Sled Tests and CIREN Data Illustrating the Benefits of Booster Seats

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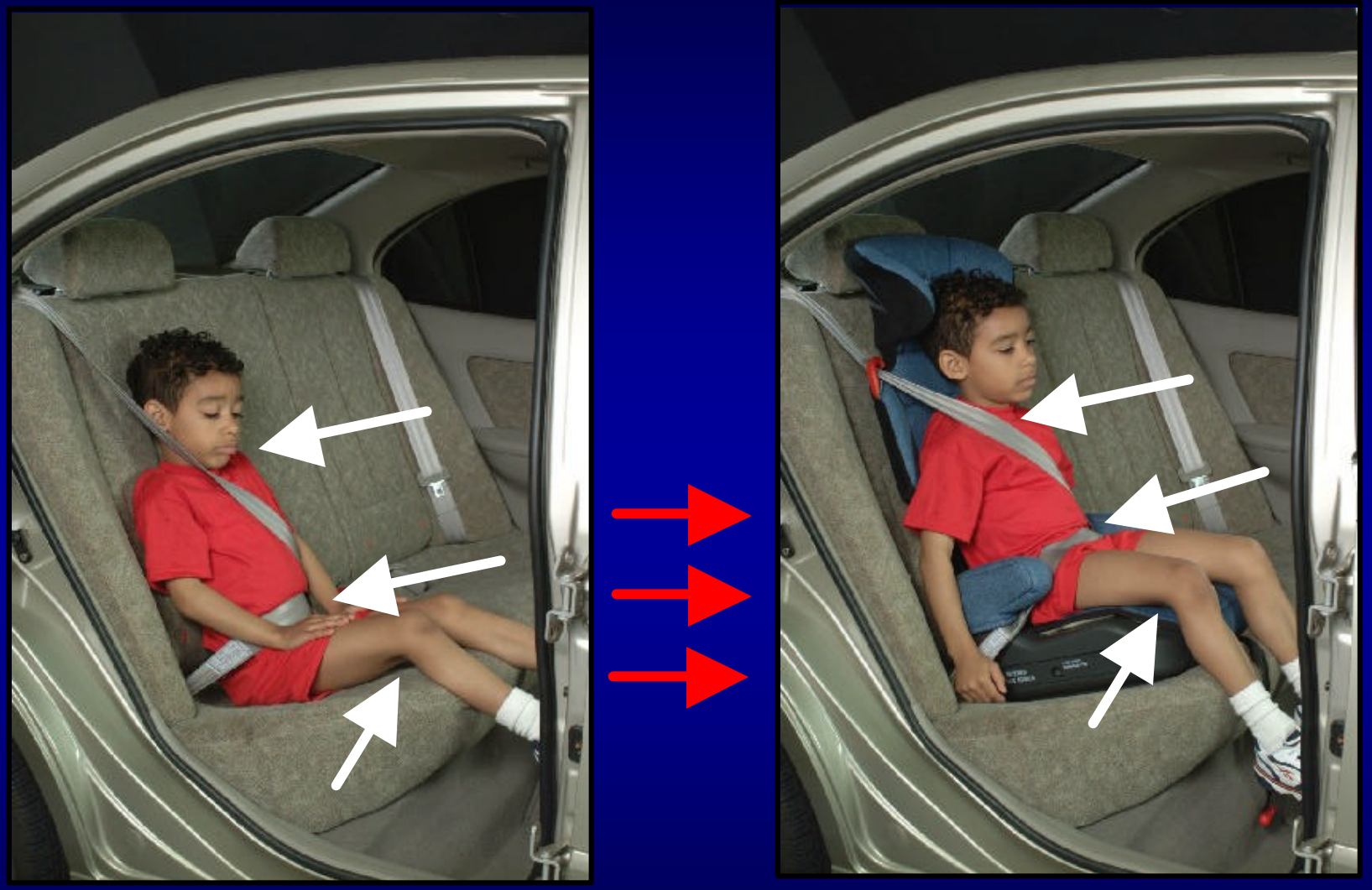
Vehicle belts are not designed for children

