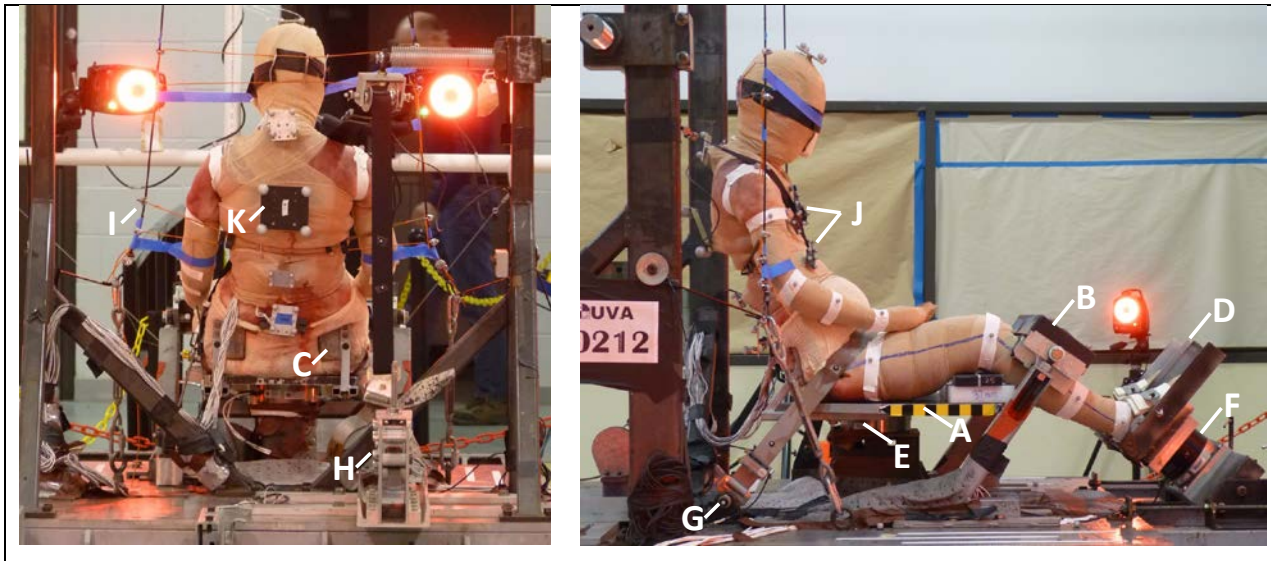


Appendix A

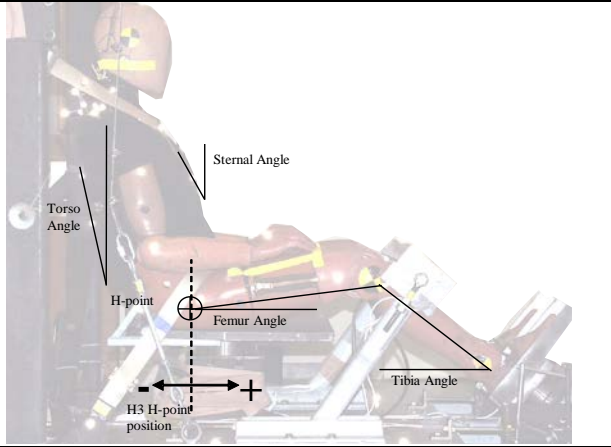


A	Seat	Rigid horizontal aluminum plate.
B	Knee bolster	Adjustable bilateral non-padded knee channels atop 5-axis load cells.
C	Pelvic block	Adjustable bilateral blocks to prevent pelvic posterior migration pre-test.
D	Footrest	Adjustable bilateral channels with ankle straps to immobilize feet and lower legs.
E	Seat load cell	6-axis load cell supporting seat.
F	Footrest load cell	6-axis load cell supporting seat.
G	Right lap belt anchor	Center of bolt head securing the right belt to the anchor mount defines the buck coordinate system for 3D movement data. Lap belt length adjuster tongue mounts here.
H	Force limiter	Shoulder belt force limiting device.
I	Back	Adjustable back and head support provided by horizontal wires attached to vertical cables.
J	Anterior marker plates	Five marker plates mounted to sternum and ribs for motion tracking.
K	Posterior marker plate	Marker plate mounted to T8. Motion capture of both the spine and anterior ribcage is required to calculate chest deflection.

