Evaluation Test Methods for Gtr 7

Results of Calibration Test with a heavy probe impactor for BioRID-II

JASIC/JAPAN

Purpose

The calibration tests with a heavy probe weight and a headrest for the BioRID-II dummies were performed, and the repeatability and the reproducibility of the dummy's responses was analyzed.

The calibration tests with the light probe weight were also performed in order to clarify the differences of probe weights (heavy and light) for the calibration tests.

Calibration Tests

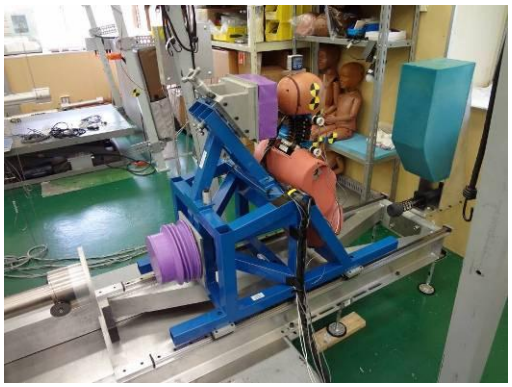
1) Calibration tests with the light probe（37.68kg）
2) Calibration tests with the heavy probe（119kg）

Dummy

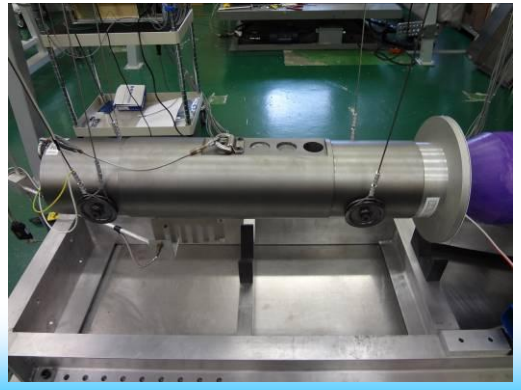
BioRID-II （Ver.G）

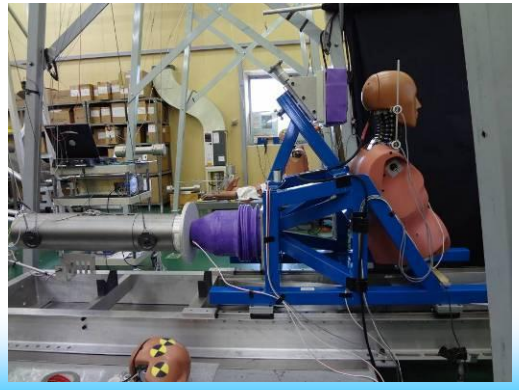
- 095G（JARI) for the calibration tests in last year.
- 102G（JARI) for the calibration tests in last year.
- 115G（Humanetics) for the calibration test in last year.

