S1. MADYMO Accord Vehicle Model Validation

The following table compares the injury metric values of the H3 small female physical dummy and the MADYMO H3 small female dummy model (Table S1.1).

Table S1.1. Comparison of injury metrics between an H3-05F physical dummy and an H3-05F MADYMO model

Measurement Description	Units	Threshold	Test (NHTSA)	Simulation (MADYMO)
Head Injury Criteria (HIC15)	N/A	700	253	268
Maximum Chest Compression	mm	52	15	16
Nij	N/A	1	0.28	0.51
Neck Tension	N	2620	799	640
Neck Compression	N	2520	241	447
Left Femur Force	N	6805	1879	1576
Right Femur Force	N	6802	1598	496

S2. Initial Postures for Parametric Crash Simulations (Total of 48 Cases)

The following figures and tables summarize the excursion amounts of the AHBM (Active Human Body Model) during pre-crash emergency braking simulations for various seat track positions and types of seat belts (Figure S2.1-S2.7, Table S2.1-S2.7).

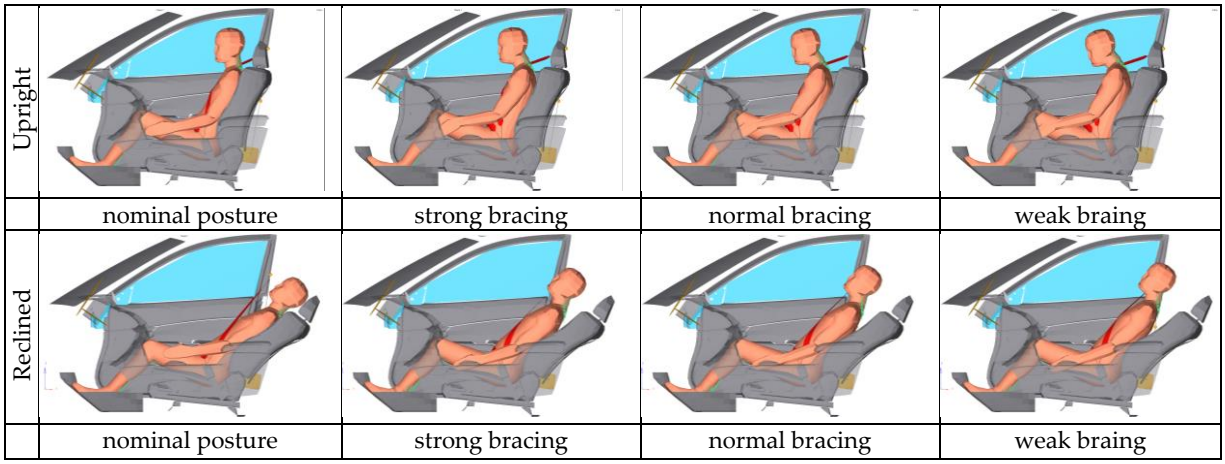


Figure S2.1. Postures of the active human body model at the time of crash (t=0) due to pre-crash emergency braking (Seat track position: front, Seat belt type: B-pillar-integrated)

Table S2.1. Excursions and body rotations of the active human body model compared to nominal posture due to pre-crash emergency braking (Seat track position: front, Seat belt type: B-pillar-integrated)

Seat back angle	**Upright**			**Reclined**		
Bracing level	weak	baseline	strong	weak	baseline	strong
Head Displacement X [mm]	144	122	93	142	115	101
T1 Displacement X [mm]	82	70	53	92	72	63
Head Rotation Y [deg]	19	12	4	19	15	9
T1 Rotation Y [deg]	11	8	4	10	7	4

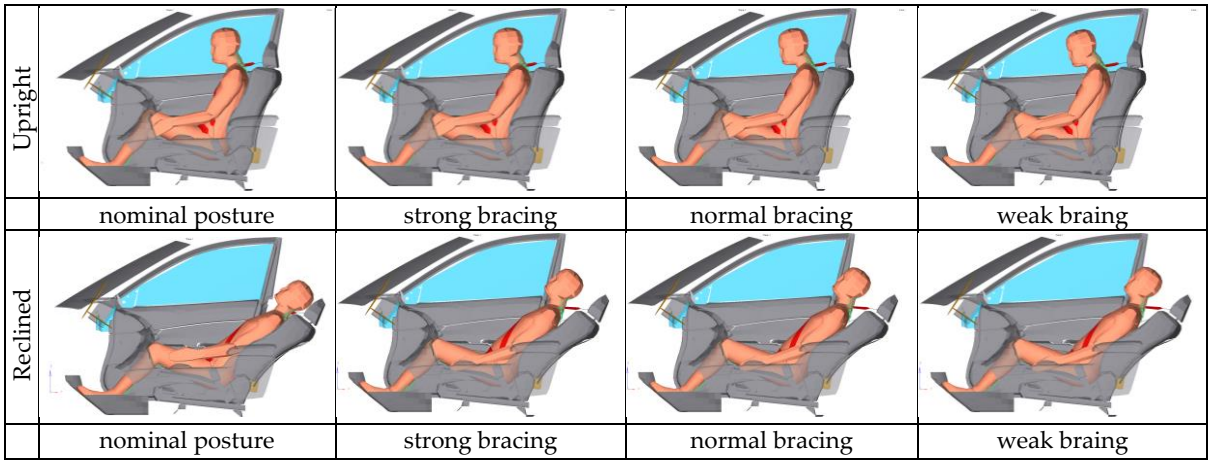


Figure S2.2. Postures of the active human body model at the time of crash (t=0) due to pre-crash emergency braking (Seat track position: front, Seat belt type: Belt-in-seat)

Table S2.2. Excursions and body rotations of the active human body model compared to nominal posture due to pre-crash emergency braking (Seat track position: front, Seat belt type: Belt-in-seat)

Seat back angle	**Upright**			**Reclined**		
Bracing level	weak	baseline	strong	weak	baseline	strong
Head Displacement X [mm]	133	111	87	99	92	85
T1 Displacement X [mm]	73	61	48	57	53	49
Head Rotation Y [deg]	18	11	4	16	13	8
T1 Rotation Y [deg]	10	7	3	7	6	4

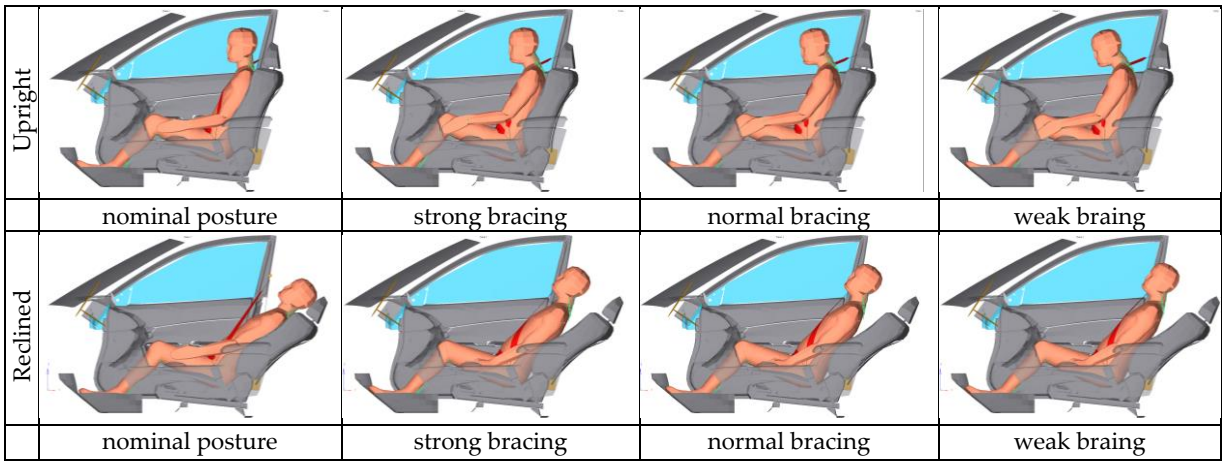


Figure S2.3. Postures of the active human body model at the time of crash (t=0) due to pre-crash emergency braking (Seat track position: baseline, Seat belt type: B-pillar-integrated)