Figure A1. Buck and subject motion capture hardware.

Table A1. PMHS Positioning.

	Right H-pt. Relative to Buck ^a	Torso Angle ^b	Femur Angle Right ^c	Tibia Angle Right ^c
Test #	mm	deg.	deg.	deg.
S0209	+4	-13	13	30
S0210	+6	-10	14	28
S0211	+2	-13	12	35
S0212	-8	-9	12	33
S0213	+1	-9	13	27



The diagram shows a Hybrid III dummy seated in a vehicle seat. A vertical dashed line indicates the 'H3 H-point position'. The 'H-point' is marked with a screw head. The 'Torso Angle' is the angle between a vertical line and the torso. The 'Sternal Angle' is the angle between a vertical line and the sternum. The 'Femur Angle' is the angle between a horizontal line and the femur. The 'Tibia Angle' is the angle between a horizontal line and the tibia.

Notes

a) Horizontal displacement of the right H-point relative to the standard position for the Hybrid III dummy H point with the Taurus passenger seat in the mid-position. Negative values indicate further away from the footrest. Pelvis rotation about z axis adjusted so that the left H-point was similarly positioned. H-point marked by a screw head installed into the center of the greater trochanter.

b) Angle of a line through the T3 and L1 spinous processes.

c) Angles measured relative to the horizontal. Left side positioned similarly.



	Belt angle from D-ring to shoulder	Belt angle from D-ring to shoulder	Belt angle across chest	Belt angle across chest	Belt centerline to subject centerline	D-ring mount from buck surface
Source:	Measured along belt from horizontal	In sagittal plane (from photos) from horizontal	Measured along top belt edge near center chest from horizontal	Measured along top belt edge near center chest from horizontal (from photos)	Measured at level of D-ring (from photos)	
Test #	deg.	deg.	deg.	deg.	mm	mm
S0209	25	28	57	51	221	943
S0210	25	30	57	53	208	942
S0211	25	30	58	56	187	938
S0212	25	23	48 ^a	50	186	994
S0213	25	27	58	59	200	1007

Notes

a- Chest concavity affected measurement.

Figure A2. Pretest belt position.

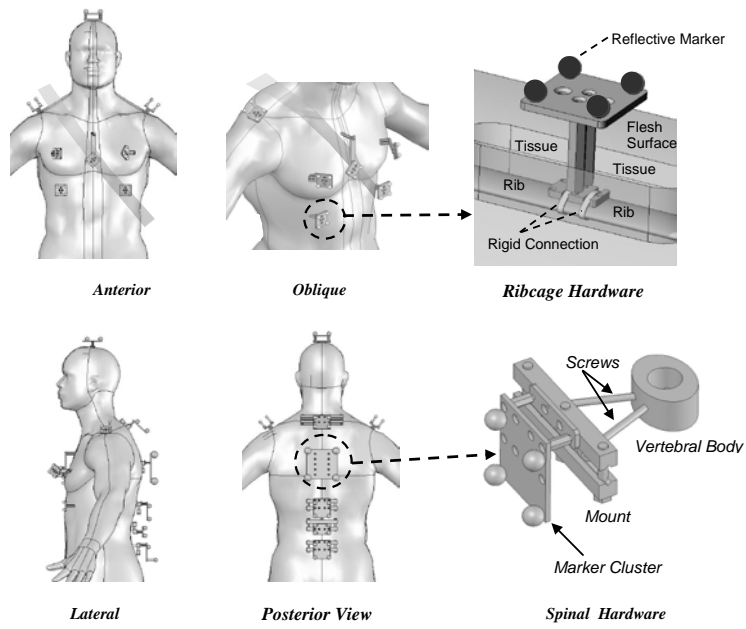
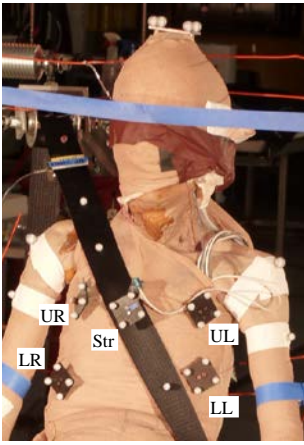
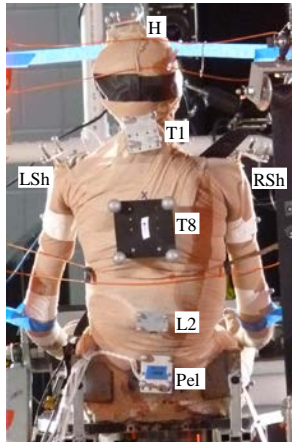