a) Calibration test with headrest（Light probe - 37.68kg）



b) Calibration test with headrest（Heavy probe - 119kg）



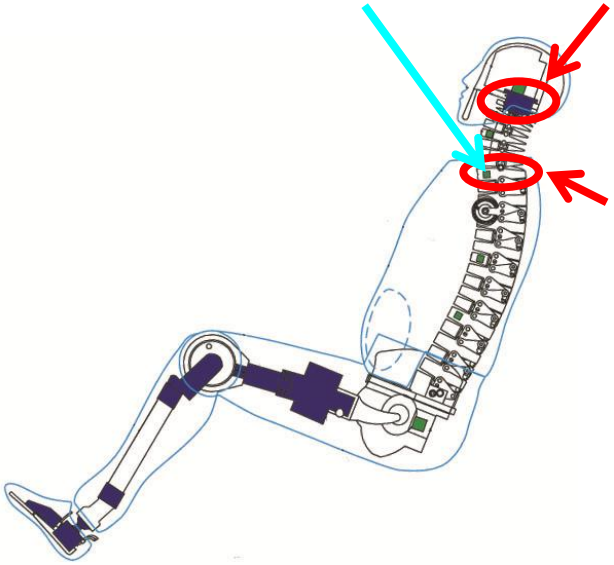


Measurements

T1 Acceleration

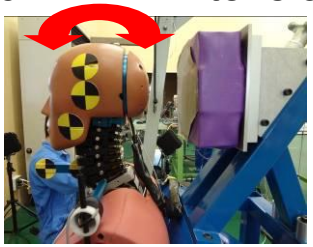
UpperNeck-FX・FZ・MY

LowerNeck-FX・FZ・MY



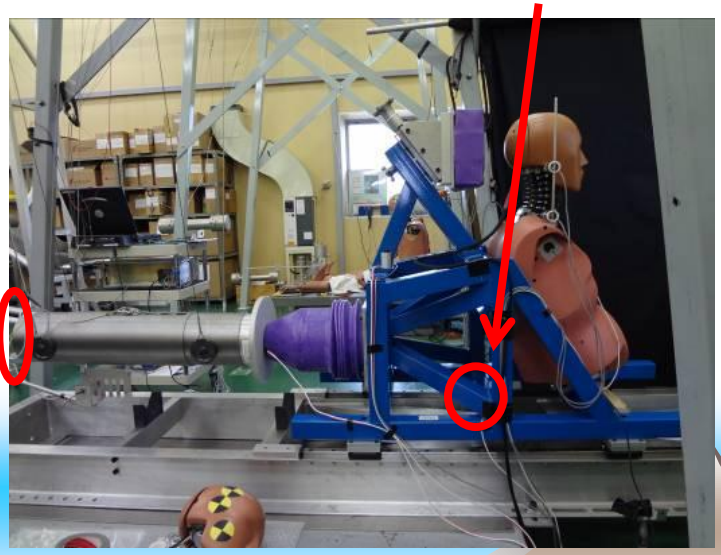
Direction of Moment

Flexion Extension



Sled Acceleration

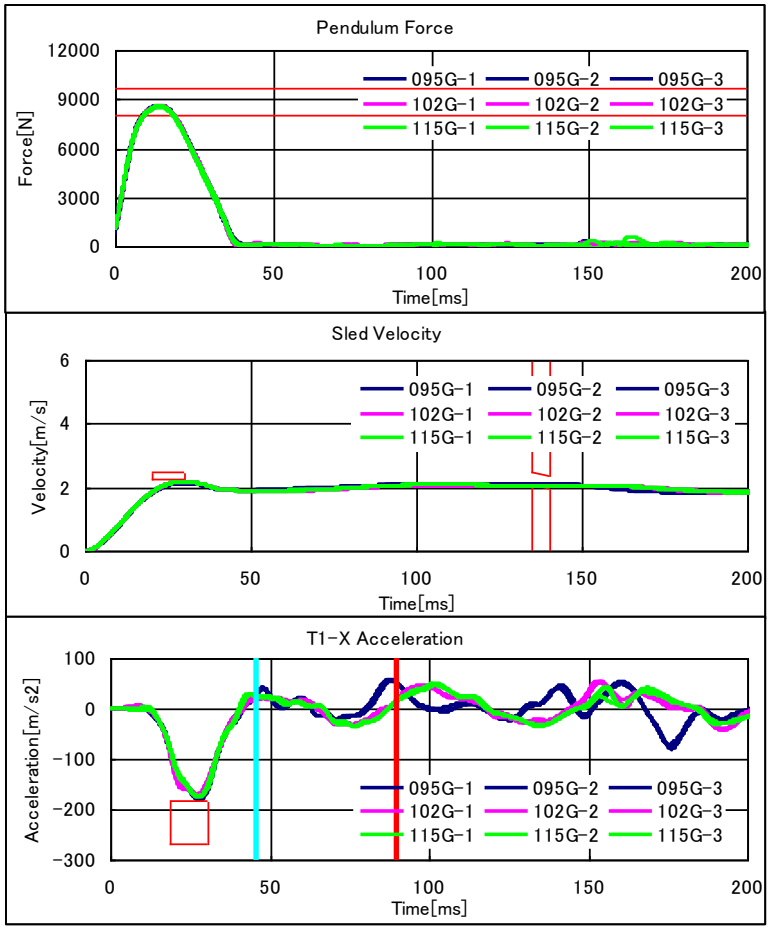
Probe Acceleration



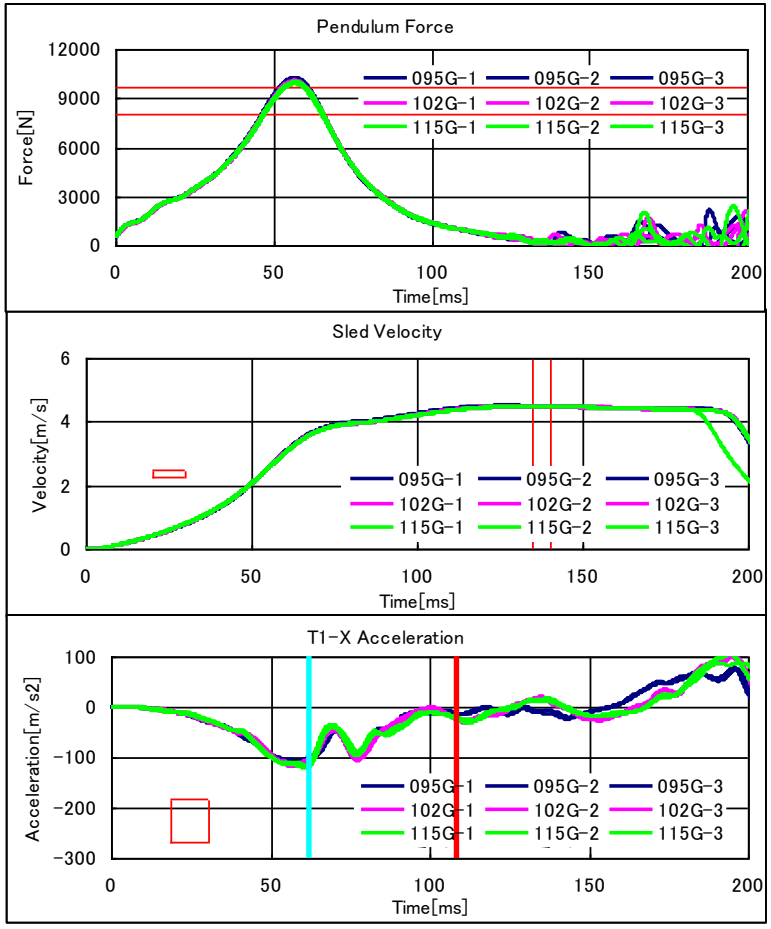
Results

HRCT-Start
HRCT-End

a) Light Probe



b) Heavy Probe



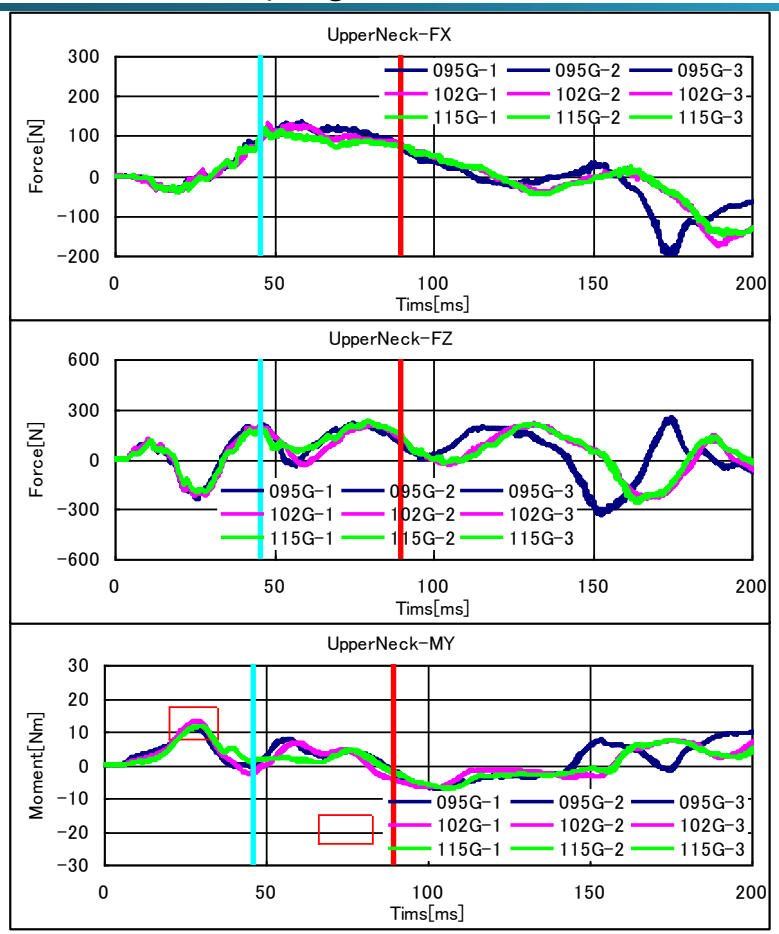
- The repeatability of impact force for each test were good.