Purpose of Booster Seats – Improve Fit



Photos courtesy of IIHS

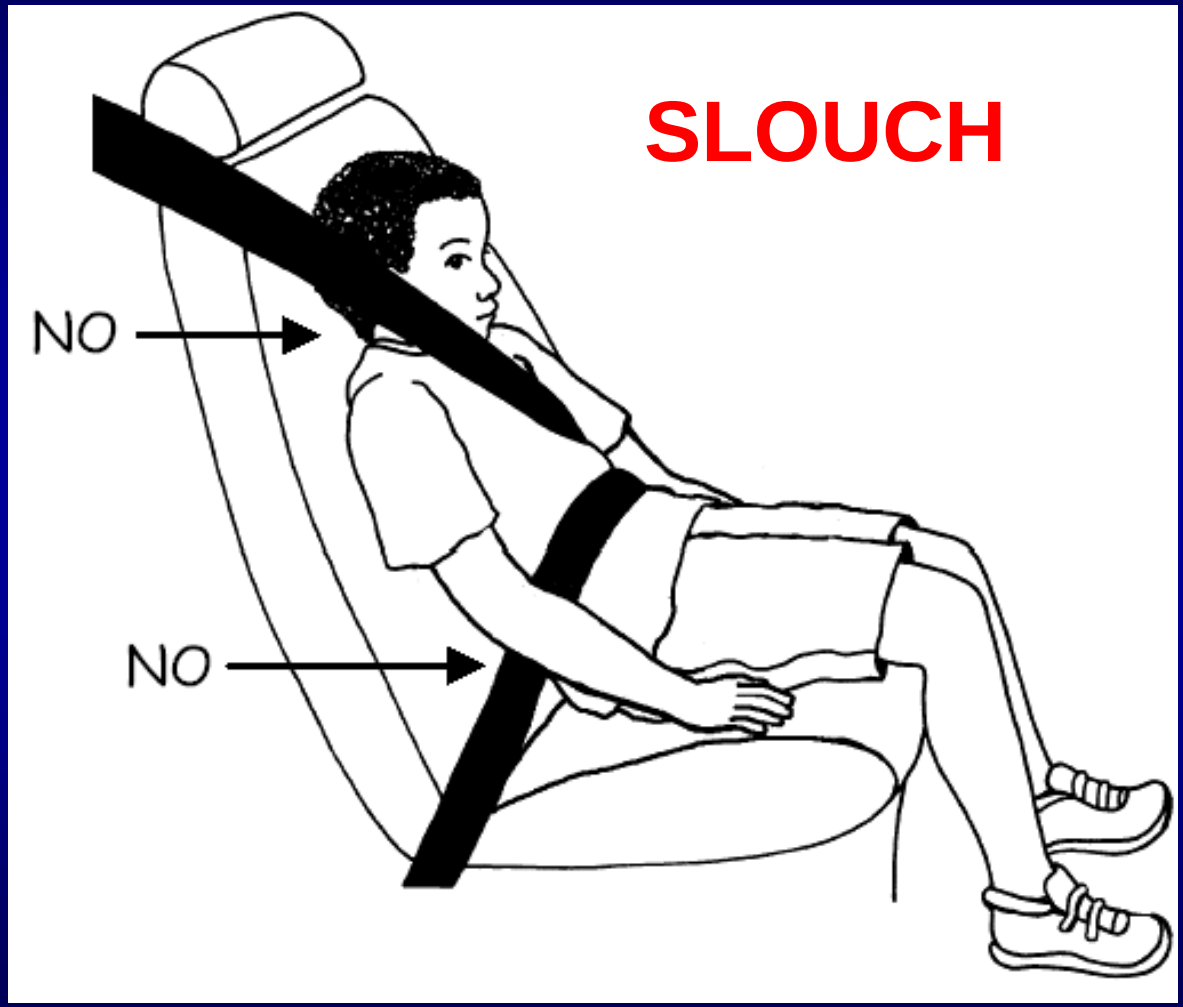
Purpose of Booster Seats – Reduce Misuse