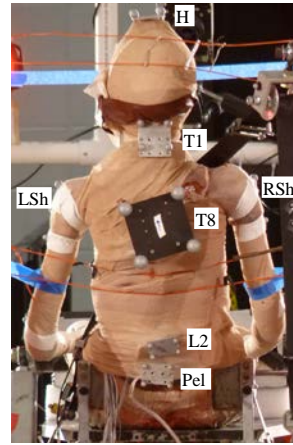
Figure A3. Motion capture hardware installation. Note that some tests did not incorporate acromia marker plates (Figure A4).



Tests 210 -213



Test 209



Tests 210-213

Abbrev.	Site	Mount / Measurement Location
H	Head	Approximate apex.
LSh	Left Shoulder	Acromion. Test 209 - marker plates on mounts screwed to the acromion. Remaining tests – single marker taped over acromion because of shoulder belt interaction with marker plate in first test.
RSh	Right Shoulder	
Str	Sternum	Body of sternum between rib 4 insertion points.
UL	Upper Left	Rib 4. Target 50 mm from the sternal centerline ^A . Actual locations 45-67mm.
UR	Upper Right	
LL	Lower Left	Rib 7. Target 95 mm from the sternal centerline ^A . Actual locations 90-108mm.
LR	Lower Right	
T1	1 st Thoracic Vertebra	Posterior aspect.
T8	8 th Thoracic Vertebra	
L2	2 nd Lumbar Vertebra	
Pel	Pelvis	Posterior superior iliac wings.

Figure A4. Vicon marker plate locations.

Notes

A – As measured from the sternum centerline along the rib:

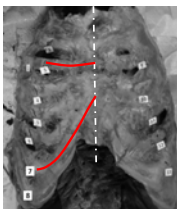


Table A2. Rib Fracture Type and Location

Subject 509 Test S0209				Subject 517 Test S0210				Subject 568 Test S0211				Subject 656 Test S0212				Subject 657 Test S0213			
Right		Left		Right		Left		Right		Left		Right		Left		Right		Left	
Rib #	Fx #	Typ e	Dist .	Rib #	Fx #	Typ e	Dist .	Rib #	Fx #	Typ e	Dist .	Rib #	Fx #	Typ e	Dist .	Rib #	Fx #	Typ e	Dist .
			mm				mm				mm				mm				mm
1				1				1				1	1	BC	45	1			5
2	1	BC	48	2	1	BC D	45	2	1	BC	73	2				2	1	BC D	65
3	2	BC	62	3	2	BC	94	9	BC	55		3	2	MC	65	8	BC	75	3
3				3	3	BC	56					3				3	2	BC	55
4	3	BC	65	4	4	BC	68	10	BC	72		4	3 ^A	MC	22	11 ^B	BC	15	4
4				4				4	4	BC	72	4	4	BC	72	12	BC	76	4
4				4				4	5	BC	96	4				4			4
5	4	BC	75	5	5	BC	69	11	BC	91		5	6	BC	109	13 ^B	BC	15	5
5				5				5				5				14	BC	88	5
6				6	6	BC	101	12	BC	115		6	5	BC	80	11	MC	125	6
7				7	7	BC	102	13	BC	155		7	6 ^C	MC	90	12 ^E	MC	110	7
7				7				7				7				7			7
8				8	8	MC	142					8	7	BC	218				8
9				9				9				9	7 ^D	BC	110				9
10				10				10	8	BC	300					10			10
				Sternal fx: MC, 87mm down from sternal notch								Sternal fx: BC, 60mm down from sternal notch							

