

Oblique Testing with PMHS and WorldSID

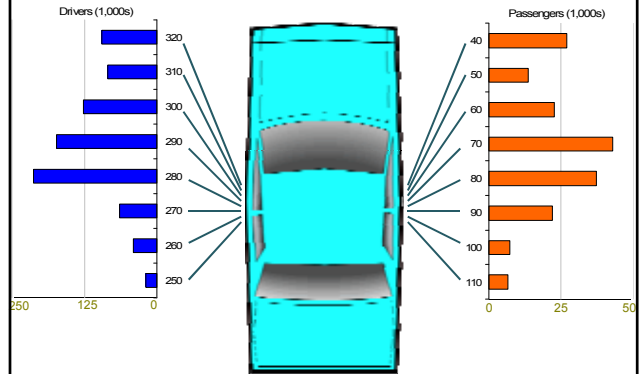
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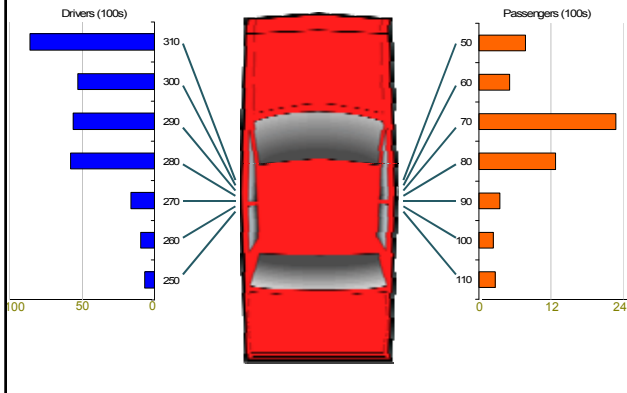
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NASS Analysis: 2003-2006 data All Side Impact Crashes by PDOF



NASS Analysis: 2003-2006 data All AIS=3+ Crashes by PDOF



Need for Oblique Side Impact Studies

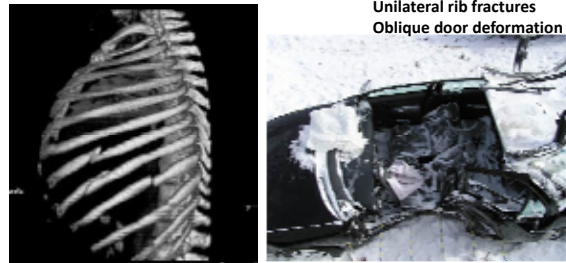


38 km/h ΔV

49 years, male, driver

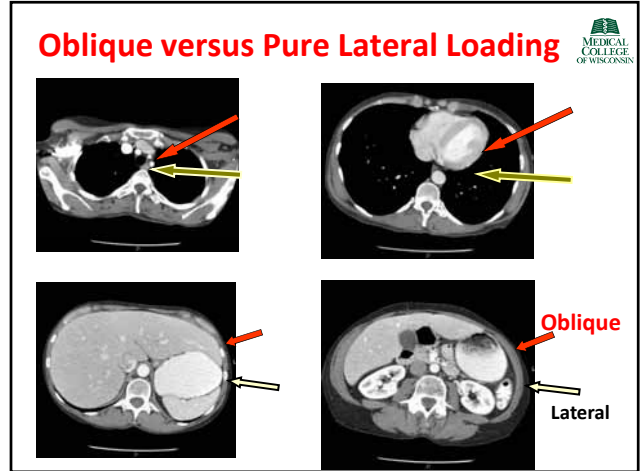
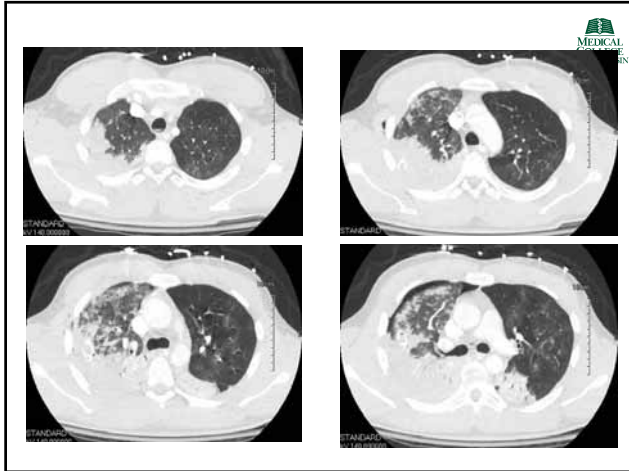
Unilateral rib fractures