- Peak value of sled velocity for b) was around twice that of a).
- For the waveform of T1 acceleration between HRCT-Start and -End, the phase shift of waveform occurred in a), but did not occur in b).

Results（UpperNeck-FX･FZ･MY）

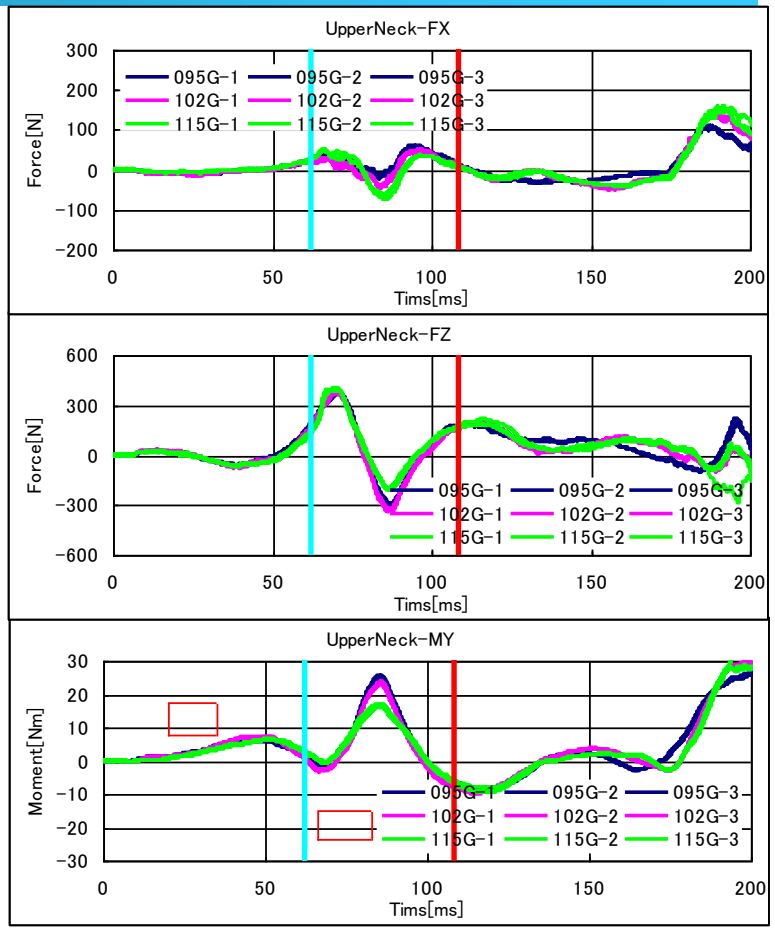
GTR7-08-12

HRCT-Start
HRCT-End

a) Light Probe



b) Heavy Probe



For the range from HRCT-Start to HRCT-End,

- For the time range of HRCT, a)（46～90ms：44ms）and b)（62～108ms：46ms）were almost similar.
- The peak value in the case of b)(C.V.：1.8～9.3%）were slightly larger than the case of a)（C.V.：1.8～4.2%）. Except for FX, the peak value of FZ･MY of b) was higher than 1).