Shoulder Belt Behind Back

Shoulder Belt Under Arm

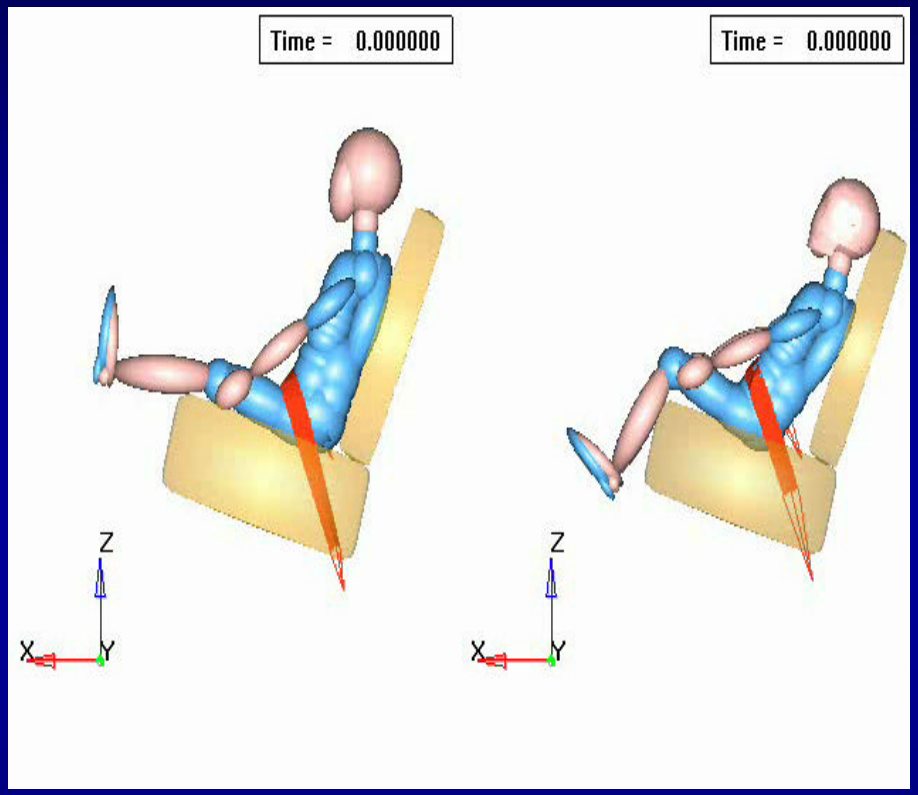
Photos courtesy of NHTSA

Purpose of Booster Seats – Reduce Misuse



Drawing courtesy of
SafetyBeltSafe U.S.A.