Table S2.3. Excursions and body rotations of the active human body model compared to nominal posture due to pre-crash emergency braking (Seat track position: baseline, Seat belt type: B-pillar-integrated)

Seat back angle	**Upright**			**Reclined**		
Bracing level	weak	baseline	strong	weak	baseline	strong
Head Displacement X [mm]	150	120	85	174	157	136
T1 Displacement X [mm]	87	69	48	116	106	93
Head Rotation Y [deg]	19	12	3	22	17	11
T1 Rotation Y [deg]	11	7	3	12	10	6

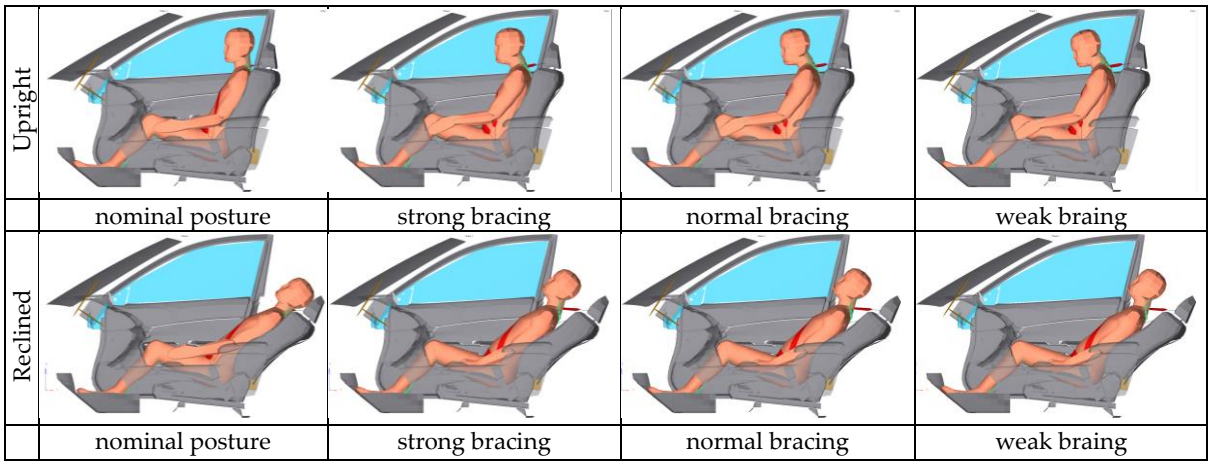


Figure S2.4. Postures of the active human body model at the time of crash (t=0) due to pre-crash emergency braking (Seat track position: baseline, Seat belt type: Belt-in-seat)

Table S2.4. Excursions and body rotations of the active human body model compared to nominal posture due to pre-crash emergency braking (Seat track position: baseline, Seat belt type: Belt-in-seat)

Seat back angle	**Upright**			**Reclined**		
Bracing level	weak	baseline	strong	weak	baseline	strong
Head Displacement X [mm]	134	110	81	112	112	105
T1 Displacement X [mm]	73	61	44	69	69	65
Head Rotation Y [deg]	18	11	3	15	13	9
T1 Rotation Y [deg]	11	7	3	7	7	5

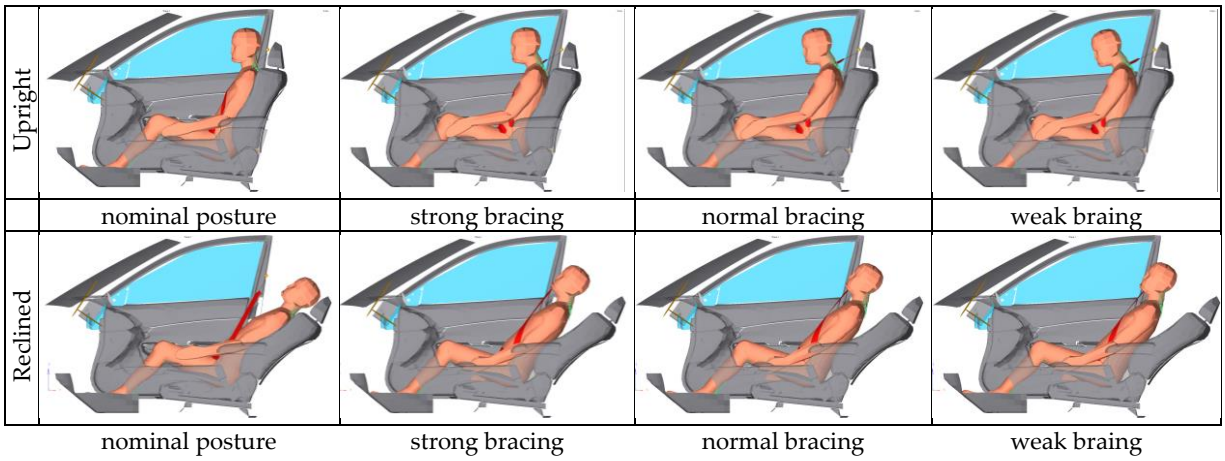


Figure S2.5. Postures of the active human body model at the time of crash (t=0) due to pre-crash emergency braking (Seat track position: rear, Seat belt type: B-pillar-integrated)

Table S2.5. Excursions and body rotations of the active human body model compared to nominal posture due to pre-crash emergency braking (Seat track position: rear, Seat belt type: B-pillar-integrated)

Seat back angle	**Upright**			**Reclined**		
Bracing level	weak	baseline	strong	weak	baseline	strong
Head Displacement X [mm]	154	122	89	186	170	149
T1 Displacement X [mm]	90	72	51	128	120	106
Head Rotation Y [deg]	19	12	4	23	18	12
T1 Rotation Y [deg]	11	7	3	12	10	7