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Results（LowerNeck-FX･FZ･MY）

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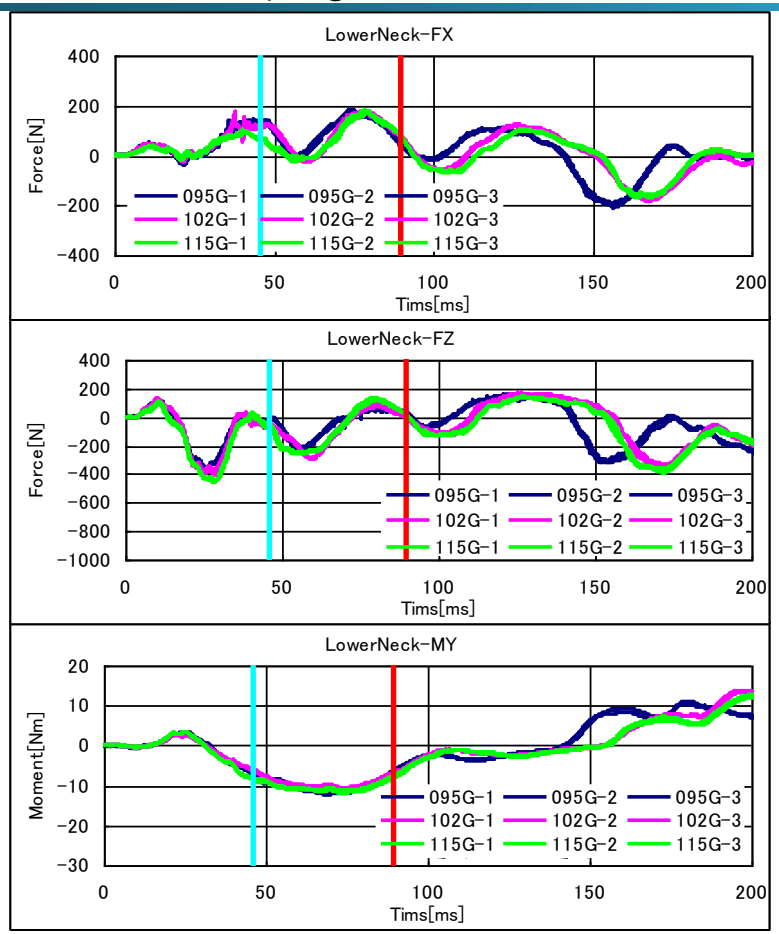
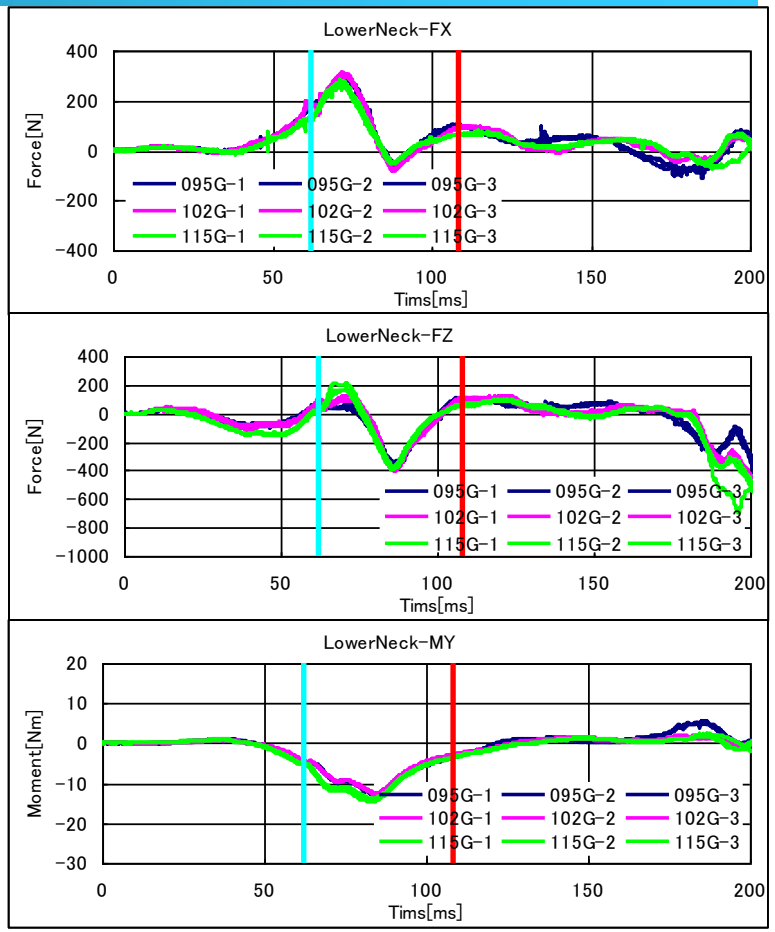
HRCT-Start
HRCT-End

a) Light Probe



b) Heavy Probe



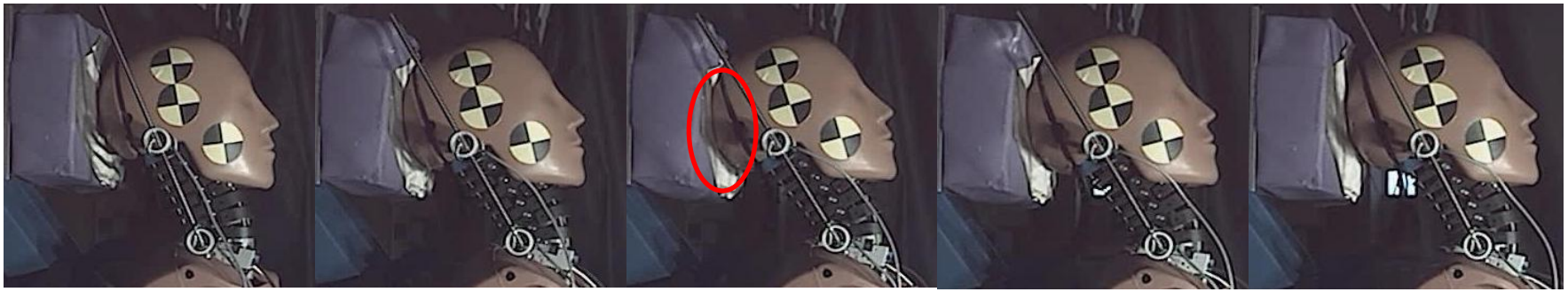
For the range from HRCT-Start to HRCT-End,

- As for FX･FZ, the peak value of case b) occurred more noticeably compared to case a). There was almost no change of MY.
- Variation of peak value of case b)（C.V.：2.4～22.5%）were slightly larger than case a)（C.V.：1.8～18.8%）.