Purpose of Booster Seats – Reduce Misuse



Seatbelt Syndrome

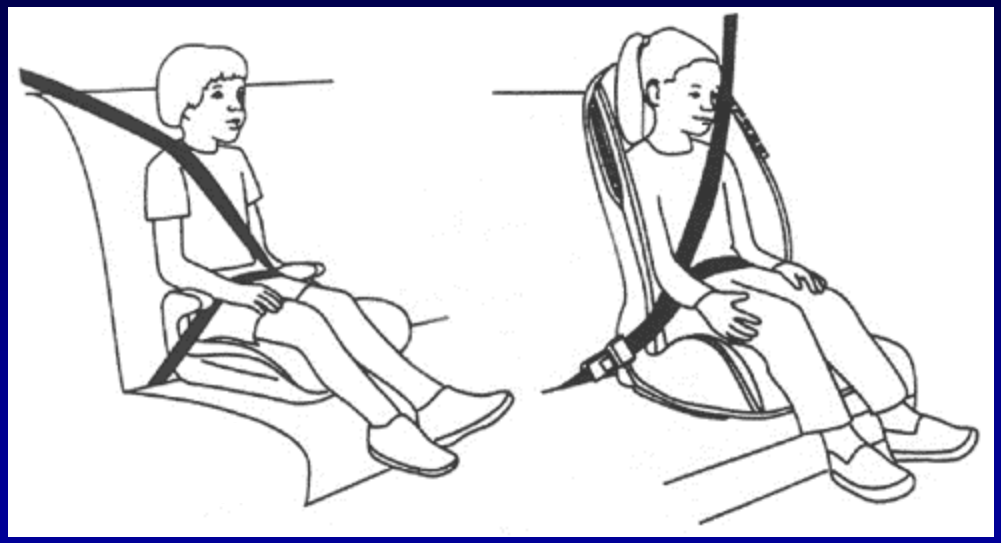
Large excursions

Head injury

Submarining

Abdominal and Lumbar Spine injury

Types of Booster Seats



Low Back or Backless Booster

High Back Booster

Shield Booster *No Longer Recommended*

Booster seats recommended for children 4-10 years old

Stature (seated height) more important than age, weight

Height of 4’9” – appropriate for vehicle belt only

Drawings courtesy of NHTSA

Objectives

To compare Booster Seat and Misuse restraint conditions

Sled Tests

CIREN data

Sled Tests

- Similar to FMVSS 213
- 48 km/h (30 mph) impact speed
- 3rd row bench seat, Windstar minivan
- Hybrid III 6 year old dummy

High Back | Low Back | Three Point | SB Behind Back | SB Under Arm

With and Without 2nd Row Seat

Shoulder Belt Misuse

Shoulder Belt Behind Back (SBBB)

Shoulder Belt Under Arm (SBUA)

No slouch in dummy, ideal seat belt positioning

High Back Booster

Three-Point Belt

Shoulder Belt Under Arm

Shoulder Belt Behind Back w/ 2nd Row Seat

Sled Tests - Results

- High Back Booster, Low Back Booster, Three-Point Belt all had head excursion less than FMVSS 213 standard of 72 cm
- Shoulder Belt Behind Back – 92 cm
- Shoulder Belt Under Arm – 73 cm
  - Underestimate due to stiff thoracic spine of dummy

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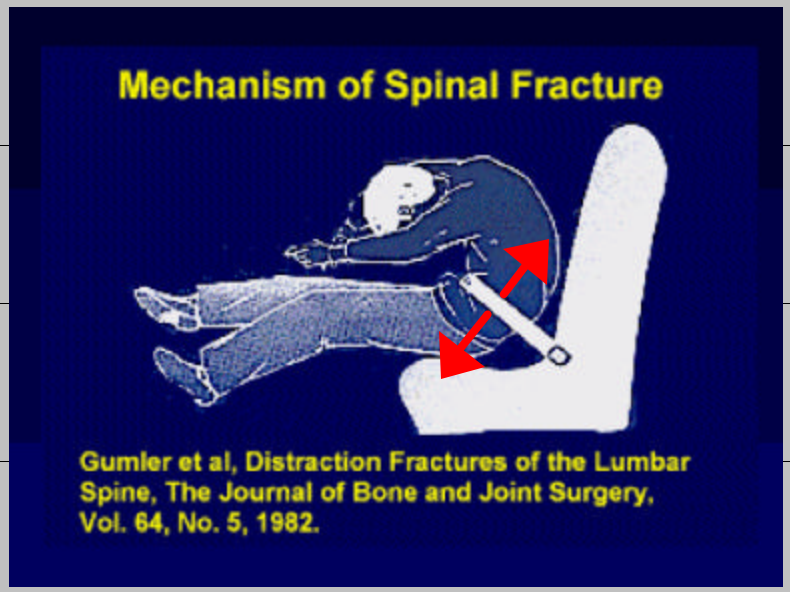
Sled Tests - Results

- Shoulder Belt Under Arm
  - Highest chest deflection – 58 mm
  - Positioned over abdomen during peak belt load – 4000 N