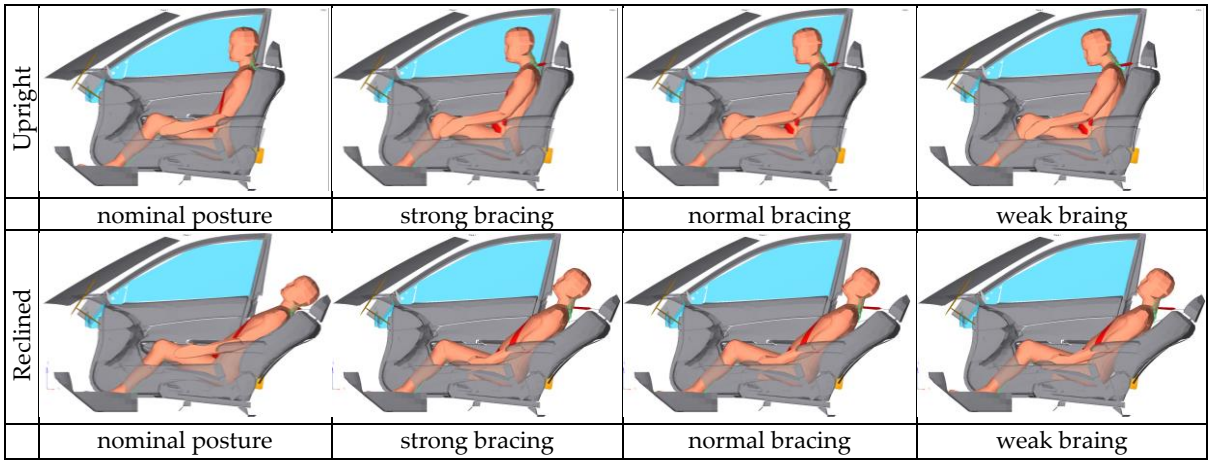


Figure S2.6. Postures of the active human body model at the time of crash (t=0) due to pre-crash emergency braking (Seat track position: rear, Seat belt type: Belt-in-seat)

Table S2.6. Excursions and body rotations of the active human body model compared to nominal posture due to pre-crash emergency braking (Seat track position: rear, Seat belt type: Belt-in-seat)

Seat back angle	**Upright**			**Reclined**		
Bracing level	weak	baseline	strong	weak	baseline	strong
Head Displacement X [mm]	133	107	83	111	113	107
T1 Displacement X [mm]	72	58	45	70	72	68
Head Rotation Y [deg]	18	11	4	15	13	9
T1 Rotation Y [deg]	10	6	3	7	6	5

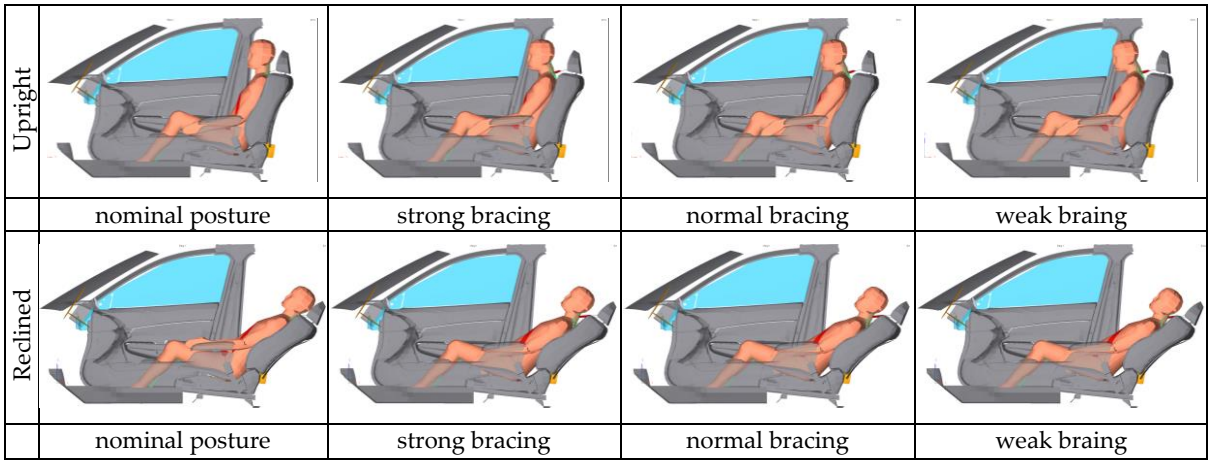


Figure S2.7. Postures of the active human body model at the time of crash (t=0) due to pre-crash emergency braking (Seat track position: concept rear, Seat belt type: Belt-in-seat)

Table S2.7. Excursions and body rotations of the active human body model compared to nominal posture due to pre-crash emergency braking (Seat track position: concept rear, Seat belt type: Belt-in-seat)

Seat back angle	**Upright**			**Reclined**		
Bracing level	weak	baseline	strong	weak	baseline	strong
Head Displacement X [mm]	108	92	82	75	80	83
T1 Displacement X [mm]	51	44	41	54	57	58
Head Rotation Y [deg]	15	10	4	2	2	1
T1 Rotation Y [deg]	7	5	3	0	0	0

S3. Biofidelity Evaluation of MADYMO Active Human Body Model – Component

The following figures show the responses of the AHBM during validation simulations (Figure S3.1 - Figure S3.15).

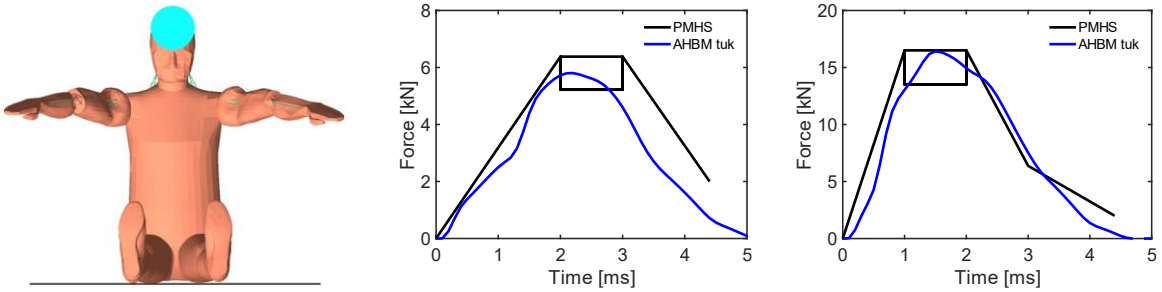


Figure S3.1. Head frontal impact (Melvin et al., 1989)

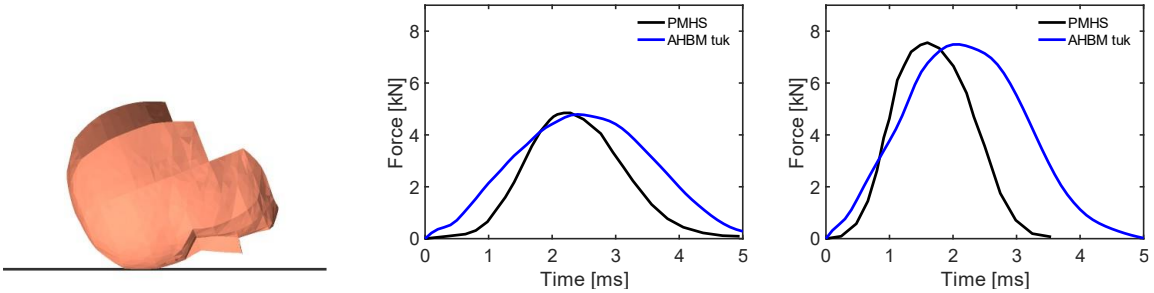


Figure S3.2. Head frontal drop (Loyd et al., 2012)