Oblique door deformation



● NASS and CIREN

- oblique more prevalent than pure side impacts
- obliquity plays a unique role in chest injuries

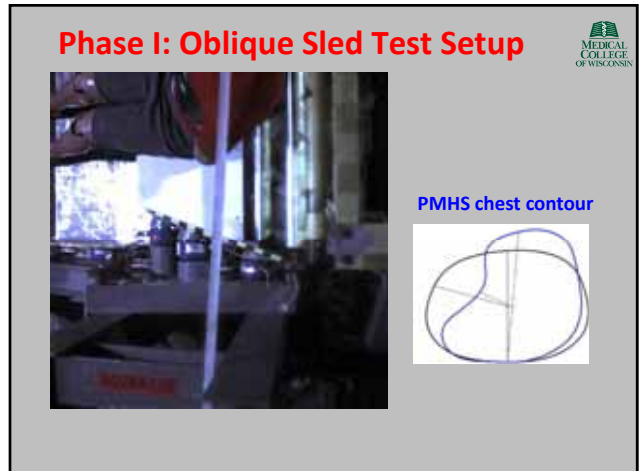
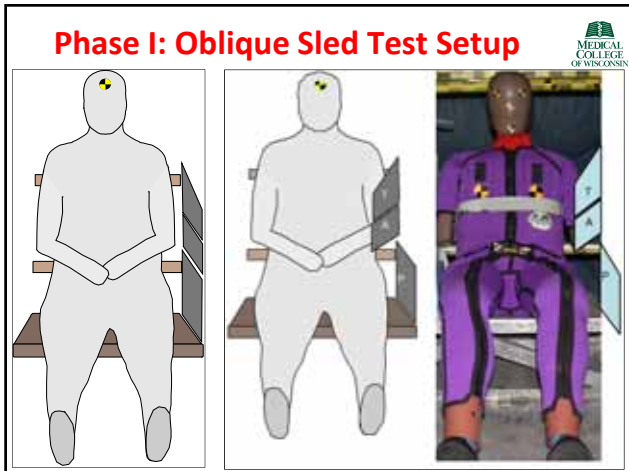
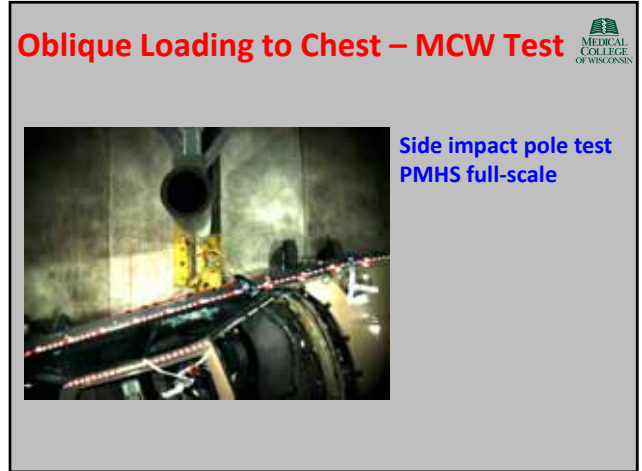
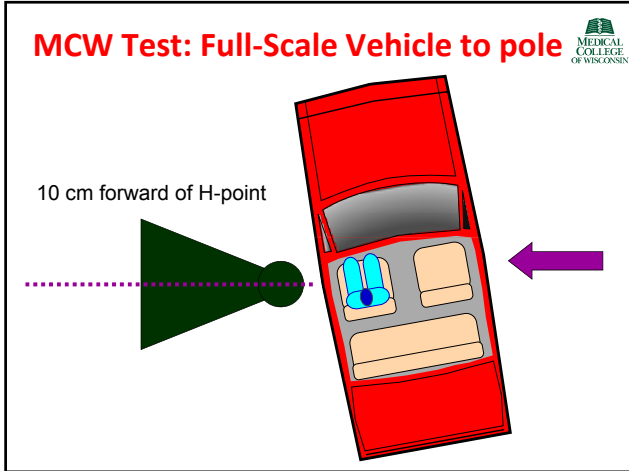


