Wide vs. Narrow Frontal Crashes: *Do Injury Patterns Differ?*

Presenters:

Gail T. Tominaga, MD, FACS (Co-PI)

Steve Erwin (Crash Investigator)

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Presentation Objectives

- Discuss differences between wide and narrow impacts
- Present examples of wide and narrow impacts investigated by San Diego CIREN
- Compare injury experience of occupants in wide vs. narrow impacts using CIREN database
- Discuss implications for injury prevention comparing wide vs. narrow impacts

Why Study Wide vs. Narrow Impacts Using CIREN Data?

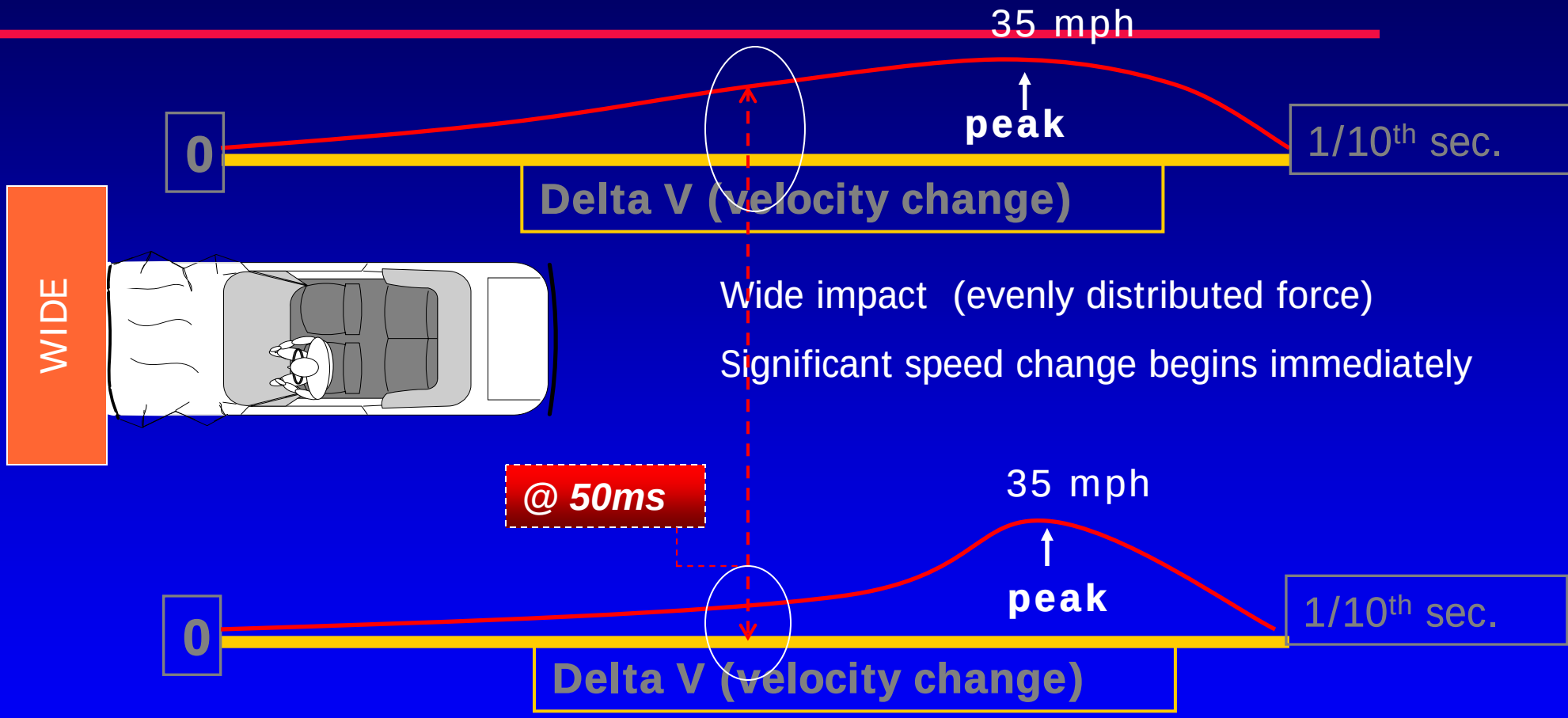
- NHTSA frontal crash test: "head on" into fixed barrier to assess safety system effectiveness
  - Not tested on narrow impacts
- Delta T differs for wide and narrow impacts
- Real world experience provides information on safety system effectiveness during narrow impacts

Definitions

- **Narrow impact**
  - 6th column of CDC="N"
  - Damage distribution across frontal plane < 41 cm
- **Wide impact**
  - 6th column of CDC="W" and 4th column of CDC="D"
  - Wide damage distribution across 66% of frontal plane

Deceleration pulses Wide

vs. Narrow Impacts (Delta V / Delta T)



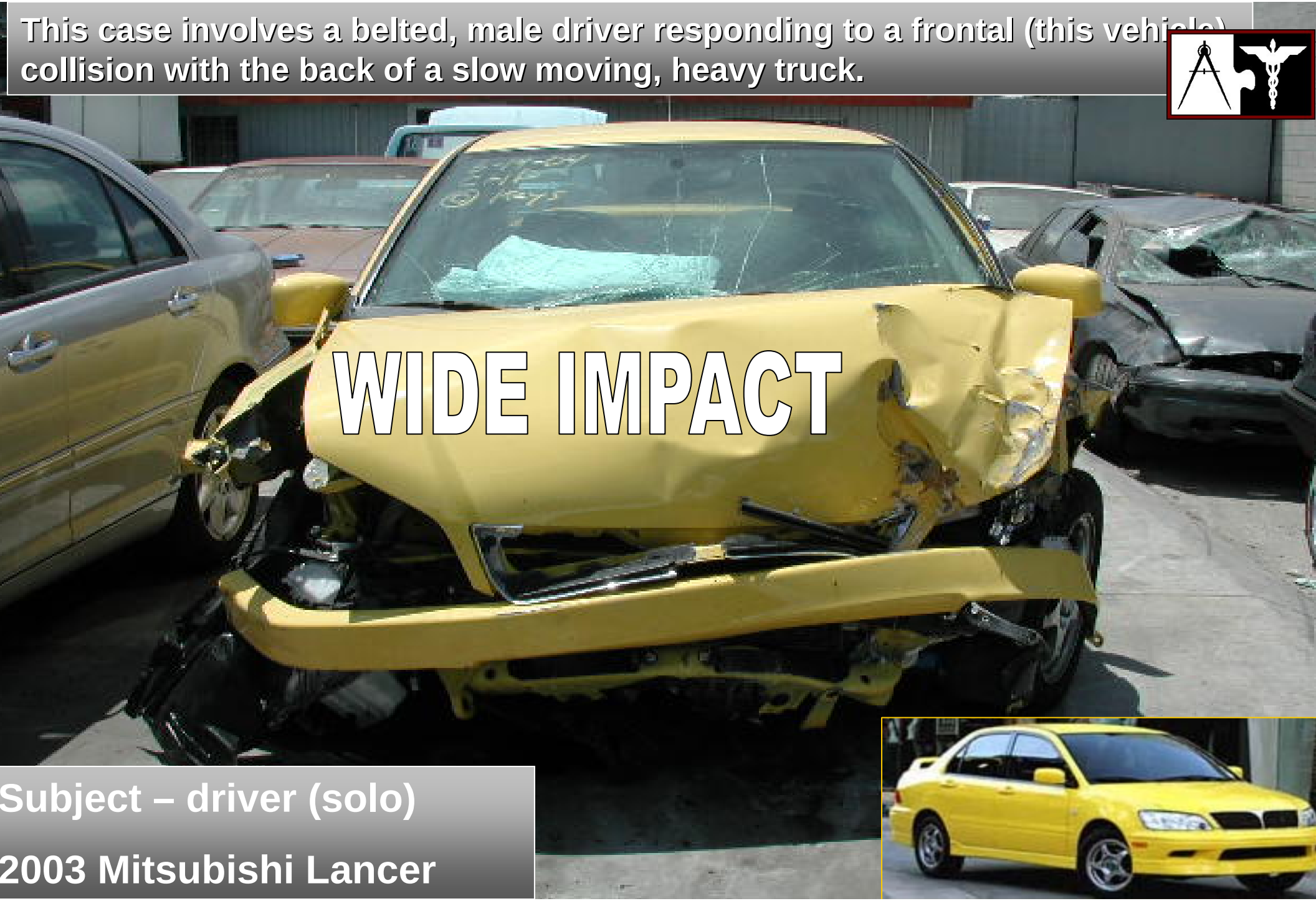
Wide impact (evenly distributed force)