Notes

- A – Partial cartilage fracture located at junction of sternum and costal cartilage.
- B - Complete cartilage fracture located at junction of sternum and costal cartilage.
- C – At the rib 6/7 junction.
- D – At the rib 7/8 junction.
- E – Between ribs 6/7 along the costal margin.

Fracture Type Key		Fracture Distance from Centerline Along Rib	
MC	Monocortical		
BC	Bicortical		
BCD	Bicortical displaced		
Cart	Cartilage		

Table A3. NASS-CDS Investigation Results

	Rib Fracture Injury Severity	AIS	Unweighted	Weighted	Weighted Percent
Total Occupants			205	58,149	100
Occupants with Rib Fracture	Any severity	AIS 1-5	10	1,576	2.7
	Minor	AIS 1	1	482	0.8
	Moderate	AIS 2	6	625	1.1
	Serious	AIS 3	1	47	0.1
	Severe	AIS 4	0	0	0.0
	Critical	AIS 5	2	423	0.7

Table A4. Subject Bone Mineral Density

Test:	S0209			S0210			S0211			S0212			S0213		
Cadaver ID No.	509			517			568			656			657		
Age at Time of Death	75			95			57			88			65		
Total Ribcage Fractures	4			13			15			12			5		
BMD	BMD (g/cm ²)	Young Adult T-score	Age Matched Z-score	BMD (g/cm ²)	Young Adult T-score	Age Matched Z-score	BMD (g/cm ²)	Young Adult T-score	Age Matched Z-score	BMD (g/cm ²)	Young Adult T-score	Age Matched Z-score	BMD (g/cm ²)	Young Adult T-score	Age Matched Z-score
Total Hip L	0.752	-2.0	0.4	0.576	-3.4	-0.1	0.771	-1.9	-0.3	0.888	-0.9	1.8	0.748	-2.1	-0.4
Total Hip R	0.748	-2.1	0.4	1.062	0.4	3.7	0.743	-2.1	-0.6	0.872	-1.1	1.7	0.598	-3.3	-1.6
Total Hip Mean	0.750	-2.0	0.4	0.819	-1.5	1.8	0.757	-2.0	-0.5	0.880	-1.0	1.7	0.673	-2.7	-1.0
Femur neck L	0.706	-2.4	0.2	0.558	-3.5	-0.2	0.774	-1.9	-0.1	0.844	-1.4	1.4	0.769	-1.9	0.0
Femur neck R	0.744	-2.1	0.4	1.069	0.2	3.5	0.771	-1.9	-0.3	0.858	-1.3	1.5	0.569	-3.4	-1.5
L1-4	0.944	-2.0	0.7	0.770	-3.4	-0.7	0.873	-2.6	-0.5	1.287	0.7	3.1	1.080	-0.9	1.3
WHO Assessment Value	Femur neck L			Femur neck L			L1-4			Femur neck L			Femur neck R		
	0.706	-2.4	0.2	0.558	-3.5	-0.2	0.873	-2.6	-0.5	0.844	-1.4	1.4	0.569	-3.4	-1.5
WHO Assessment ^A	Osteopenia			Osteoporosis			Osteoporosis			Osteopenia			Osteoporosis		

Notes

A –World Health Organization (WHO) criteria for postmenopausal Caucasian women:

Normal: T score at or above -1 SD

Osteopenia : T score between -1 SD and -2.5 SD

Osteoporosis : T score at or below -2.5 SD