3). On impact, the case vehicle sustained a total delta v of 23.0 km/h (14.3 mph)[1], a longitudinal delta v -7.9 km/h (-4.9 mph) and a lateral delta v of 21.6 km/h (13.4 mph). Results fit the collision model and appear reasonable for the case vehicle. At impact, the driver's seat mounted side air bag deployed in the case vehicle.

Figure 3. Left side damage (impact 1) to case vehicle.

After impact, the Kia Optima rotated clockwise and crossed through the intersection. The front of the case vehicle struck the traffic signal pole on the south-west corner of the intersection with its front (12FLEN1). The Kia sustained a total delta v of 20.0 km/h (12.4 mph). The longitudinal and lateral components were -20 km/h (-12.4 mph) and 0 km/h (0 mph), respectively. The results appear high. The collision did not exceed the manufacturer's front air bag deployment threshold and neither the driver's nor the front right passenger's air bags deployed.

Figure 4. Front damage to case vehicle (impact 2).

Post-Crash

The driver of the Kia Optima indicated that he was not injured. He reported that he had a sore back.

The driver of the Toyota complained of chest pain. He did not seek medical treatment.

[1] Calculated using the missing vehicle option of WinSmash 2.12. Size and stiffness coefficients were based on the vehicle's wheelbase.

The case vehicle sustained major damage to its left side. The case vehicle's engine started, but was towed from the scene. It was later declared a total loss by the insurance company.

Figure 5. Angle view of side impact

VEHICLE DATA - 2002 Kia Optima four door sedan

The 2002 Kia Optima five passenger four door sedan was equipped with front wheel drive, power steering, 4-speed automatic transmission, vented disc front brakes, drum rear brakes, and a tilt steering column.

VIN:	KNAGD1268251xxxxxx
Odometer:	26,964 km (16,755 miles)
Engine:	2.4L I4
Reported Defects:	None reported
Cargo:	

The 2002 Kia Optima was equipped with Hankook Radial H406 P205/60R15 tires. The specific tire data is as follows:

Tire	Tread	Pressure	Maximum Manufacturer Recommended Pressure
LF	6 mm (7/32 in)	214 kPa (31 psi)	241 kPa (35 psi)
LR	6 mm (7/32 in)	207 kPa (30 psi)	241 kPa (35 psi)
RF	5 mm (6/32 in)	186 kPa (27 psi)	241 kPa (35 psi)
RR	5 mm (6/32 in)	200 kPa (29 psi)	241 kPa (35 psi)

The front seating positions in the 2002 Kia Optima were configured with bucket seats with adjustable head restraints. The rear seating positions were configured with a bench seat with a 60/40 folding back and adjustable head restraints for all three positions.

VEHICLE DAMAGE

Exterior Damage - 2002 Kia Optima

Damage Description:	The case vehicle sustained major damage to its left side. There was lateral intrusion of the driver's door panel and the B-pillar into the driver's compartment. The case vehicle's engine started, but the vehicle was towed from the scene anyhow.	
CDC:	Impact 1: 10LYEW3 Impact 2: 12FLEN1	
Delta V (Impact 1):	Total	23.0 km/h (14.3 mph)
	Longitudinal	-7.9 km/h (-4.9 mph)
	Latitudinal	21.6 km/h (13.4 mph)
	Energy	50,996 joules (37,613 ft lbs)
Delta V (Impact 2):	Total	20.0 km/h (12.4 mph)
	Longitudinal	-20.0 km/h (-12.4 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	27,964 joules (20,625 ft lbs)

The Kia Optima sustained major left side damage as a result of the impact with the Toyota Camry. The direct contact damage began 47.0 cm (18.5 in) forward of the rear axle and extended forward for 169.0 cm (66.5 in). The direct plus induced damage began 10.0 cm (3.9 in) forward of the rear axle and extended for 206.0 cm (81.1 in). Both left side doors were jammed shut. The driver's window glazing was disintegrated from impact forces. Six C measurements were taken along the sill and were as follows: C1=0 cm (0 in), C2=11.5 cm (4.5 in), C3=24.5 cm (9.6in), C4=29.0 cm (11.4in), C5=19.0 cm (7.4 in), and C6=7.5 cm (2.9 in). Maximum crush was located at C3.

The Kia Optima sustained minor frontal damage as a result of the impact with the pole. The direct damage began 13.0 cm (5.1 in) from the left front bumper corner and extended laterally to the right for 25.0 cm (9.8 in). The direct and induced damage included the entire front bumper. Six C measurements were taken along the front bumper beam and were as follows: C1=0 cm (0 in), C2=23.5 cm (9.3 in), C3=18.0 cm (7.0 in), C4=10.5 cm (4.1 in), C5=1.0 cm (0.4 in), and C6=0 cm (0 in). Maximum crush was located at C2.