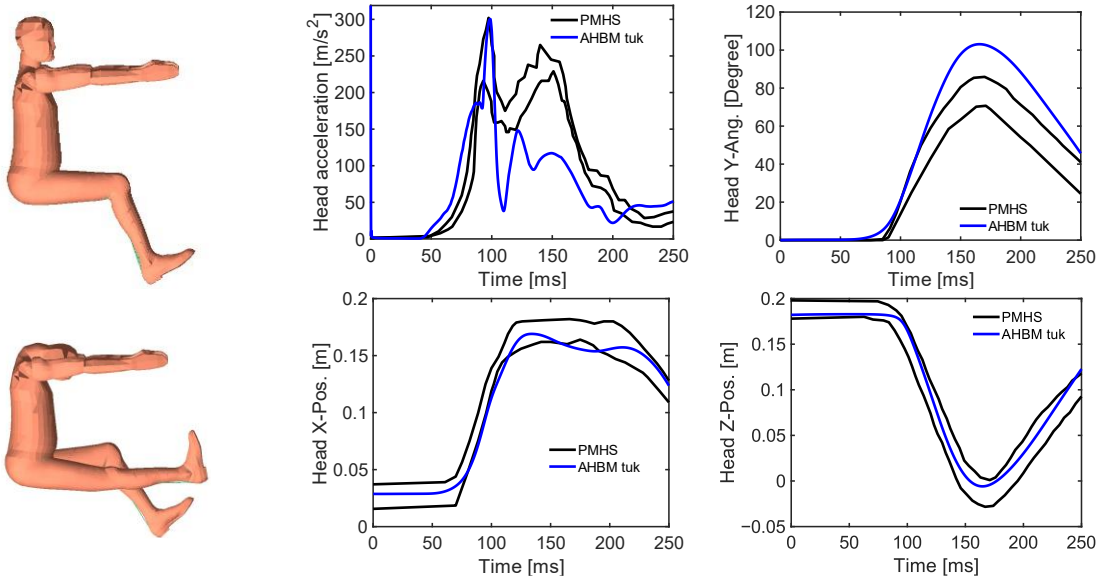


Figure S3.31. Frontal sled 15 g (Ewing et al., 1968, 1973)

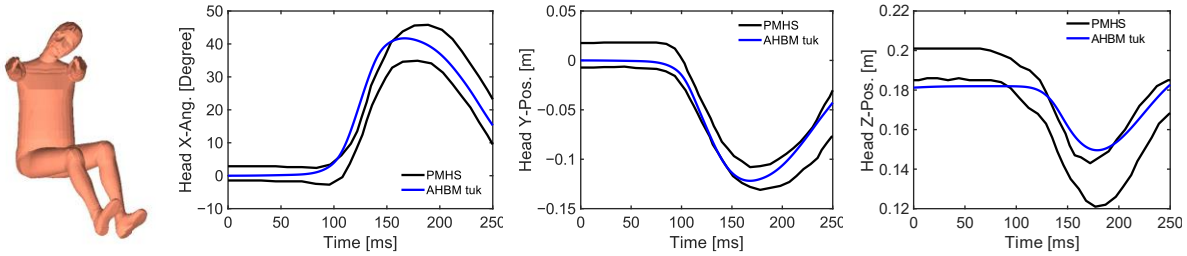
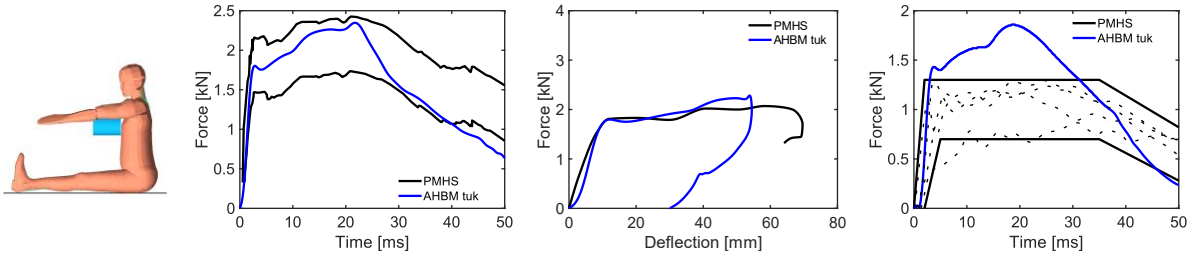


Figure S3.4. Lateral sled 7 g (Klinich et al., 1995)



(a) Impact speed: 4.3 m/s (b) Impact speed: 4.3 m/s (c) Impact speed: 3.5 m/s

Figure S3.5. (a), (b) Thorax frontal cylindrical impact (Kroell et al., 1971; Kroell et al., 1974), (c) Thorax frontal hammer impact (Bouquet et al., 1994)

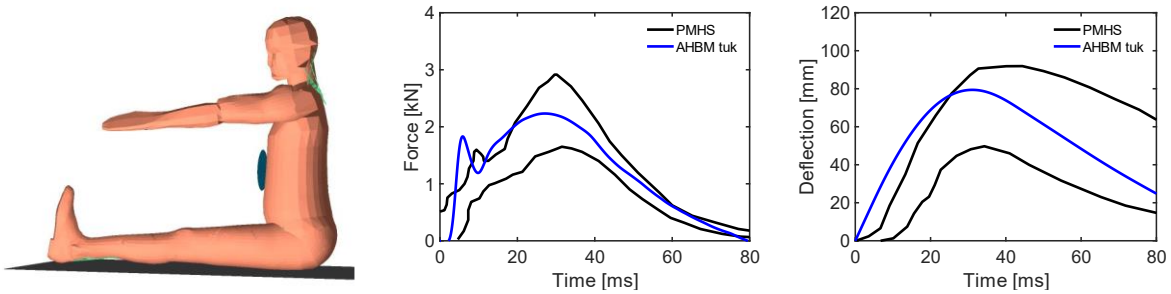


Figure S3.6. Thorax frontal oblique cylindrical impact, 4.3 m/s (Yoganandan et al., 1997)

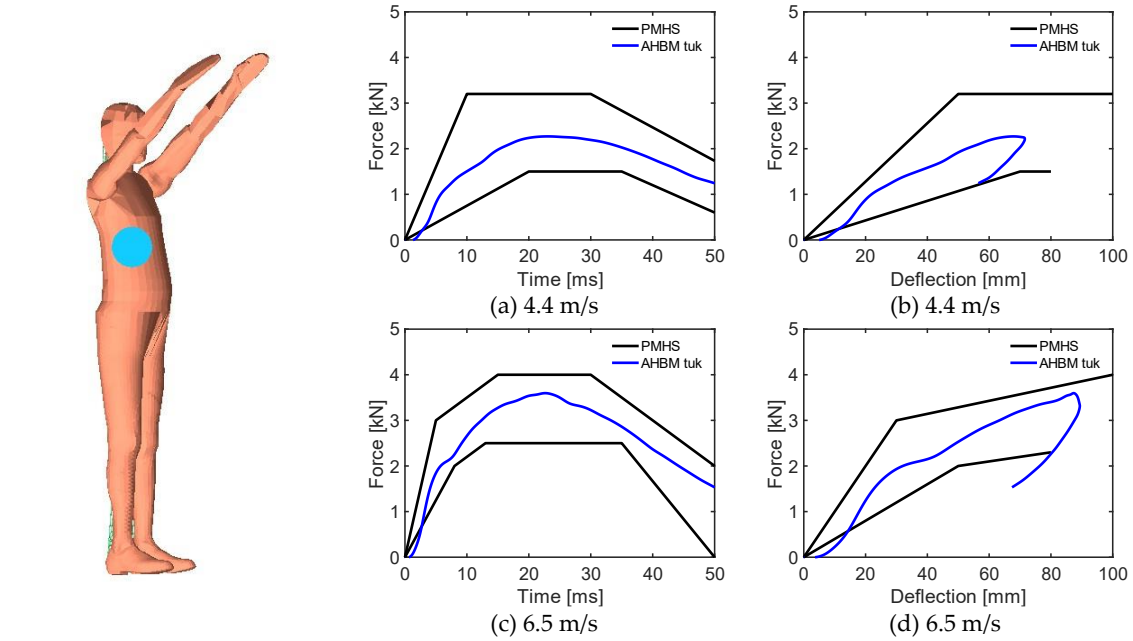


Figure S3.7. Thorax oblique pendulum impact (Viano et al., 1989)