Results（Sequential photographs）

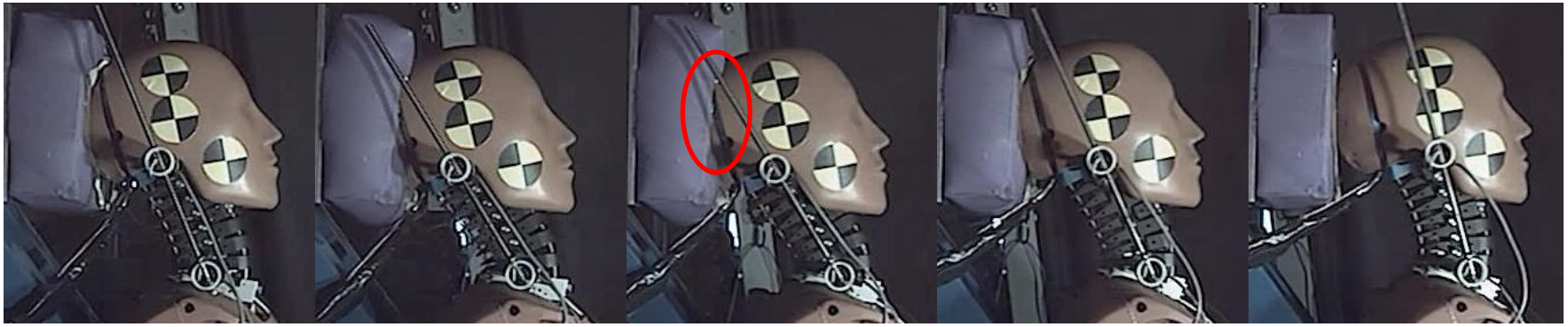
Sequential photographs（During HRCT）of a) Light Probe and b) Heavy Probe

a)



50ms　60ms　70ms　80ms　90ms

b)



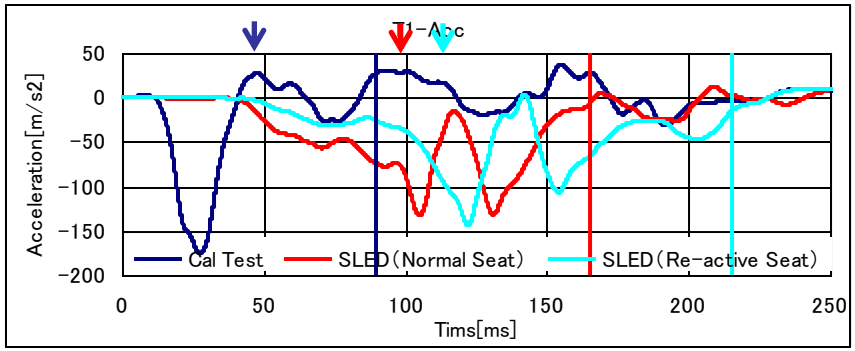
70ms　80ms　90ms　100ms　110ms

For the configuration of the neck（During HRCT）

- When we look at the configuration of the neck in cases a) and b), the neck motion shows an S-Shape in the sled tests. Case b) was more apparent compared to case a).
- As for the head motion to the headrest, case b) was also more apparent compared to case a) (please see the parts shown in the red circle).

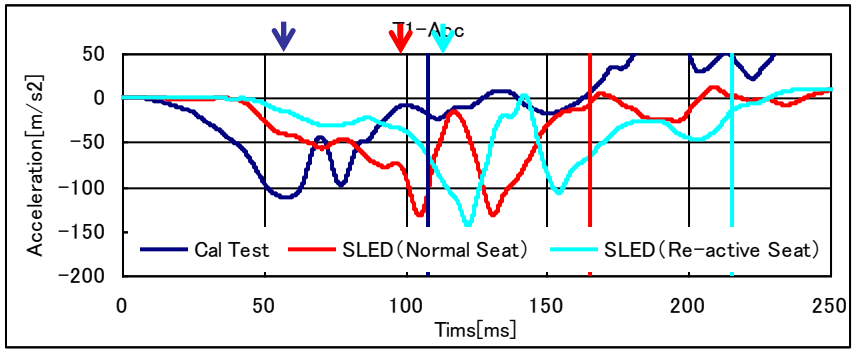
Results（T1 Acceleration compared with sled test ）

a) Light Prove



※Figure shows
↓: HRCT-Start
Vertical line： HRCT-End

b) Heavy Prove



Comparison with sled test（**ΔV16km/h**） during the HRCT from Time 0 to End

- As for the starting slope of T1 acceleration, a) is sharper compared with b). Case b) showed a similar slope to the sled test compared to case a).
- As for a peak value compared with sled test, case a) was large and case b) was small.
- As for waveform configuration, case b) was similar to the sled test compared to case a).