Significant speed change begins immediately

Narrow impact (focalized force)

Significant speed change is delayed until enough resistance is built up

This case involves a belted, male driver responding to a frontal (this vehicle) collision with the back of a slow moving, heavy truck.



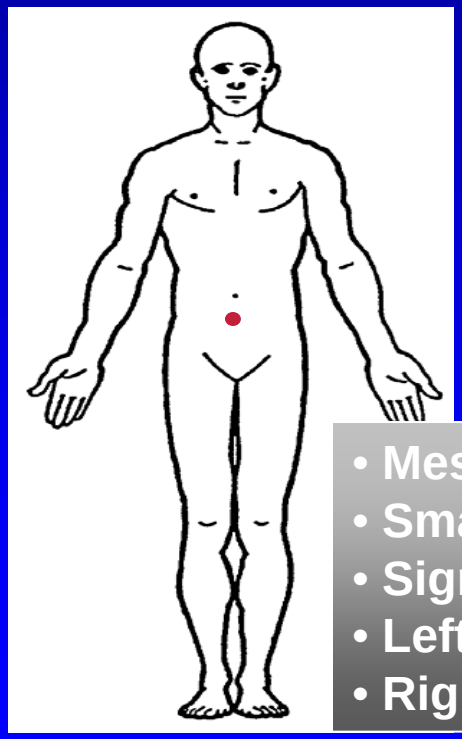
Subject – driver (solo)

2003 Mitsubishi Lancer

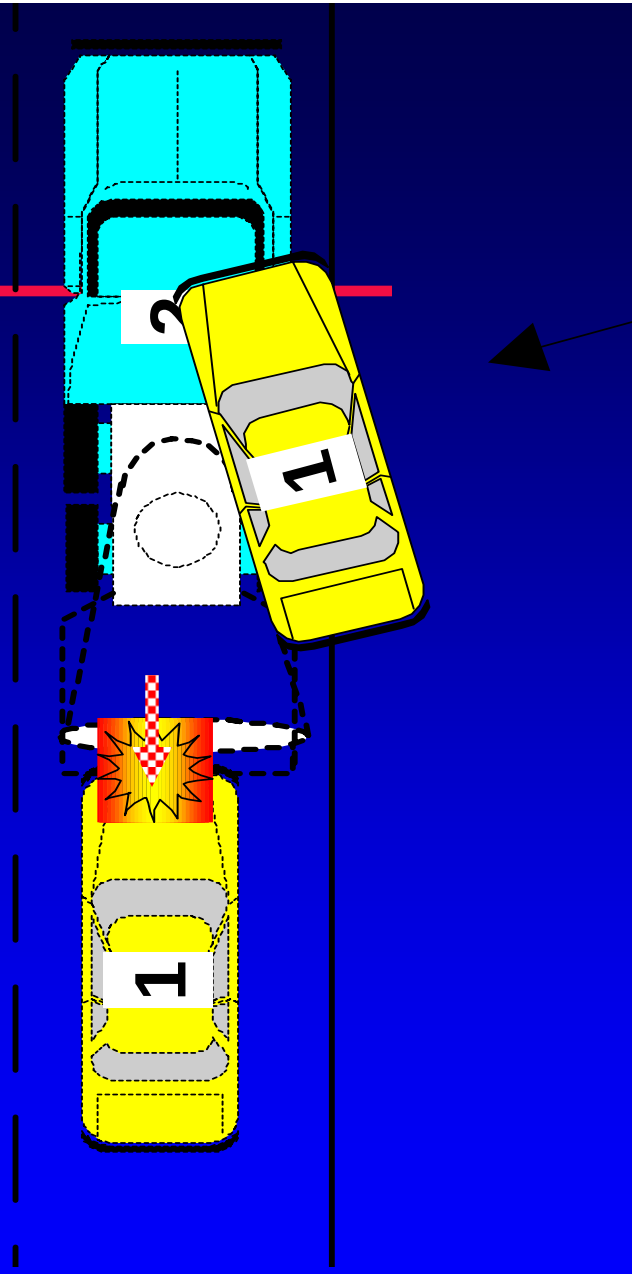
Driver – sole occupant

21yo male, 6’2”, 205 lbs

Pretensioner equipped belt used, frontal impact air bag(s) deployment. Bucket seat between mid & rear, slightly reclined. Cushion twisted to right, seat back twisted to left due to remote buckling



12:00 PDOF



- **Mesenteric arterial avulsion**
- **Small bowel avulsion**
- **Sigmoid colon “degloving” injury**
- **Left testicular artery and vein laceration**
- **Right rectus muscle partial transection**