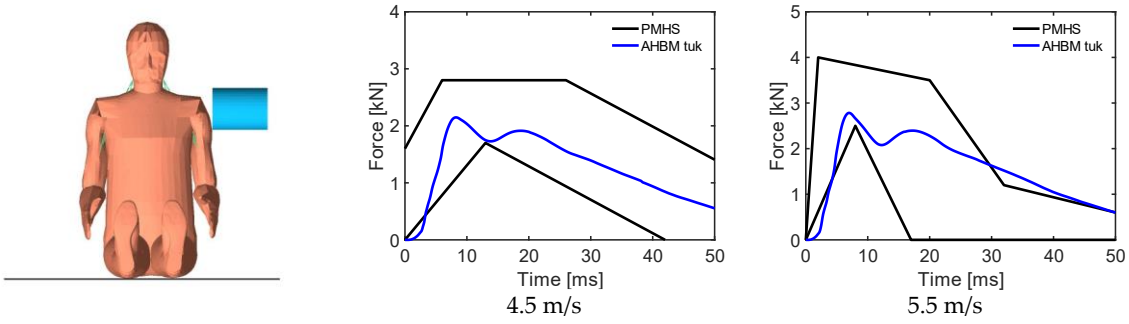


Figure S3.8. Shoulder lateral pendulum impact (ISO9790)

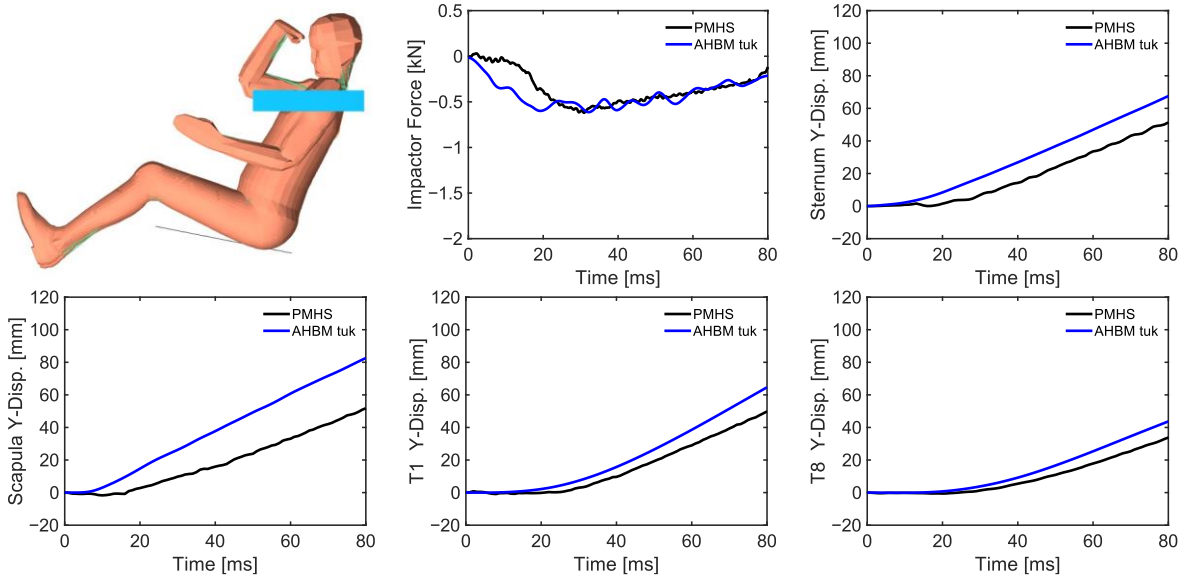


Figure S3.9. Shoulder lateral cylindrical impact 1.0 m/s (Subit et al., 2010)

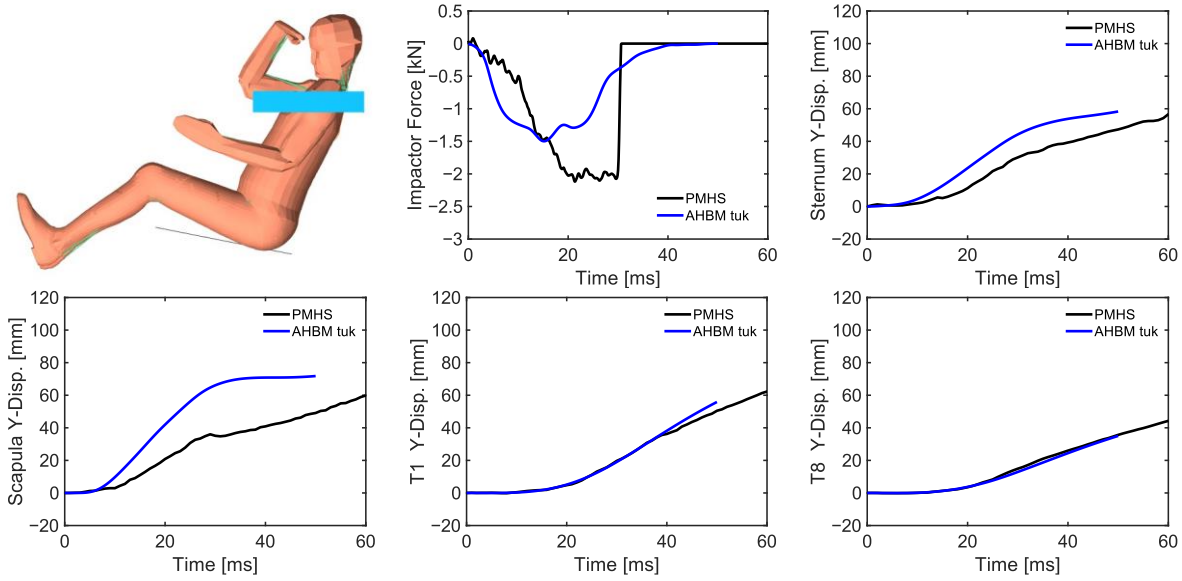


Figure S3.10. Shoulder lateral cylindrical impact 3.0 m/s (Subit et al., 2010)

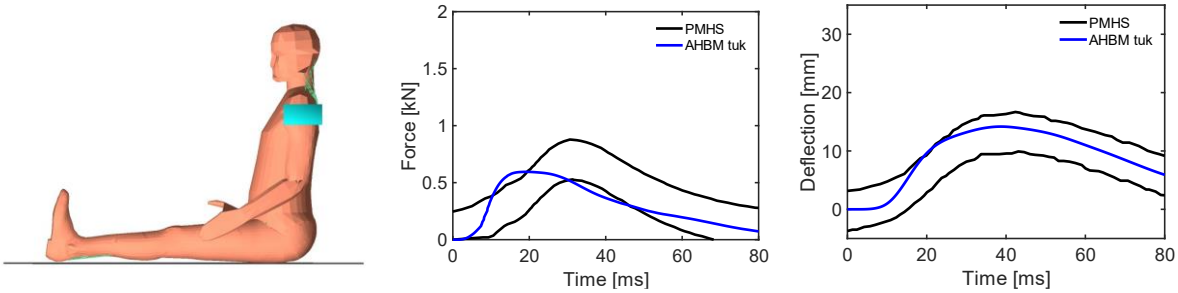


Figure S3.11. Shoulder lateral cylindrical impact 1.5 m/s (Compigne et al., 2004)