Results（UpperNeck-FX･FZ･MY compared with sled test）

※Figure shows Vertical Time: HRCT-End

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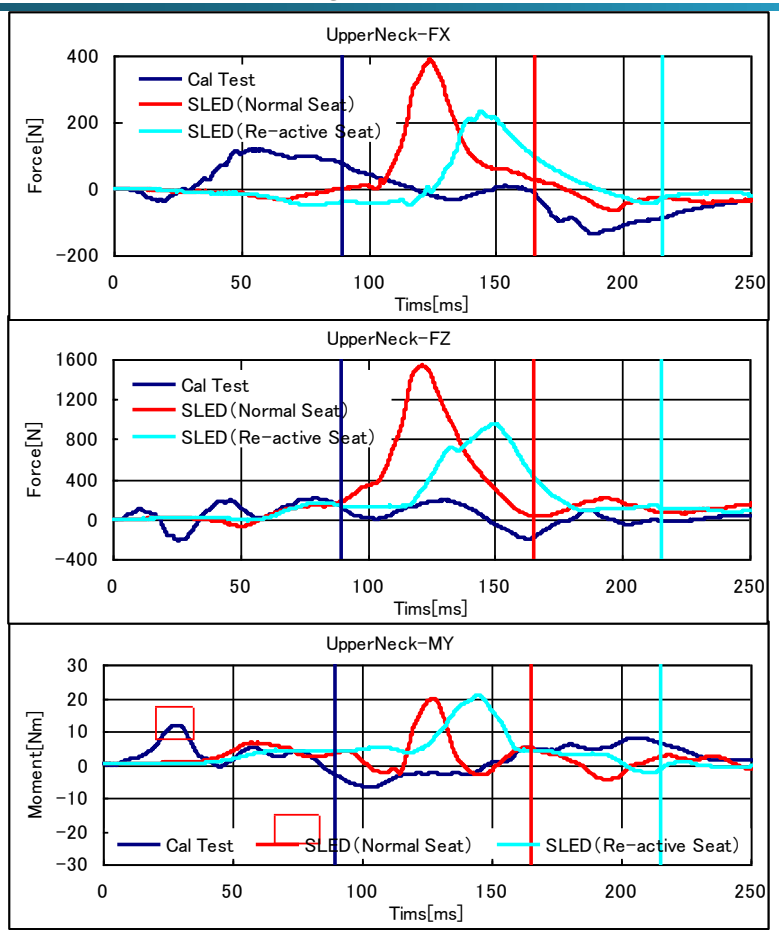
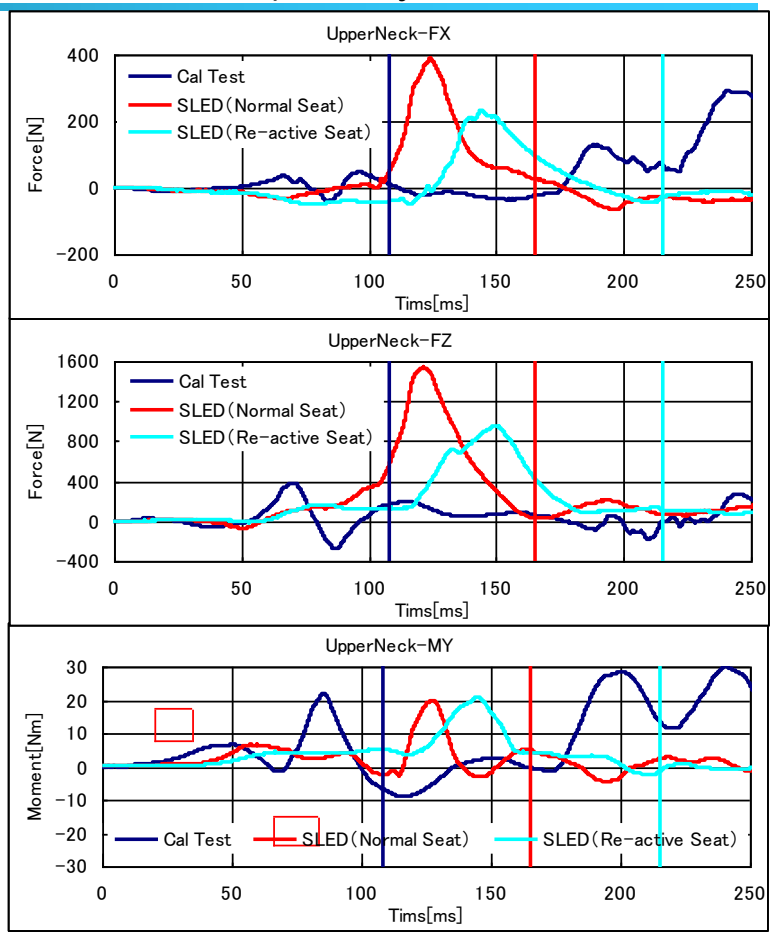
a) Light Probe