Interior Damage - 2002 Kia Optima

Interior damage to the Kia Optima was moderate and attributed to occupant contact and passenger compartment intrusion. The left side of the windshield was fractured by impact forces. A star-shaped fracture was found on the windshield directly forward of the steering wheel–possibly from the driver's hand. The rear view mirror was knocked off. Lateral intrusions into the driver's seating position included the left door panel, B pillar, sill, and roof. Lateral intrusions into the left rear seating position included the door panel, sill, and the seat back. The driver knee bolster was deformed longitudinally into the driver's seat position by the left side intrusion.

Figure 6. Windshield contact

Figure 7. Deformed knee bolster

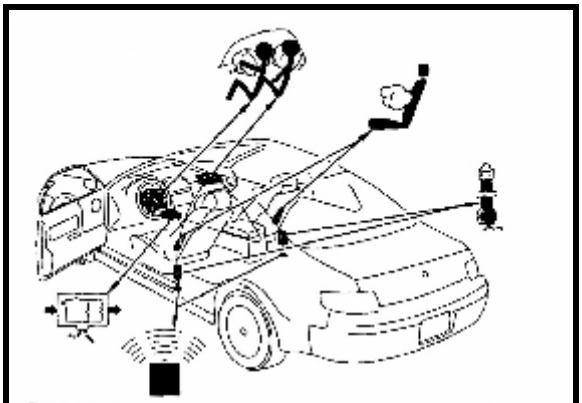
MANUAL RESTRAINT SYSTEMS - 2002 Kia Optima

The Kia Optima was equipped with three-point safety belts at all five seating positions with switchable retractors (ELR/ALR) at all but the driver's position (ELR only). The driver's seat belt was found locked, in a retracted position-- pinned/locked between the B-pillar and the seat. The vehicle was also equipped LATCH anchors and tether connections for the two rear outboard seats.

Figure 8. Driver's seat belt

AIR BAG SYSTEM - 2002 Kia Optima

The case vehicle is equipped with four air bags[2]. A driver's steering wheel mounted depowered air bag, a front right passenger's depowered air bag that is mid-mounted in the instrument panel. The vehicle is equipped with a driver's seat mounted and front right seat mounted side air bags. The driver's and front right passenger's frontal air bags did not deploy. The driver's seat mounted side air bag did deploy. It measured approximately 78.0 cm (30.7 in) long by 31.0 cm (12.2 in) wide. It was housed inside a plastic bag that was encased within a metal frame. The side air bag appeared to be tied to the back of the driver's seat. The side air bag had one tether and no vent ports. There was no evidence of occupant contact.



Component	Location
Control Module	Under Front Of Center Console
Driver Air Bag Module	On Steering Wheel
Passenger Air Bag Module	Passenger-Side Instrument Panel
Seat Belt Pretensioners	Driver & Passenger-Side Lower B-Pillars
Side Impact Air Bag Modules	Driver & Passenger-Side Front Seat Outer Seat Backs
Side Impact Sensors	Driver & Passenger-Side Lower B-Pillars

Figure 9. Case vehicle air bag system.

Figure 10. Driver's side air bag

[2] Data about the air bag system was obtained from Kia's web page and *The Rescuer's Guide to Vehicle Safety Systems, Second Edition, page 2-319*.

VEHICLE DATA - 1996 Toyota Camry

Description:	1996 Toyota Camry
VIN:	Unknown
Odometer:	Unknown
Engine:	Unknown
Reported Defects:	None noted
Cargo:	Unknown
Damage Description:	Major front end damage, per police report. Vehicle towed from the scene due to damage.
CDC:	Unknown
Delta V:	Total
	Longitudinal
	Latitudinal
	Energy

OCCUPANT DEMOGRAPHICS - 2002 Kia Optima

	Driver
Age/Sex:	19/Male
Seated Position:	Front left
Seat Type:	Fabric covered bucket seat. Seat adjusted to rear most track position. Seat back slightly reclined.
Height:	178 cm (70 in)
Weight:	66 kg (145 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Three years
Body Posture:	Normal, upright
Hand Position:	One hand on steering wheel, one using cell phone.
Foot Position:	Right foot on accelerator, left on floor board.
Restraint Usage:	Lap and shoulder belt available, not used
Air bag:	Steering wheel mounted front air bag available, did not deploy. Seat back mounted side air bag, did deploy.

OCCUPANT DEMOGRAPHICS - 1996 Toyota Camry

	Driver
Age/Sex:	49/Female
Seated Position:	Front left
Seat Type:	Unknown
Height:	157 cm (62 in)
Weight:	50 kg (110 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be > 10 years
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report.