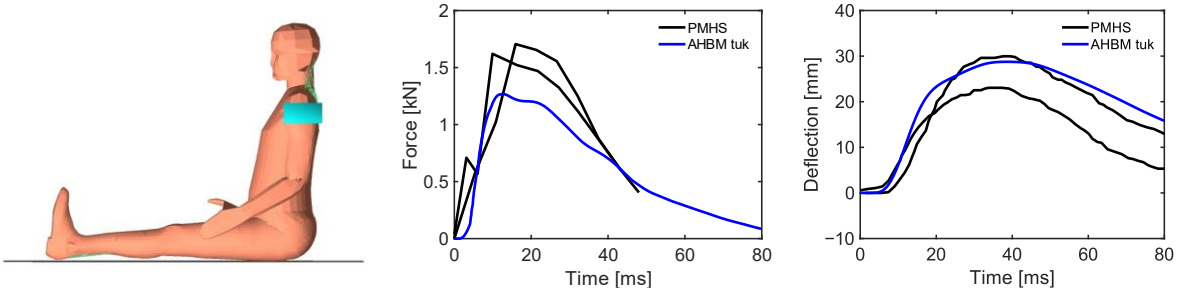


Figure S3.12. Shoulder lateral cylindrical impact 3.0 m/s (Compigne et al., 2004)

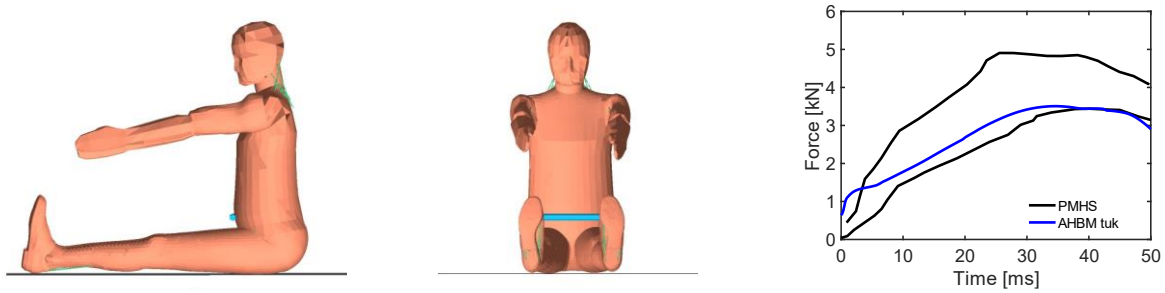


Figure S3.13. Abdomen frontal bar impact 6.1 m/s (Cavanaugh et al., 1986)

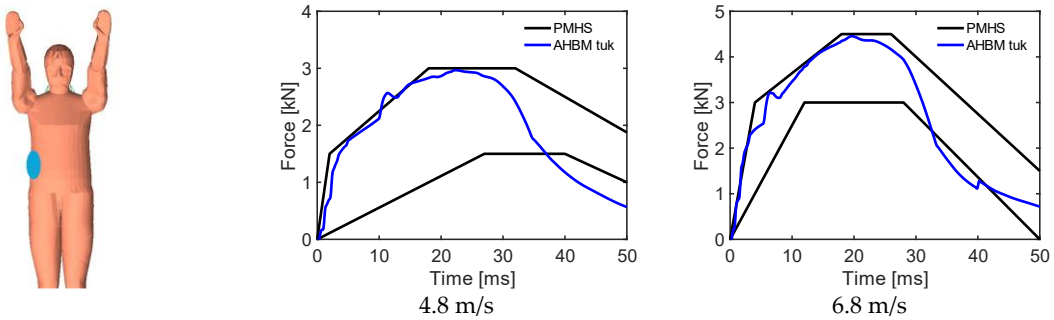


Figure S3.14. Abdomen lateral oblique pendulum impact (Viano et al., 1989)

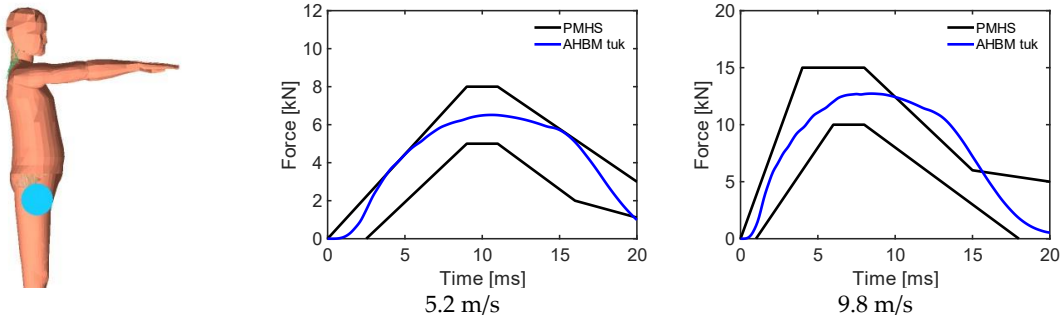


Figure S3.152. Pelvis lateral pendulum impact (Viano et al., 1989)

S4. Time-history Signal of MADYMO Active Human Body Model During the Parametric Crash Simulations

The following figures show the responses of the AHBM during selected parametric crash simulations (Figure S4.1 - Figure S4.4).