b) Heavy Probe



Comparison with sled test（**ΔV16km/h**） during the HRCT from Time 0 to End

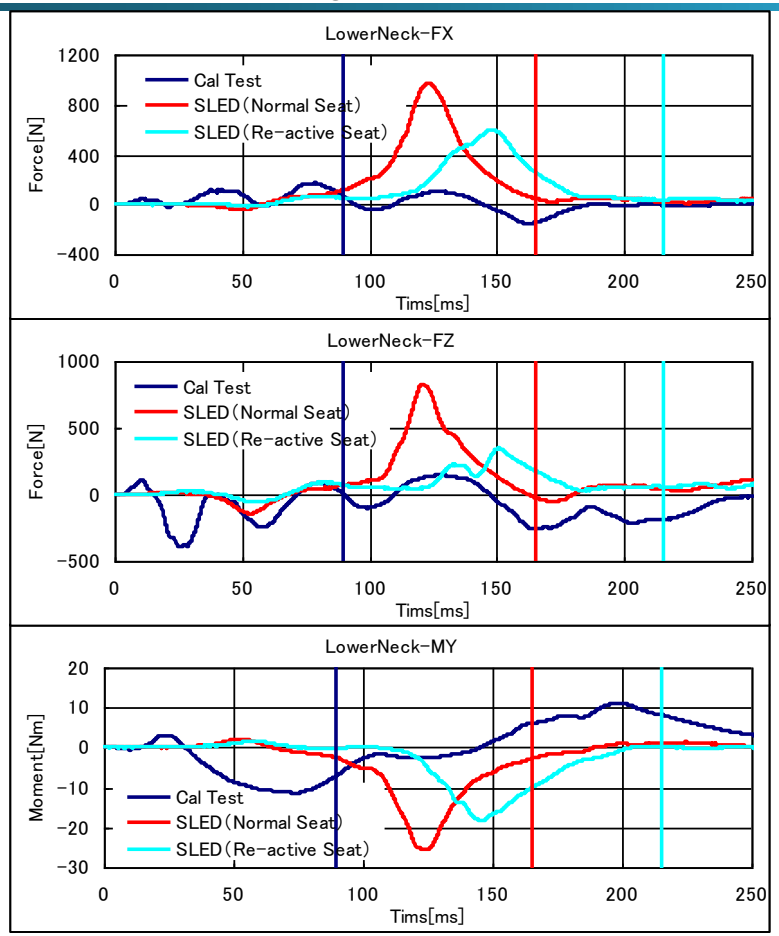
- Compared with the peak value of sled test, the output of the calibration test was small except for b) UpperNeck-MY.
- As for waveform configuration, case b) was more similar to the sled test compared to case a).

Results（LowerNeck-FX･FZ･MY compared with sled test)

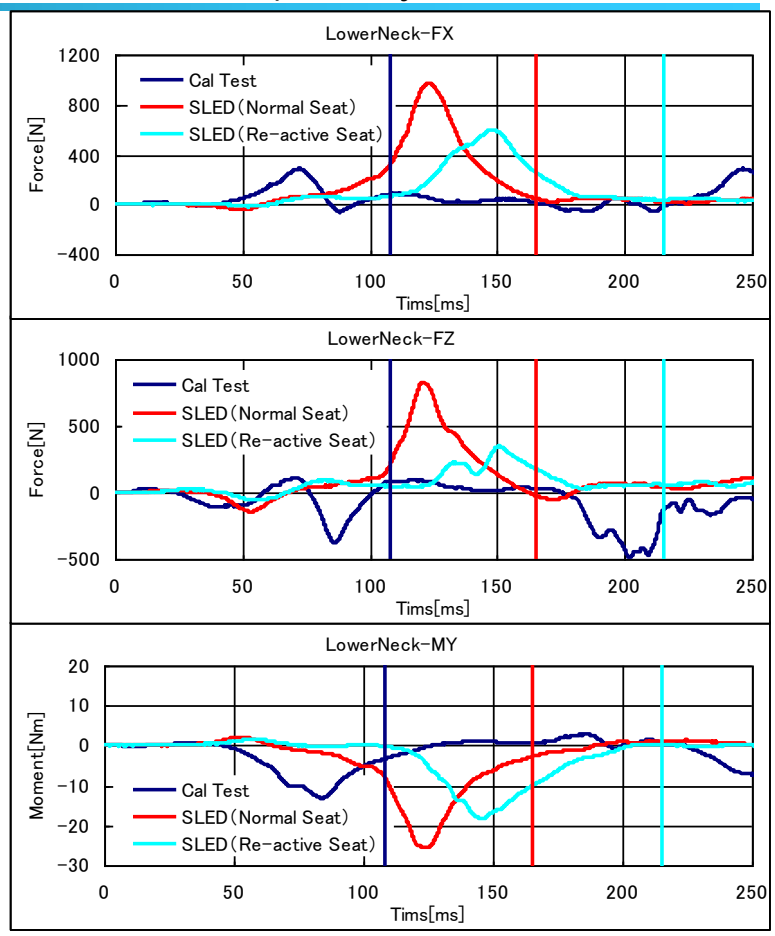
※Figure shows Vertical time: HRCT-End

GTR7-08-12

a) Light Probe



b) Heavy Probe



Comparison with sled test（**ΔV16km/h**） during the HRCT from Time 0 to End

- Both a) and b) compared with the peak value of sled test, the output of the calibration test was small.
- As for waveform configuration, case b) was more similar to the sled test compared to case a).

Results（Coefficient of Variation）

a) Light Probe

Light Prove	Impact Acc. (m/s^2)	SLED Acc. (m/s^2)	T1 Acc. (m/s^2)	UpperNeck				LowerNeck			
				FX (N)	FZ (N)	MY-Flx. (Nm)	MY-Ext. (Nm)	FX (N)	FZ (N)	MY-Flx. (Nm)	MY-Ext. (Nm)
095G	228.4	119.5	−179.9	135.3	216.4	11.1	−7.3	178.1	157.5	5.7	−12.1
102G	227.7	119.7	−172.7	129.0	219.8	13.0	−6.9	178.0	160.0	2.8	−10.8
115G	226.7	120.0	−175.3	117.2	228.2	11.6	−7.1	177.9	143.1	3.3	−11.6
C.V値(%)	0.2	0.2	1.1	3.8	1.8	4.2	1.9	1.8	3.8	18.8	3.1
S.D.	0.9	0.5	3.5	8.6	6.8	0.9	0.2	5.6	10.4	1.4	0.6