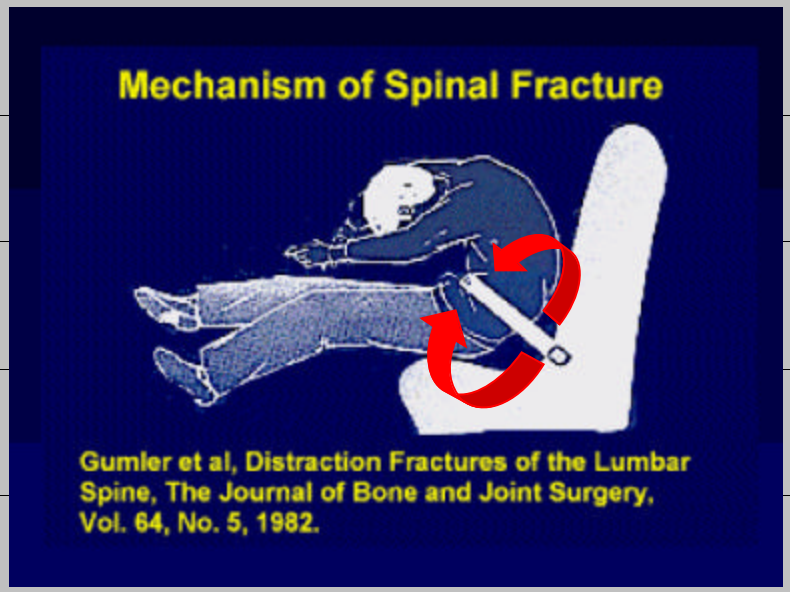
Lumbar Tension (N)



6000
5000
4000
3000
2000
1000
0

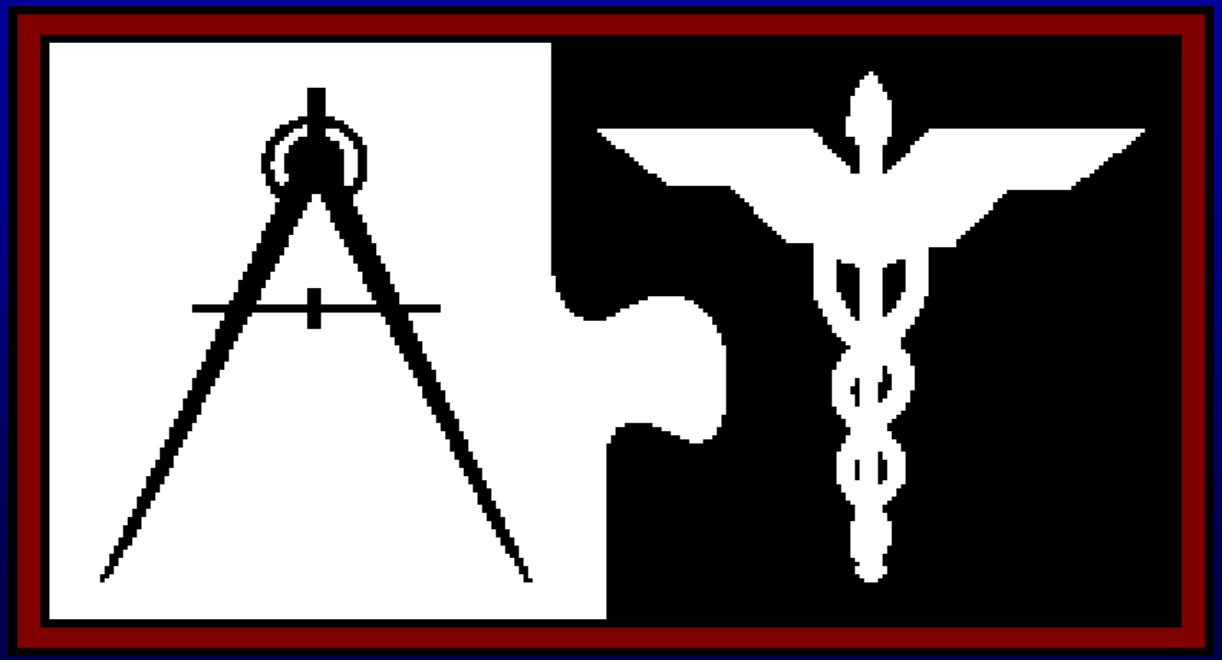
HBB
LBB
Three-Point
SBBB
SBUA

Lumbar Flexion Moment (Nm)