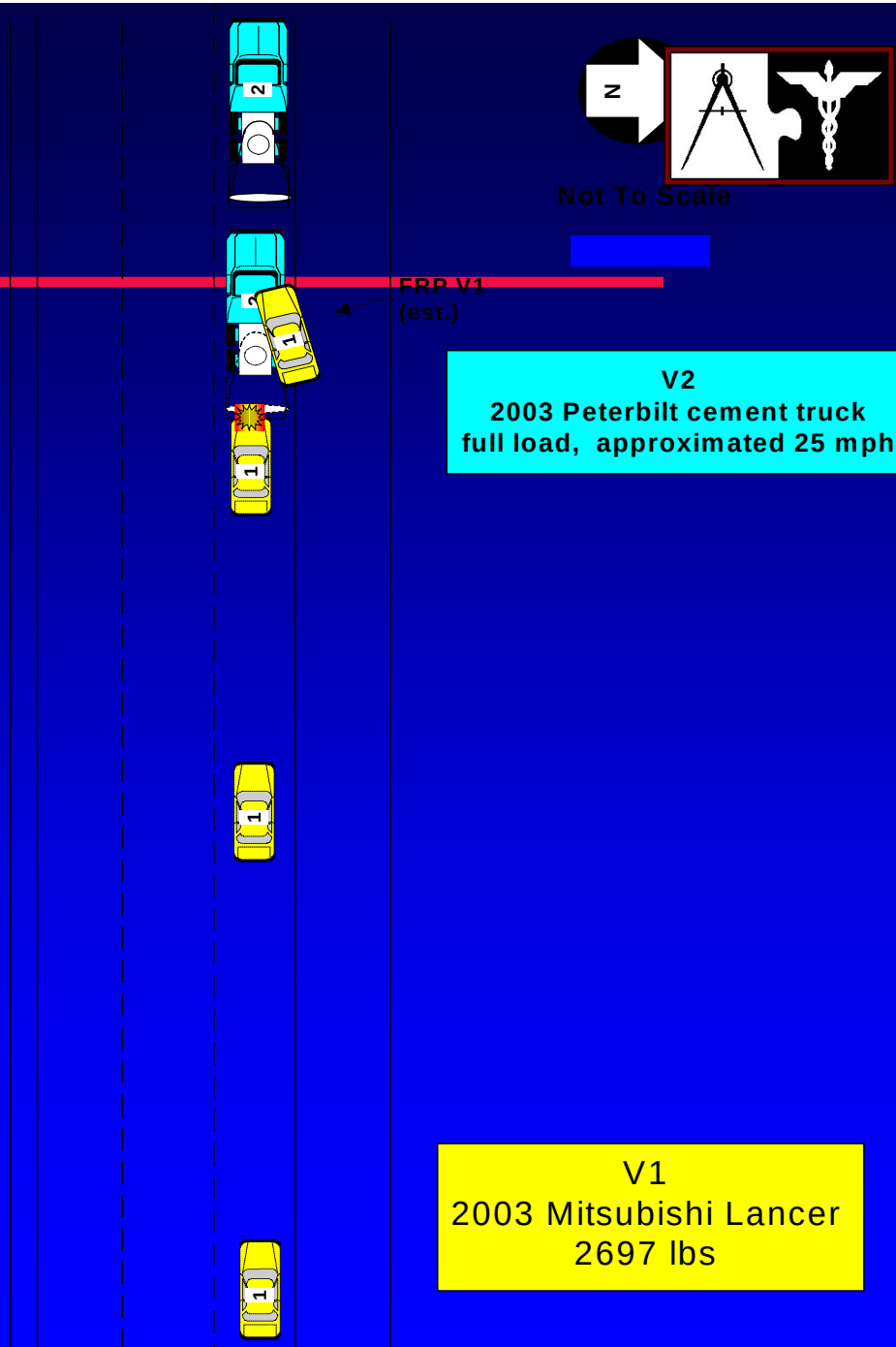
Crash: 1 event

- Frontal to Vehicle – Back plane
full end plane impact

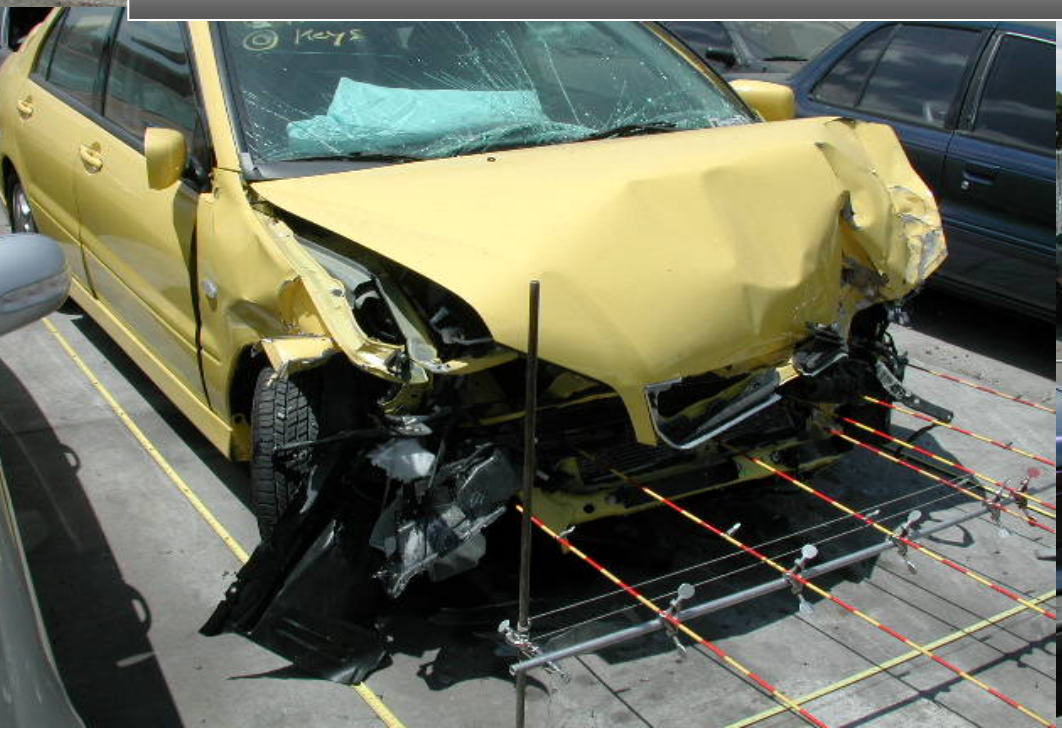
- Case vehicle
2003 Mitsubishi Lancer
4-door sedan, 2697 lbs.
12:00 PDOF (Zero-degrees)
54 kmph BES **DV** (**34 mph**)

- Opposing vehicle (V2)
2003 Peterbilt 3-axle “cement truck” nfs.
Heavy Truck, full load, > 10,000 lbs GVWR

- 6:40 am, Saturday, cloudy, dry, daylight



2002 Mitsubishi Lancer / 54 cm Max. crush / 34 mph DV / 12:00 PDOF



Direction of travel

POI


Transfer on bag (skin?)


Sheared completely


Contact: lower dash/bolster, belt, air bag, steering assembly

Pretensioner locked

Friction burns @ ‘D’ ring

Wide Impact CIREN Case

Right lower abdominal abrasion

Left lower abdominal abrasion

Toe pan intrusion 5 cm

Wide Impact CIREN Case

- 21 year old male, 6’2”, 205 lbs
- MAIS 4, ISS 17
- Ground transport to ED with complaint of pain
- US and DPL positive ⇨ OR ½ hour after arrival
- Multiple operative procedures
  - Exploratory laparotomy, repair of partial transection of right rectus muscle
  - Ligation of mesenteric arterial bleeds, left testicular artery, and left testicular vein
  - Small bowel resection with primary anastomosis
  - Sigmoid colon resection with primary anastomosis

Wide Impact Case: Injury Sources

- **Abdomen**
  - AIS 3-4 Major lac of arteries and veins (safety belt)
  - AIS 4 Massive (OIS Grade IV/V) jejunum-ileum lac (safety belt)
  - AIS 4 Massive (OIS Grade IV/V) colon laceration (safety belt)
  - AIS 1 Contusions and abrasions