OCCUPANT INJURIES -2002 Kia Optima

	Injury	OIC Code	Injury Mechanism	Confidence Level
Driver:	Not injured			

OCCUPANT INJURIES - 1996 Toyota Camry

	Injury	OIC Code	Injury Mechanism	Confidence Level
Driver:	Not injured			

OCCUPANT KINEMATICS - 2002 Kia Optima

The 19-year-old male driver of the Kia Optima was seated in a normal, upright fashion. He was seated in a fabric covered bucket seat that was adjusted to the rear most track position. The seat back was slightly reclined. He was not wearing the available 3-point lap and shoulder belt. It is believed that one hand (probably his left) was on the steering wheel while the other was holding a cell phone. He was engaged in a cell phone conversation at the time of the crash according to one witness. Prior to the impact, the driver had stopped his vehicle at a red light then, while the light was still red, had begun to enter the intersection. His right foot was on the accelerator and the left was on the floor. At impact, the driver responded to the 10 o'clock direction of force by pitching sharply to the left and slightly forward. He likely contacted the driver's door side panel and the deployed side air bag. There were no indications of contact to either, however. The driver did not sustain any injuries. It appears likely that the presence of the deployed side air bag was largely responsible for the lack of any injury. After this initial impact, the driver rebounded from the left side contact to the right. He was in an unknown position at the time of the second impact, but it appears that he had remained in his original seated position. At impact, he would have pitched straight forward in response to the 12 o'clock direction of force. There was a fracture contact to the windshield that might have come from the driver's left hand. The rear view mirror was knocked off possibly as a result of contact with the driver's other hand. The left lower instrument panel intruded rearward due to the left side intrusion and the driver's knees many have contacted the panel, but there were no residual contacts.

Attachment 1. Scene Diagram

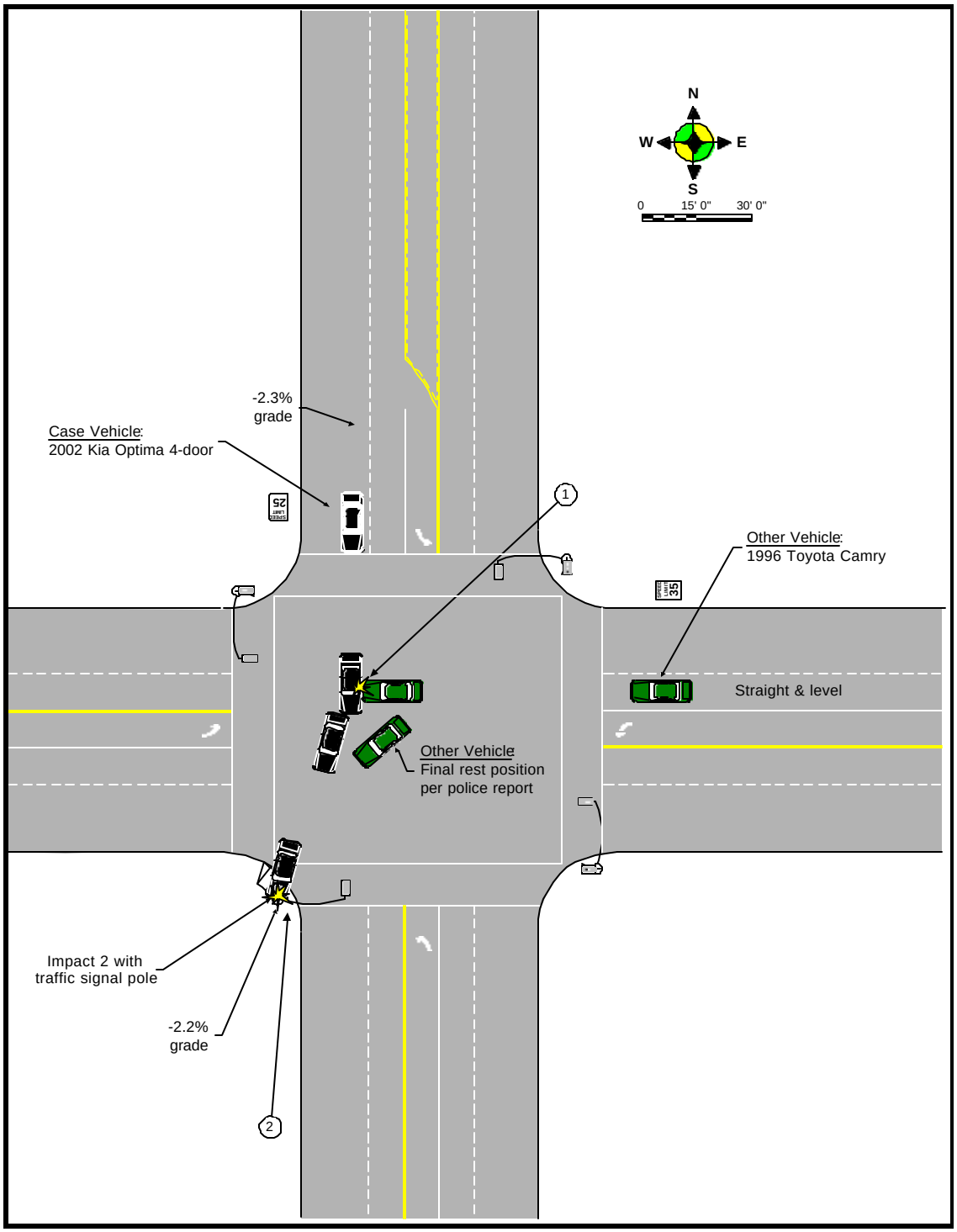


Figure 11. Scene Diagram