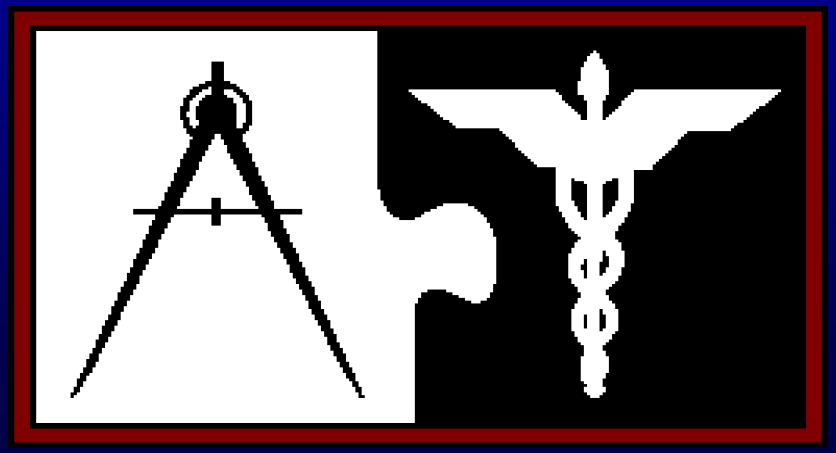
CIREN Data

- 4-11 years
- 18 kg or greater
- 148 cm or shorter
- AIS 2+ injuries
  - Excluding extremities
- Frontal Crashes
- Vehicle belt
  - With or Without Booster
  - With or Without Other Restraint Misuse
- No exposure to airbag



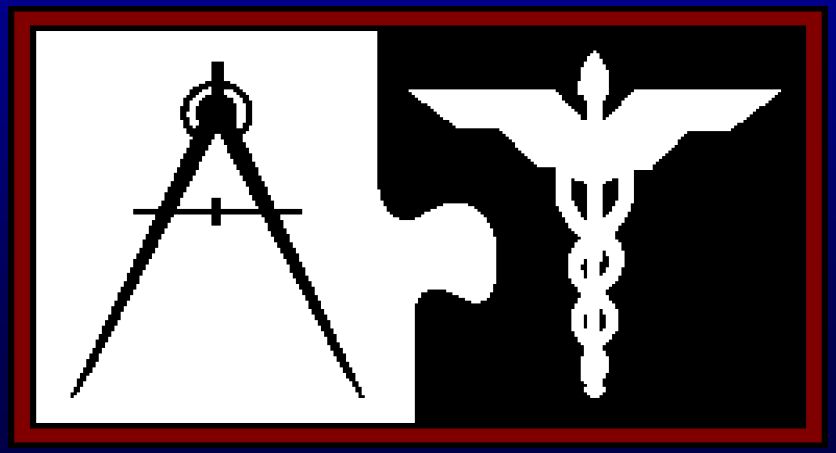
CIREN Data

- 34 cases in CIREN which met inclusion criteria
  - **Shoulder Belt Behind Back – 13**
  - **Lap Belt Only – 10**
  - **Lap and Shoulder Belts Used “Correctly” – 7**
  - Other Improper Use – 3
  - Booster Seat - 1