MCW Studies: Focus


- **Oblique response**
 - Is region specific (shoulder, thorax, abdomen,...)
 - Results in greater injury metrics than pure lateral
 - Injury criteria depends on orientation and magnitude
- **Oblique biofidelity > severe than lateral**
- **Therefore, need to evaluate dummies**
 - Injury criteria (risk curves)
 - Biofidelity corridors

Phase I: Oblique Tests

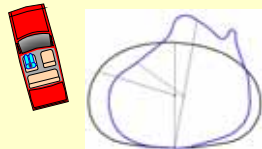
- **Ensure similar chest loadings**
 - Full-scale vehicle to pole tests (ATD, PMHS)
 - Sled tests with oblique load walls
 - Use PMHS and ATD test subjects
 - Chest deflections: use chestband
 - Deflections ⇔ loads



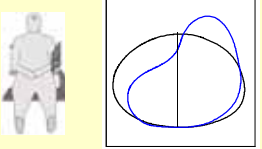
Comparison of Chest Deflections



Full-scale vehicle to pole test



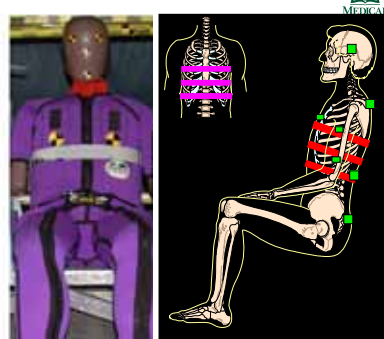
Sled test



Chest loading & kinematics are similar in full-scale vehicle-pole and sled tests. Establishes validity for sled tests.


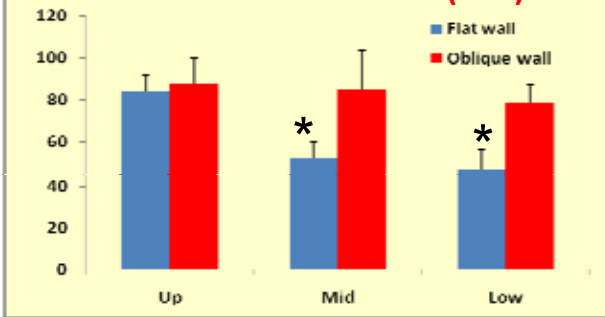
Methods

	# of channels
load cell	11
accelerometer	15
chestband - external	59
IR-TRACC: T1, T2, T3, A1, A2	5



	# of channels
load cell	11
accelerometer	15
chestband -	
upper	59
middle	59
lower	59


Peak PMHS Chest Deflections (mm)

Position	Flat wall (mm)	Oblique wall (mm)
Up	~85	~88
Mid	~55*	~85
Low	~48*	~78

Antero-lateral loading is different from pure lateral loading
Oblique loading biofidelity and injury criteria also different
Dummy should be able to sense oblique from pure loading

PMHS Data



Type	Age (years)	Rib fractures	Mean AIS
Flat wall	62	7	2
Oblique wall	55	9	3.5

Antero-lateral loading is different from pure lateral loading
Soft tissue injuries – oblique load wall tests

Phase I: Oblique Load Wall Sled Tests



- Matched chest loading: vehicle-pole & sled tests
- Thoracic and abdominal deflections
 - Peaks and angulations
 - PMHS and WorldSID
- Load wall: used uni-axial load cells
- Region-specific loading and timing?
 - Thorax, abdomen, pelvis, ...
- Dummy biofidelity issues?

Biofidelity Assessments



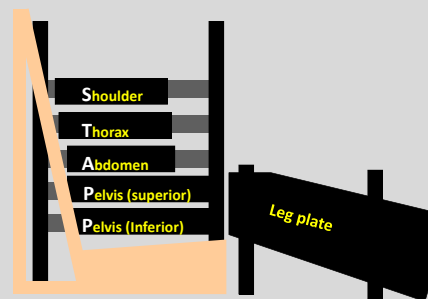
- Need for modular load wall
- Design for various anthropometry
- Allow load plates to be placed at any height and offset from pelvis to shoulder
 - For different occupants
 - PMHS: males and females
 - WorldSID 50th (5th planned)

Phase II: modular oblique load-wall sled tests

Scalable Load Wall – Anthropometry



Phase II: Modular Oblique Load Wall



“STAPP load wall design”