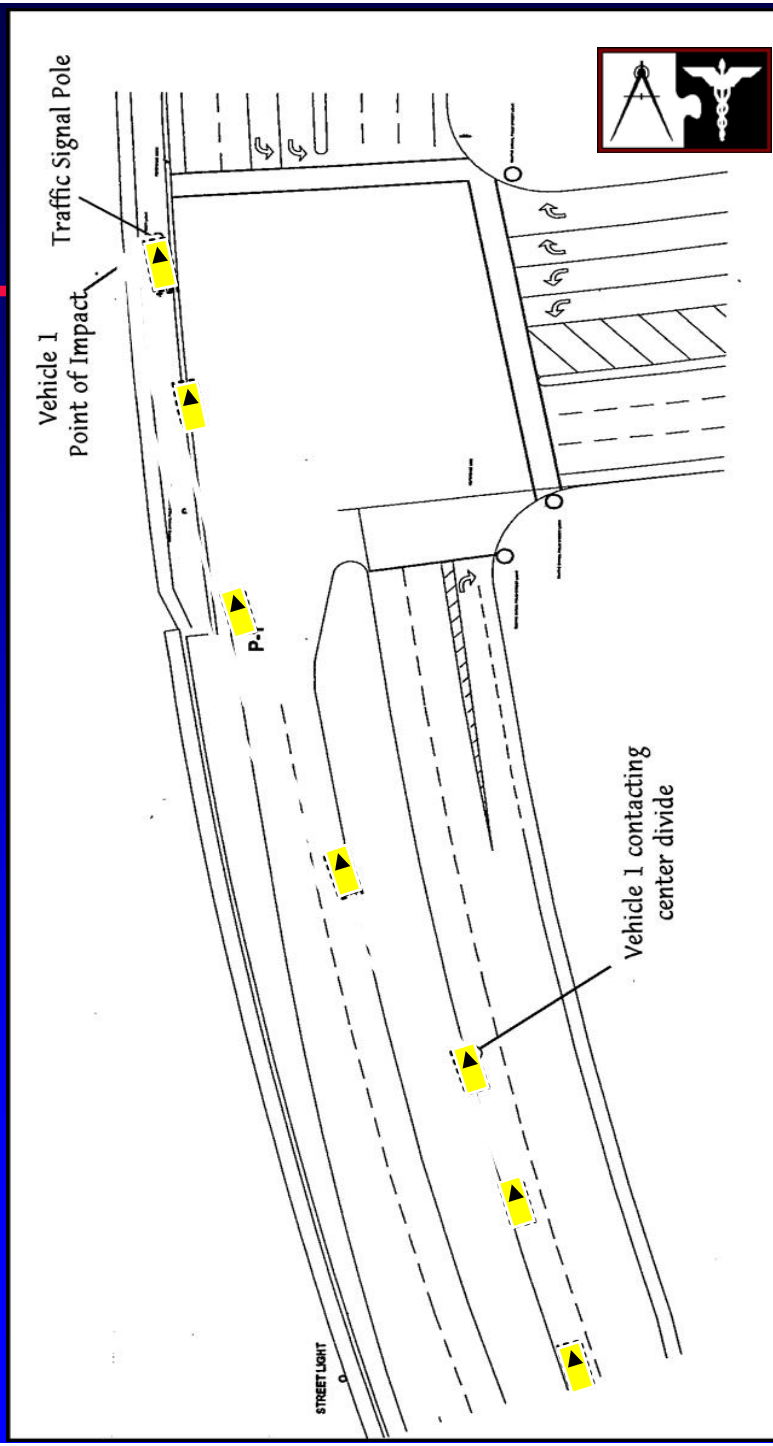

This case involves a belted driver responding to a narrow frontal impact into a rigid object with frontal impact air bag deployment
Subject – Driver
1996 Nissan Sentra
NARROW IMPACT

Crash: 1 event

- Narrow front to rigid object
30cm steel, non-breakaway utility pole, not damaged

- Case vehicle
1996 Nissan Sentra
4-door sedan, 2315 lbs., 100” wheelbase
12 o’clock PDOF
WinSmash dV = 66 mph

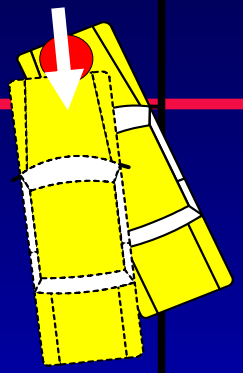
- 1:54 am, Saturday, clear, dry dark-street lights

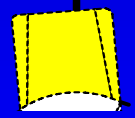


Subject – Driver (sole occupant)

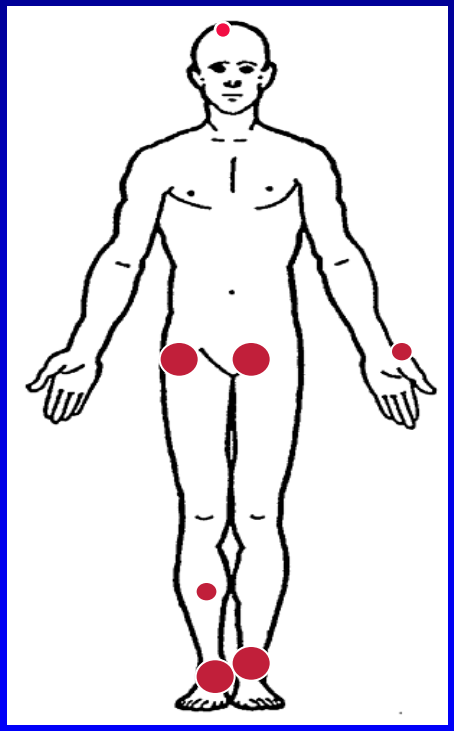
30-year-old male, 5’10”, 200 lbs. Belt used, frontal impact air bag(s) deployed.