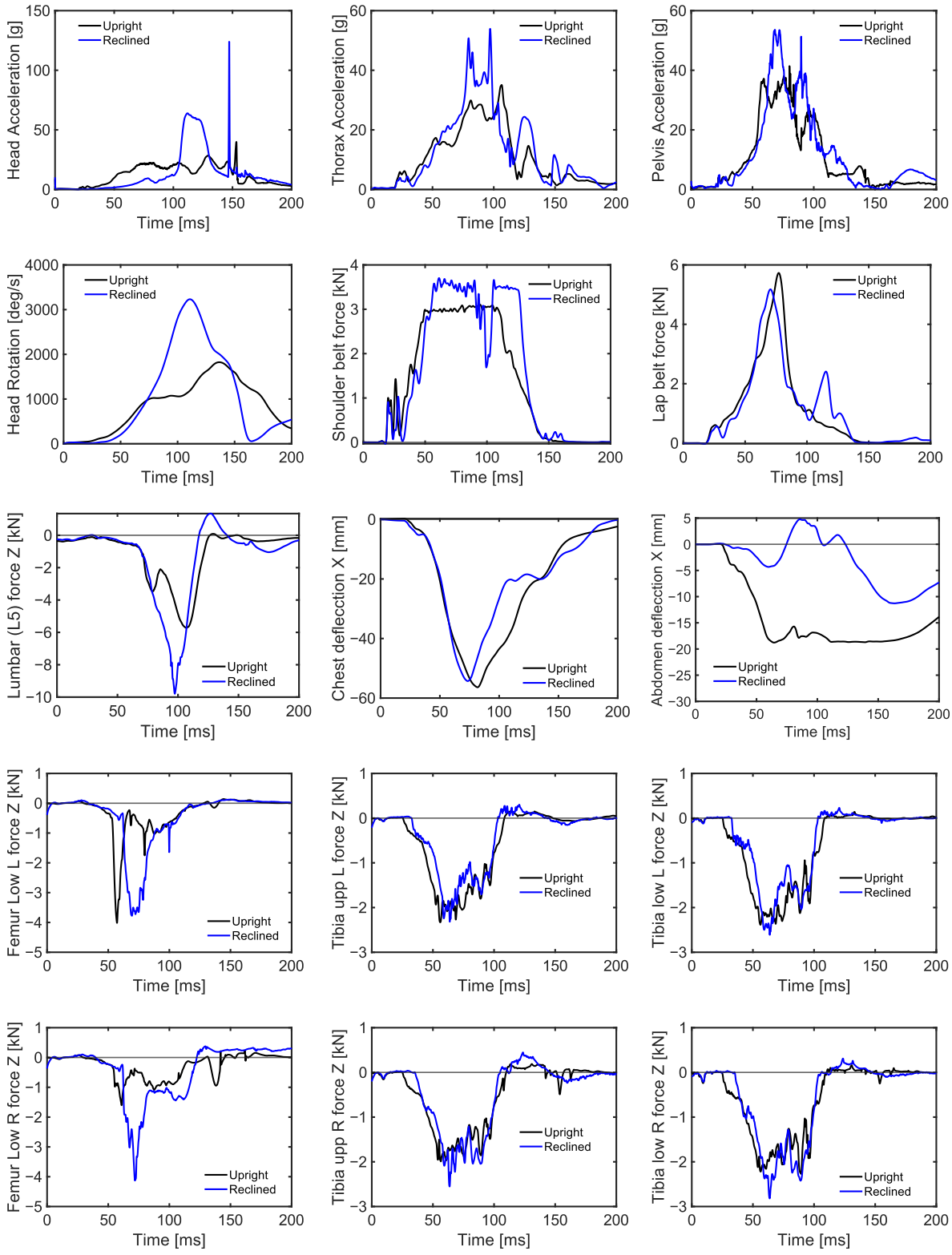


Figure S4.1. Time-history signal of MADYMO Active Human Body Model (Crash pulse: 21KR0040 / Nominal posture without AEB activation / Seat back angle: upright, reclined / Seat track position: baseline / Seating location: driver / Seat belt type: Belt-in-seat)

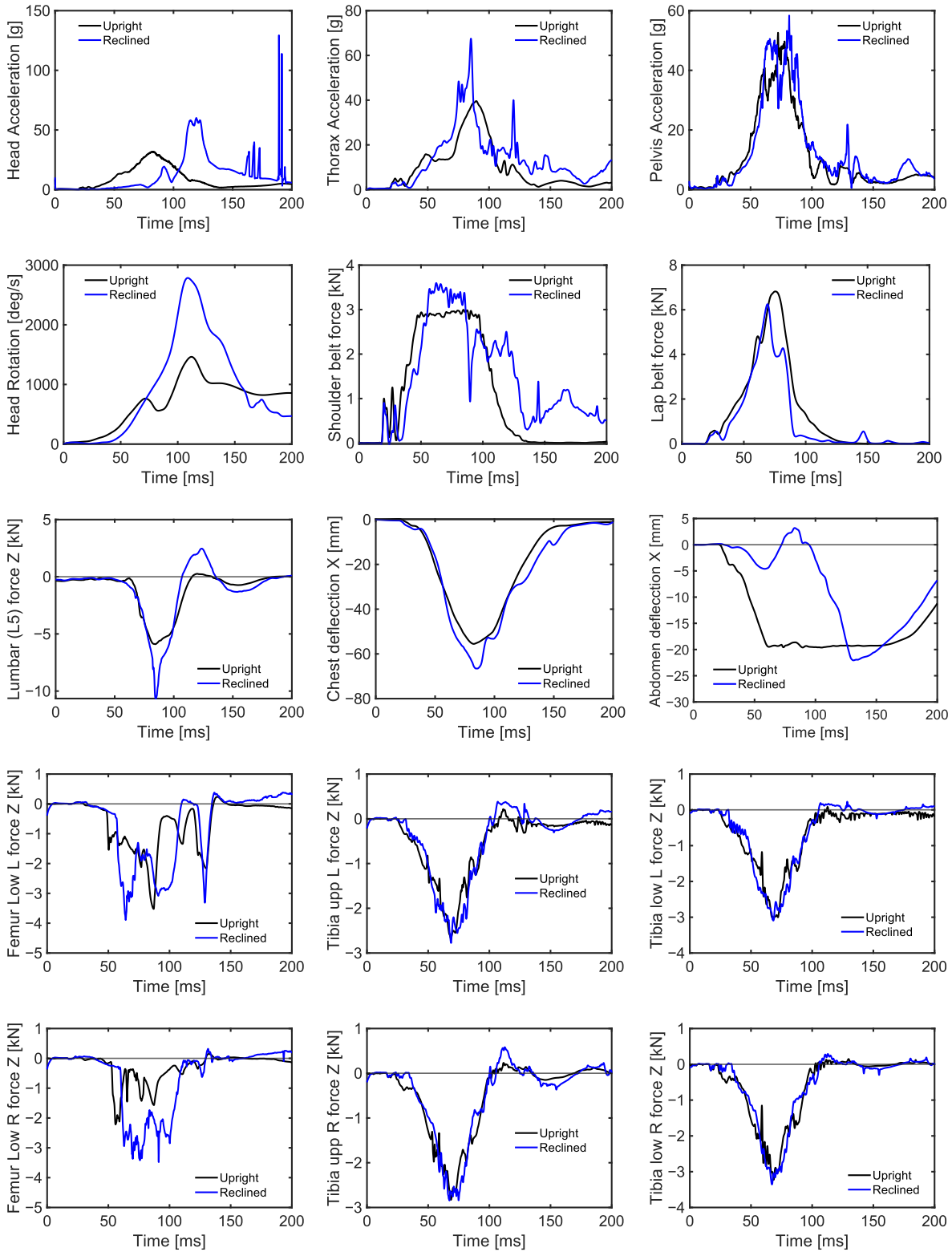


Figure S4.2. Time-history signal of MADYMO Active Human Body Model (Crash pulse: 21KR0040 / Nominal posture without AEB activation / Seat back angle: upright, reclined / Seat track position: baseline / Seating location: passenger / Seat belt type: Belt-in-seat)