Modular Oblique Load Wall Sled



- **Vertical plate Alignment:**
 - Shoulder plate to greater tubercle of humerus
 - Thorax plate to rib number five
 - Abdomen plate to rib number ten
 - Pelvis – superior plate to iliac wing
 - Pelvis – inferior plate to greater trochanter
- **Lateral plate Alignment:**
 - Adjust lateral position of each load plate
 - Uniform contact with STAPP load plates

Alignment – Shoulder Plate



Alignment – Thorax Plate



Alignment – Abdomen Plate



Alignment – Pelvis Plate



Alignment – Leg Plate



Test Matrix

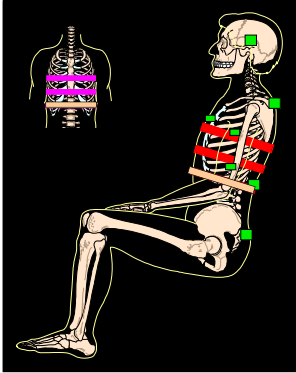


- PMHS tests at velocities: 3.3, 6.7 m/s
- WorldSID tests at 3.3, 6.7, 7.5 m/s
- Repeated testing protocol
 - PMHS 4 subjects; 6 sled runs
 - Dummy tests: 3 runs at each DV
- Region-specific results:
 - shoulder, thorax, abdomen,...

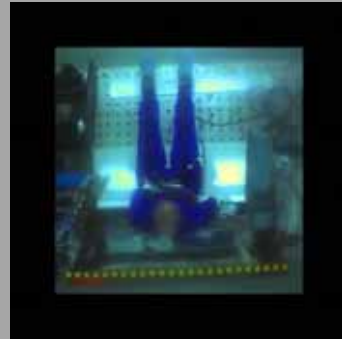
Video - Front



PMHS and WorldSID



Video – Overhead (WorldSID)