12:00 PDOF





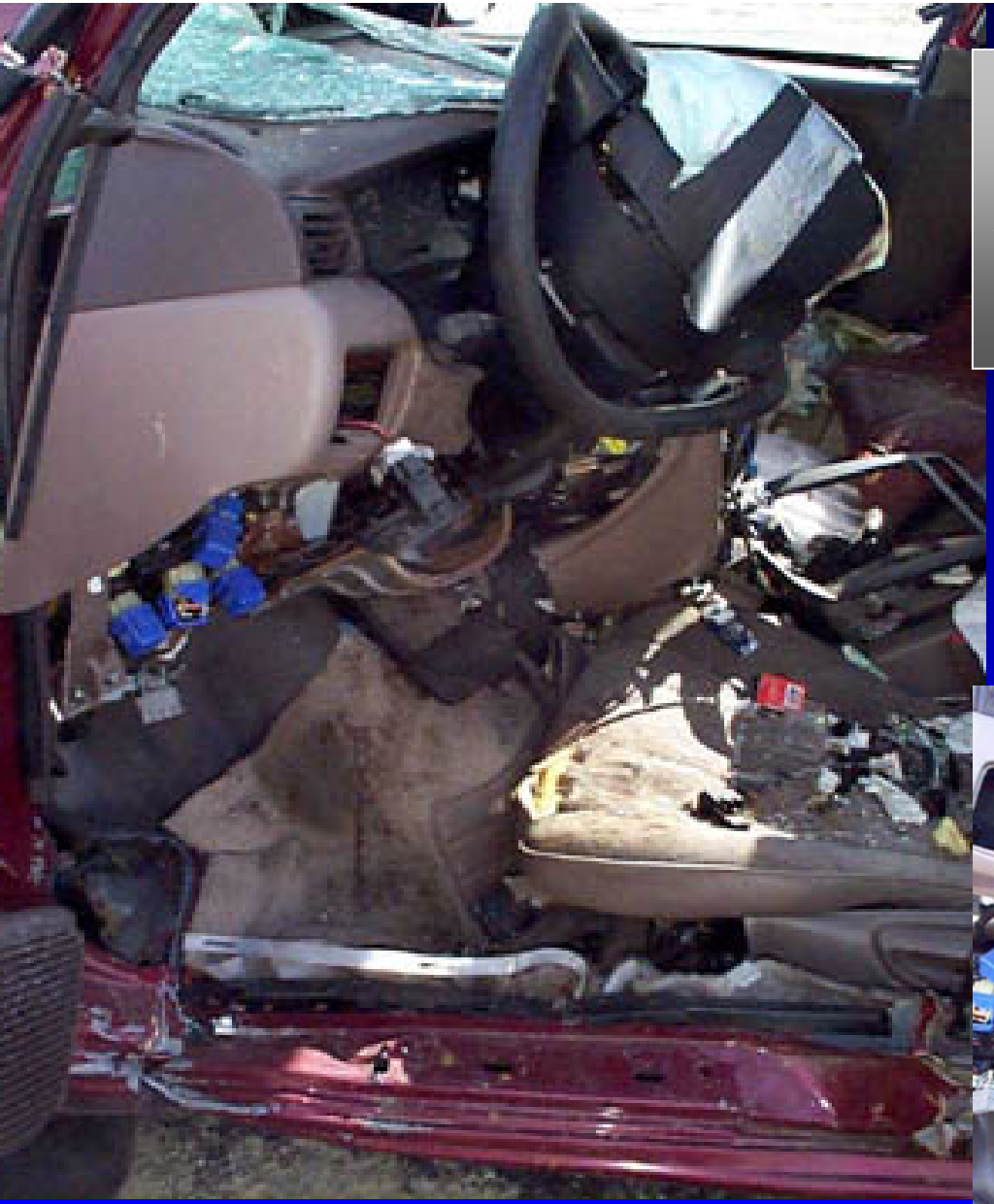
- R - internal pudenal artery laceration
- R - acetabulum fracture
- R - posterior tibial artery and vein transection
- R - fibula mid shaft fracture, nondisplaced, minimal angulation
- Concussion w/ LOC < 1 hour (CT negative)



- Multiple R - foot fractures and soft tissue injury
- L - extensive diastasis sacroiliac joint and pubic symphysis w/ retroperitoneal hematoma
- L - iliolumbar artery laceration
- L - distal tibia/fibula
- L - medial malleolus
- L - calcaneous fracture
- L - hand laceration w/ extensor tendon lacerations

1996 Nissan Sentra / Max. crush = 135 cm / 12:00
PDOF / 66mph dV (stvz 45mph)

Left: dash (32), toe pan (86), steering assembly (31), A-pillar, floor pan (15) intrusion.



Contacts:

knee bolster (L & R), steering assembly, belt, floorboard (pedals)

Right Foot

Left medial malleolus fracture

Right Calcaneous Fracture

L - Sacroiliac Joint Diastasis

Narrow Impact CIREN Case

- 30 year old male, 5’11”, 201 lb, MAIS 4, ISS 34
- 45 minute extrication ⇨ helicopter transportation
- Multiple operative procedures
  - Pelvic angioembolization: gelfoam embolism R-internal pudenal artery, coil embolism L-iliolumbar branches
  - Exploratory laparotomy
  - ORIF symphysis pubis
  - Irrigation & debridement w/splinting open heel injury
  - Vascular grafting L-tibial artery transection
  - External fixation R-foot and ankle
  - Irrigation & debridement L-hand w/repair of 3rd & 4th digit extensor tendons
  - Closed reduction L-pilon fracture w/ internal and external fixation
  - Closed reduction, percutaneous screw fixation L-sacroiliac joint dislocation
- Hospital length of stay 24 days, discharged to extended care facility

Narrow Impact Case: Injury Sources

- **Head**
  - AIS 2 LOC < 1 hour (Air bag)
- **Upper extremity**
  - AIS 1 Multiple hand tendon lacerations (IP)
- **Abdomen**
  - AIS 4 Major laceration iliac artery (Steering wheel)
  - AIS 3 Minor laceration other named arteries (IP)
- **Lower extremities**
  - AIS 3 Skin laceration w/ blood loss >20% volume (IP)
  - AIS 3 Symphysis pubis diastasis (Floor/toe pan)
  - AIS 3 Open, displaced, comminuted tibia shaft fx (Floor/toe pan)
  - AIS 3 Laceration arteries/veins (IP)
  - AIS 2 Closed pelvic fractures (Floor/toe pan)
  - AIS 2 Calcaneal fracture (Floor/toe pan)
  - AIS 2 Talus, Metatarsal/Tarsal fracture and traumatic arthrotomy (Floor/toe pan)
  - AIS 2 Fibula fracture (head/neck/shaft) (Floor/toe pan)
  - AIS 2 Medial malleolus tibia fracture (IP)

CIREN Database

Used to compare injury patterns for wide vs. narrow impacts

- Regions injured
- Within regions, compare severity and sources
- Specific injuries for selected regions

Study Criteria

- Frontal impact
  - PDOF=12 o'clock and GAD=F
  - Ranked #1 impact by Crash Investigator
  - Wide: damage distribution $\geq$ 66% of frontal plane
  - Narrow: damage distribution < 41 cm