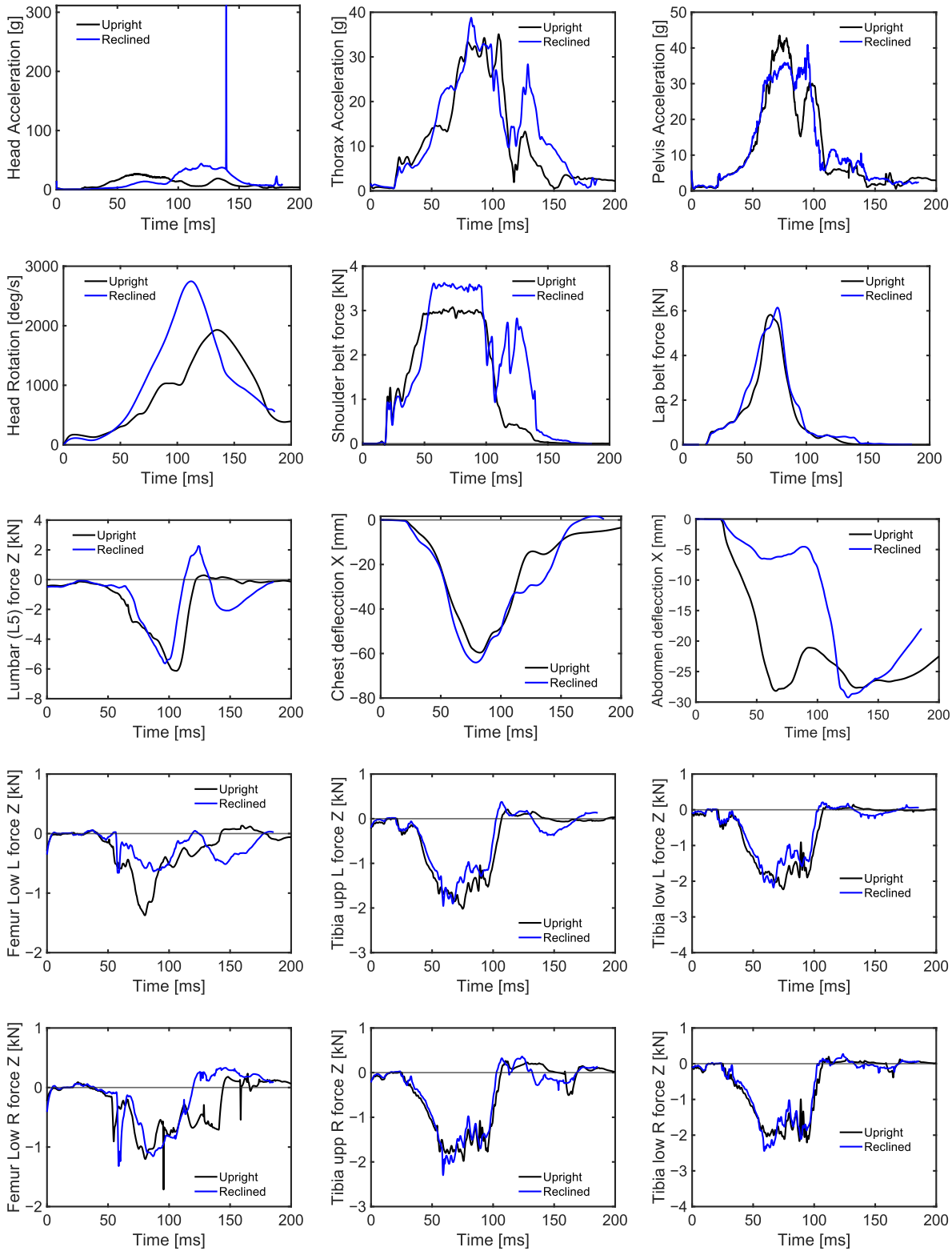


Figure S4.3. Time-history signal of MADYMO Active Human Body Model (Crash pulse: 21KR0040 / Normal bracing with AEB activation / Seat track position: baseline / Seating location: driver / Seat belt type: Belt-in-seat)

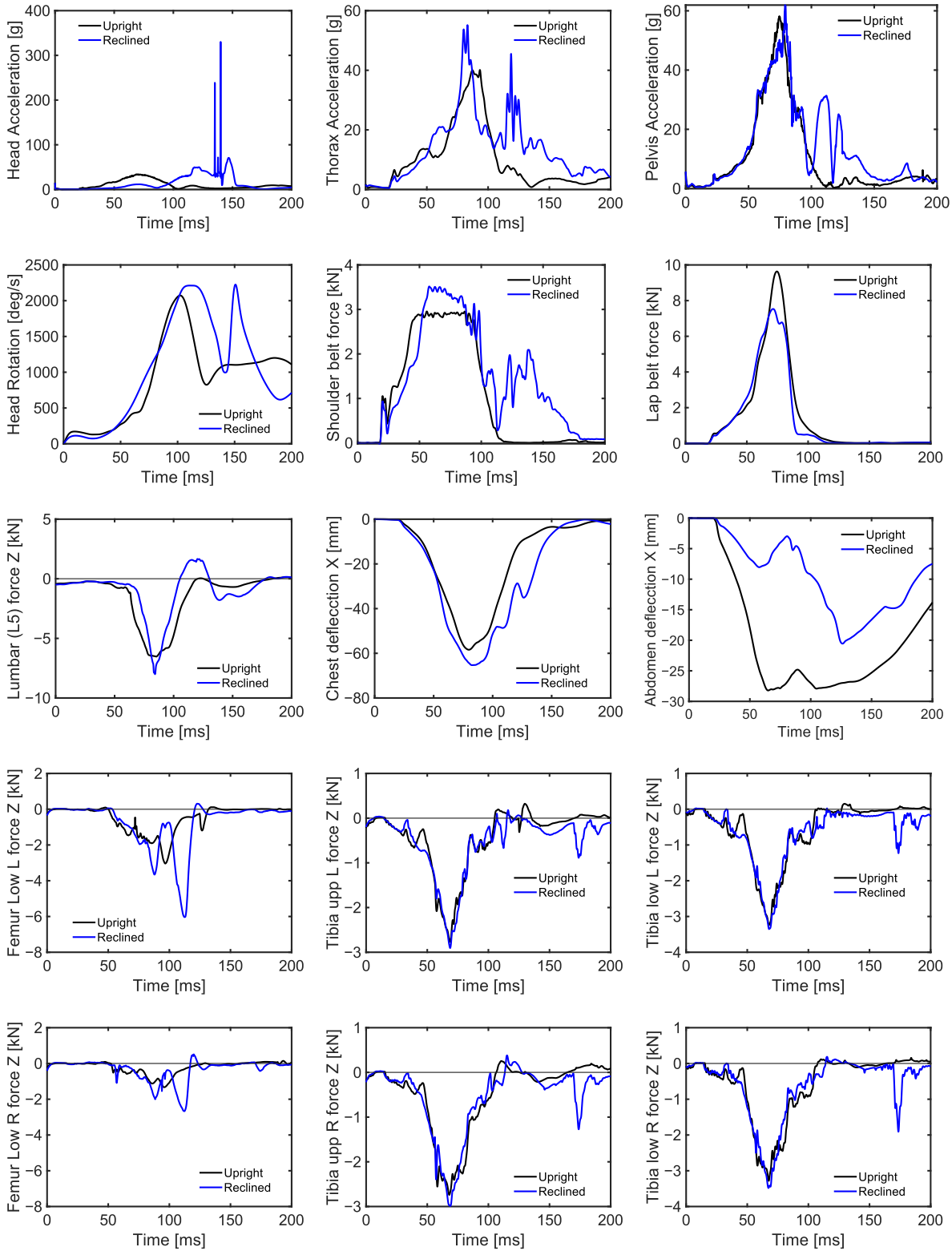


Figure S4.4. Time-history signal of MADYMO Active Human Body Model (Crash pulse: 21KR0040 / Normal bracing with AEB activation / Seat back angle: upright, reclined / Seat track position: baseline / Seating location: passenger / Seat belt type: Belt-in-seat)