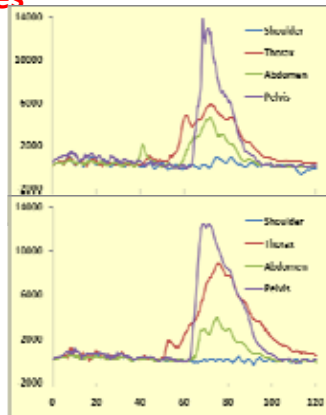
Loading Histories



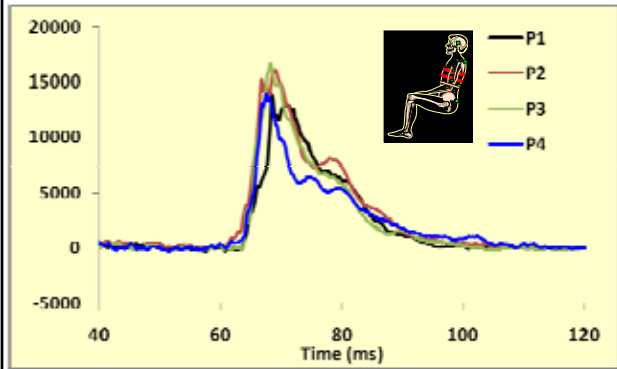
PMHS

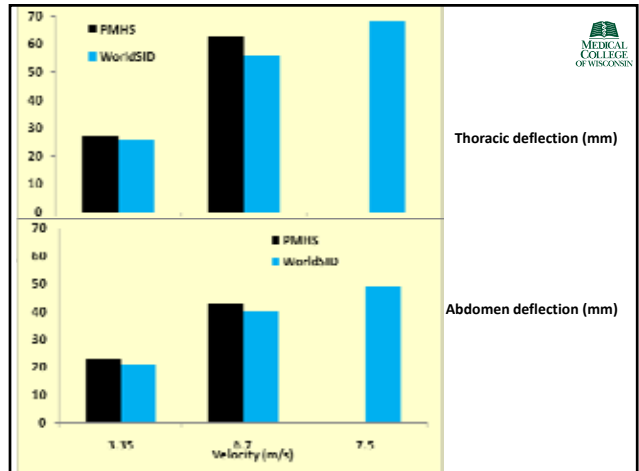
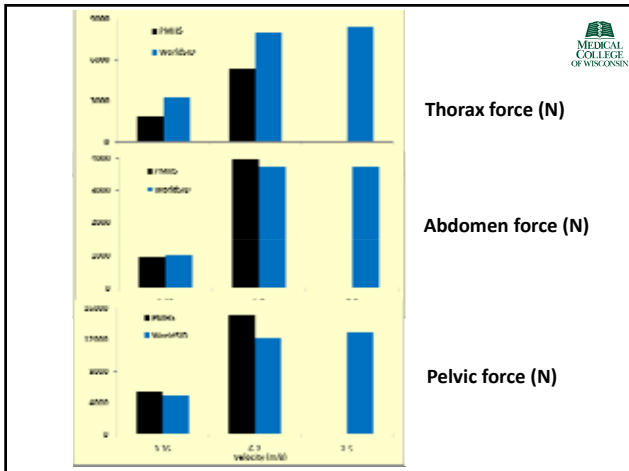
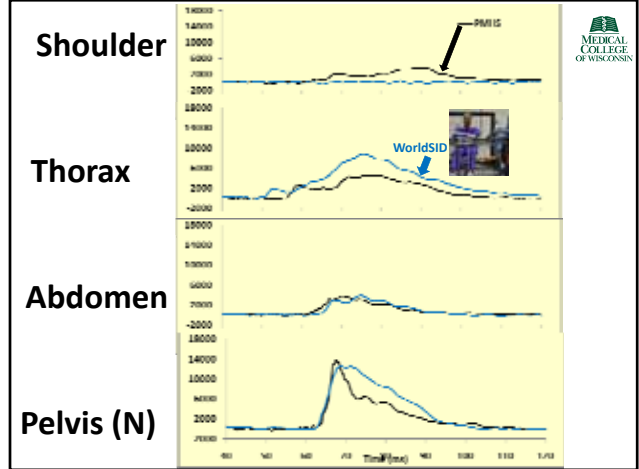
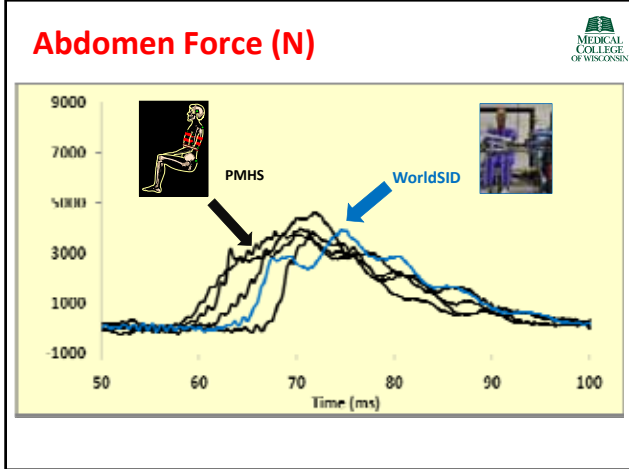


WorldSID



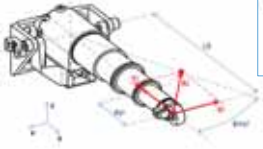
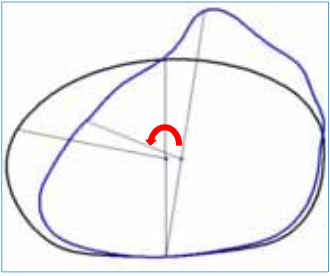


Pelvis Force (N)





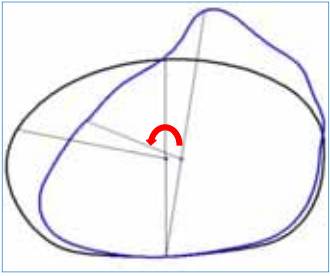



2D IR-Tracc


Mapping algorithm

RibEye

Multipoint sensing

PMHS and WorldSID Tests at MCW



- **Need: oblique loading and region specificity**
- **Modular oblique load wall sled tests to:**
 - Accommodate human & dummy anthropometries
 - Simulate oblique real-world impacts
 - Biofidelity characterizations
- **Determination of injuries using PMHS tests**
- **Development of PMHS response corridors**
 - Region-specific deflections using chestbands
 - Region-specific forces using load plates
- **WorldSID potential to sense injury metrics**
 - 2D IR-Tracc and RibEye – possible candidates

Thank You



Acknowledgement

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