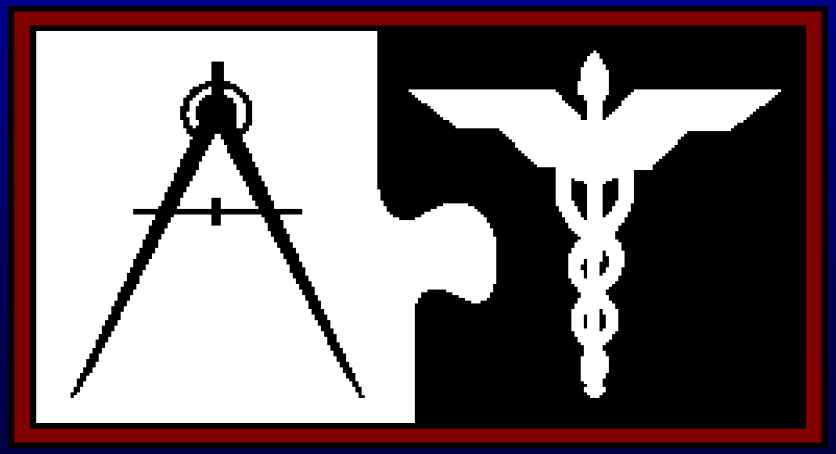
CIREN Data

Restraint	Average Age (months)	Average Delta V (km/h)	Average ISS
Shoulder Belt Behind Back	79	40	17.4
Lap Belt	83	42	16.0
Three-Point	86	38	6.7



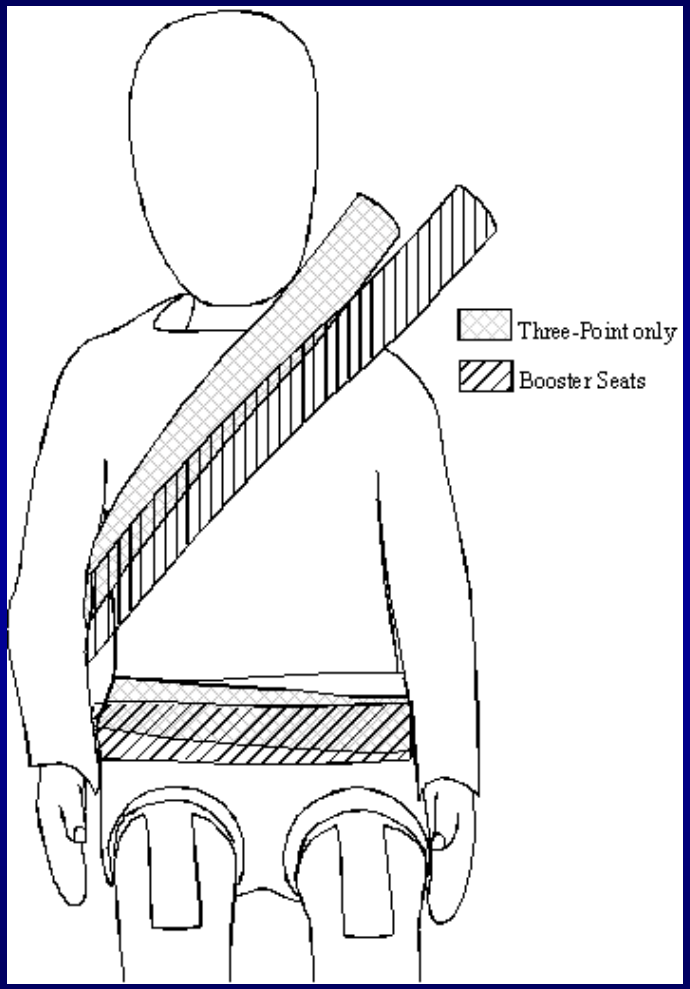
CIREN Data

Restraint	Head/Face AIS 3+	Abdomen	Cervical Spine	Lumbar Spine
Shoulder Belt Behind Back	39%	54%	23%	31%
Lap Belt	88%	70%	10%	40%
Three-Point	—	29%	—	14%



Discussion – Sled Tests

- Shoulder belt misuse - increased head excursion
- Misuse of shoulder belts resulted in high Lumbar Spine loads
- No submarining – due to optimal positioning of belts and questionable biofidelity of dummy pelvis
- Data should not be used to suggest that Three-Point belt is safe



Discussion – CIREN data

- ISS values higher in children with shoulder belt misuse
- More abdominal injuries with misuse
- More severe head injuries with misuse
- Data consistent with recent literature (Durbin et al. 2003, Nance et al. 2004) that misuse of shoulder belt increases injury risk, particularly to abdominal organs

Acknowledgements

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INSURANCE INSTITUTE
FOR HIGHWAY SAFETY

Thank You

Children's
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