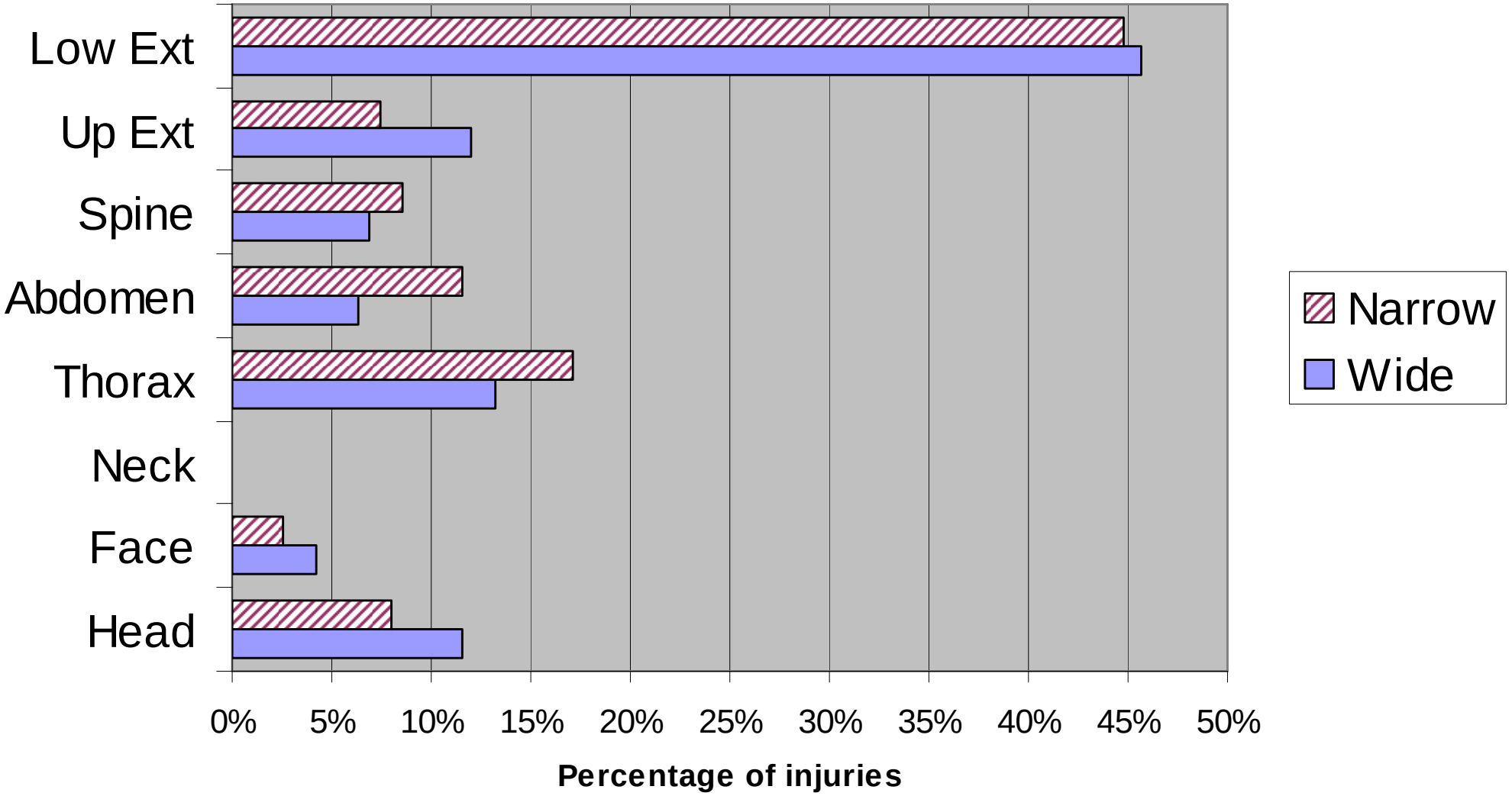
Study Criteria

- Inclusion criteria
  - Safety belt use
  - Frontal air bag deployment during impact
  - AIS $\geq$ 2 injury severity
- Exclusions criteria
  - Children (<13 yrs)
  - Passengers
  - Open cases

CIREN Cases

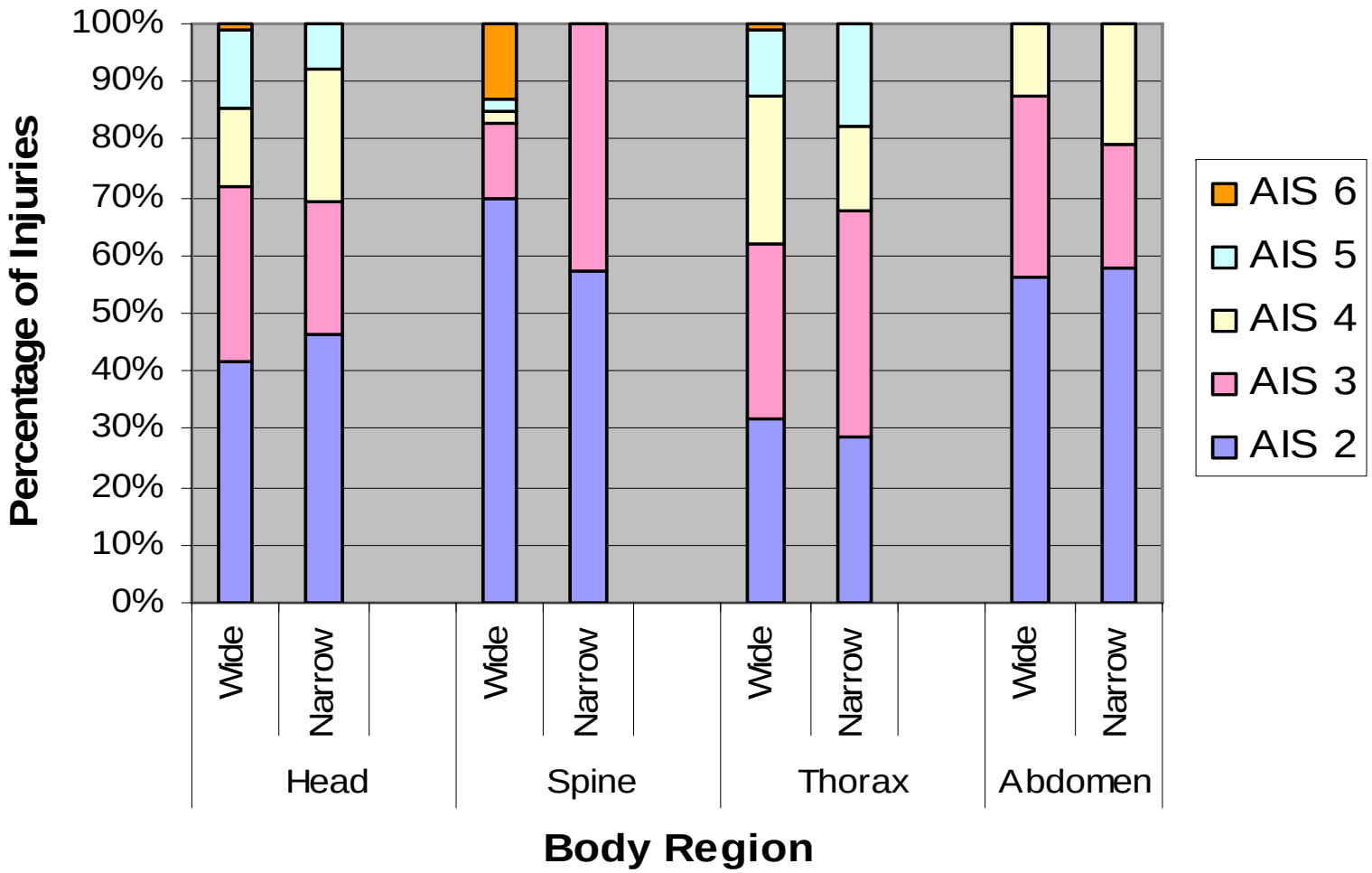
- **Wide Impacts: N =141**
  - Mean age=43, Median age=41 (range: 16-80 yrs)
  - Mean ISS=19, Median ISS=14 (range: 5-75)
  - Mean delta V=49, Median=47 (range: 14-92 kmph)
- **Narrow Impacts: N = 35**
  - Mean age= 46, Median age=47 (range:17-86 yrs)
  - Mean ISS= 17, Median=14 (range: 5-43)
  - Mean Delta V=52, Median= 47 (range: 22-113 kmph)

Occupant Injury Regions



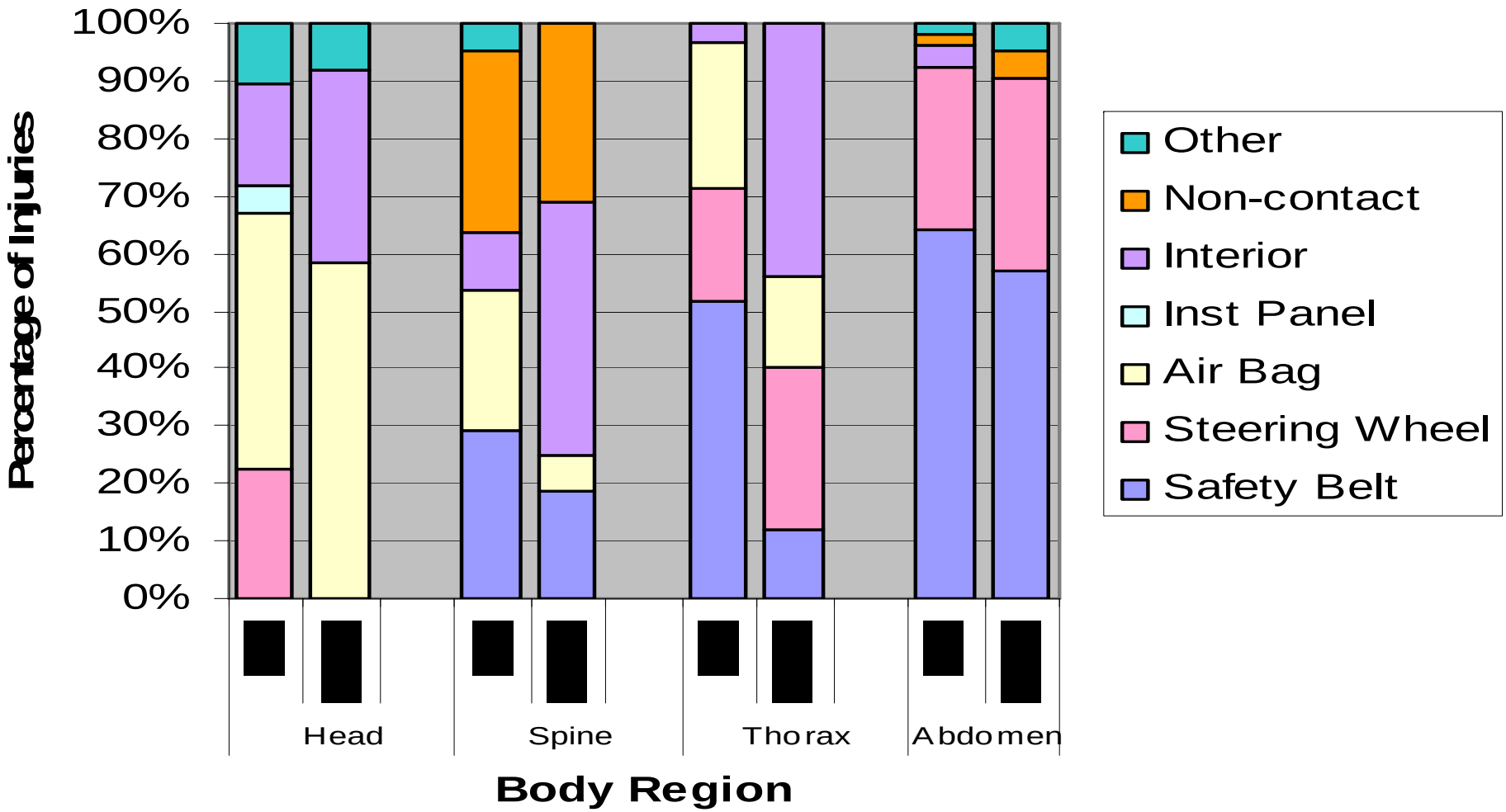
WIDE vs. NARROW FRONTAL CRASHES

Injury Severity by Body Region



WIDE vs. NARROW FRONTAL CRASHES

Injury Sources

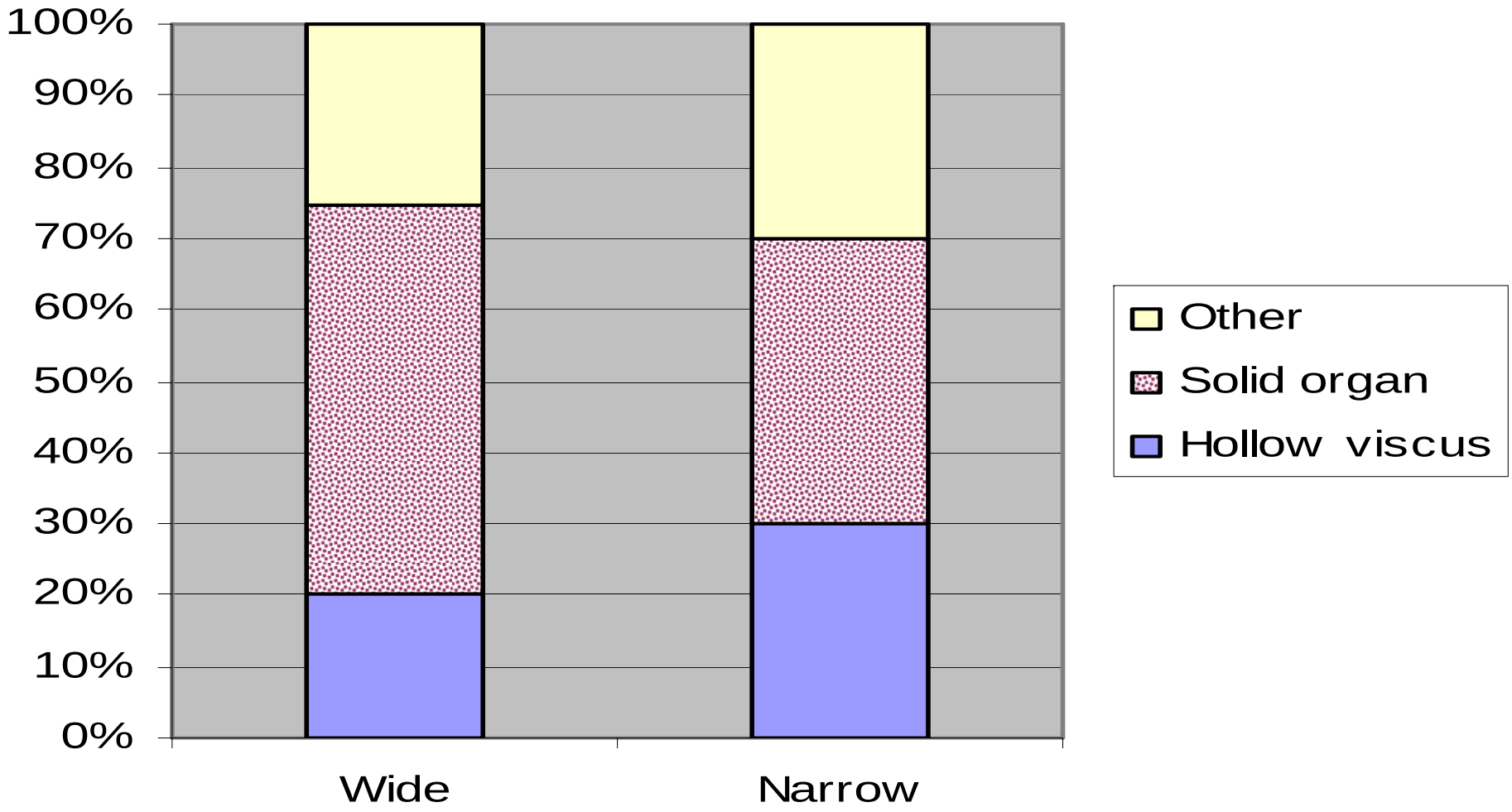


WIDE vs. NARROW FRONTAL CRASHES

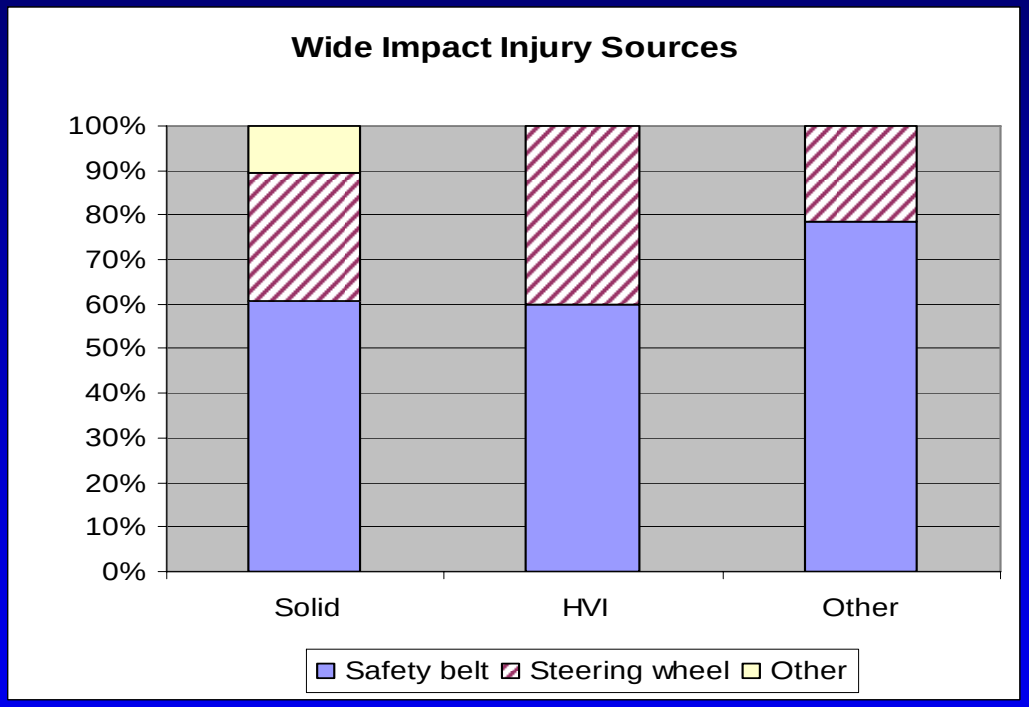
Injury Patterns

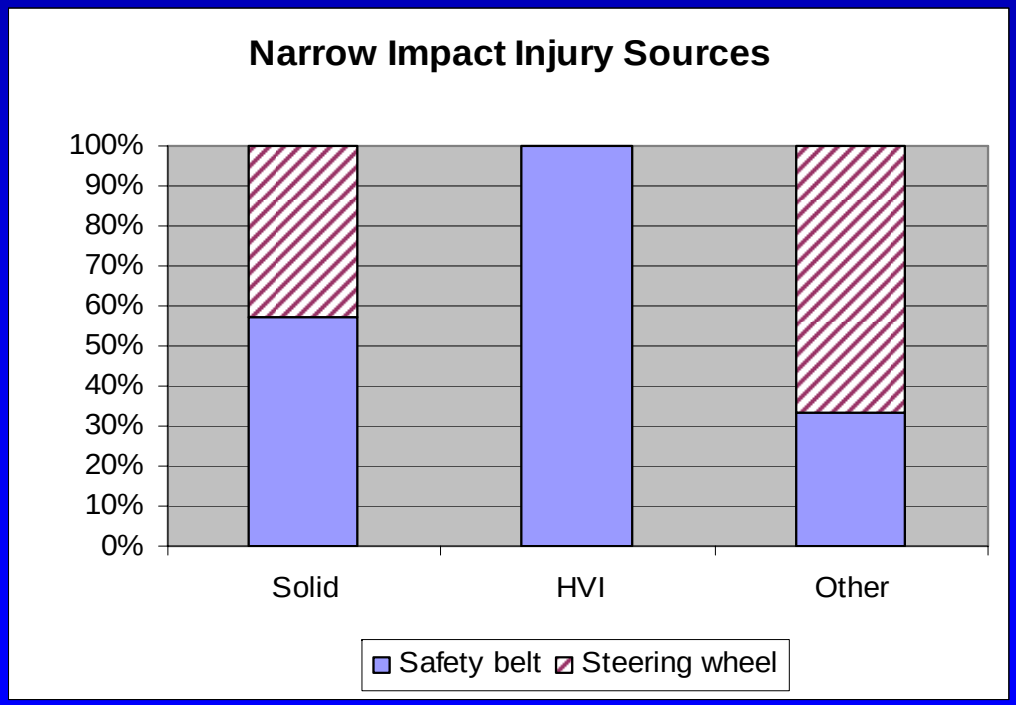
- Head
- Thorax
- Abdomen*
  - Wide impact ⇨ Solid organ injury
  - Narrow impact ⇨ Hollow viscus injury

Abdomen injuries



Source of Injuries





WIDE vs. NARROW FRONTAL CRASHES

Differences in Abdominal Injury

	Wide	Narrow
Abdominal injury	Solid organ	Hollow viscus
Seatbelt use & air bags	100%	100%
Age (years)	Mean 43, Median 41	Mean 46, Median 37
ISS	Mean 19, Median 14	Mean 17, Median 14
Death	11%	3%
Type of Auto = Car	77%	74%
Object hit	78% moving auto	89% pole or tree
Delta T	Evenly distributed	Focalized

Summary

- Different injury patterns observed for some regions
  - Wide impacts have more head and upper extremity injuries
  - Narrow impacts have more abdomen and thoracic injuries
  - Wide impacts have more solid organ abdominal injuries compared to narrow impacts with more hollow viscus injuries
- Wide impacts result in greater injury severity for each region except the abdomen
- Different patterns of injury sources observed for some regions comparing wide vs. narrow impacts
  - Implications for vehicle and safety system design to prevent injury
- Needs further study as more CIREN cases become available

San Diego CIREN Team

Principal Investigators

Raul Coimbra, MD, FACS (UCDS)

Gail T. Tominaga, MD, FACS (Scripps Memorial La Jolla)

Team

Sharon Pacyna, RN, BSN, MPH

Steve Erwin

Carol Conroy, MPH, PhD

MarSue May, RN, BSN

Barbara Frasier