b) Heavy Probe

Heavy Prove	Impact Acc. (m/s^2)	SLED Acc. (m/s^2)	T1 Acc. (m/s^2)	UpperNeck				LowerNeck			
				FX (N)	FZ (N)	MY-Flx. (Nm)	MY-Ext. (Nm)	FX (N)	FZ (N)	MY-Flx. (Nm)	MY-Ext. (Nm)
095G	85.7	101.7	−108.9	58.4	380.7	25.4	−8.7	292.4	100.3	1.2	−12.9
102G	84.4	98.9	−116.4	49.7	378.7	23.5	−9.8	304.9	114.2	1.4	−12.7
115G	83.4	97.9	−118.7	50.8	399.7	16.8	−9.0	278.7	182.8	1.3	−14.4
C.V値(%)	0.7	1.0	2.6	5.2	1.8	9.3	3.9	2.4	22.5	9.0	3.7
S.D.	1.1	1.8	5.0	4.9	12.2	3.9	0.6	12.3	41.8	0.2	0.8

Coefficient of Variation

- Light Probe：As for LowerNeck-MY（Flx）, C.V. was exceeded 10%. However, the measurement value (the amplitude) was only 2.9Nm.
- Heavy Probe： C.V of LowerNeck-FZ exceeded 10%. However, the measurement value (the amplitude) was only around 100-200 (N).

Results: Ratio to Injury Criteria applied for the J-NCAP

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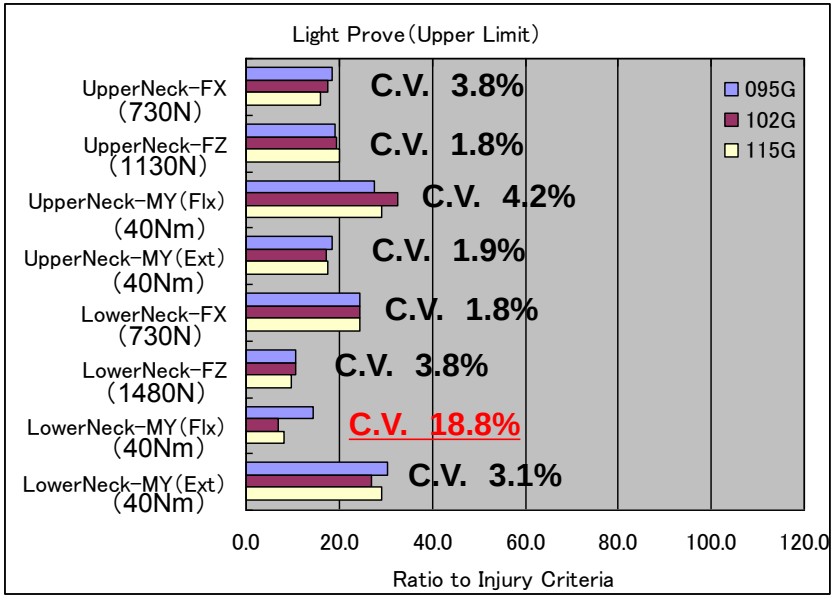
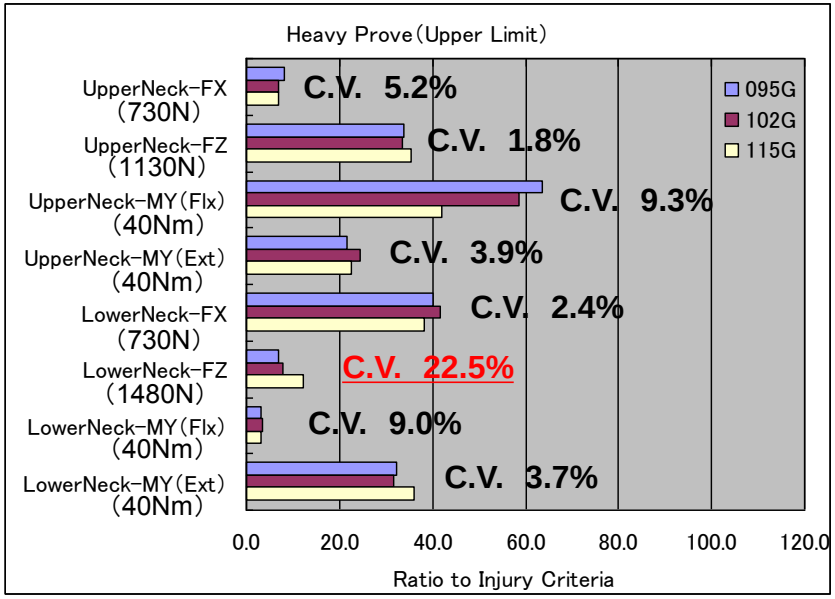
a) Light Probe



b) Heavy Probe



Relationship between Injury Criteria and Items in which C.V. exceeded 10%

The rate of test results and injury criteria were calculated, and the result was compared with the value of WAD2+ Risk 95%.

- Light Probe：LowerNeck-MY（Flx）in which C.V. exceeded 10% had become 20% or less on the injury criteria.
- Heavy Probe：LowerNeck-FZ in which C.V. exceeded 10% had also become 20% or less on the injury criteria.

Summary

- The repeatability of impact force for each tests (a) Light Probe and b) Heavy Probe) were good.
- Peak value of sled velocity for b) is around twice that of a).

UpperNeck Force・moment, LowerNeck Force・Moment（HRCT Time 0 to End ）

- As for the peak value, the case of b) was slightly larger than the case of a).
- Base on the kinematics by a high-speed video, neck motions such as the S-shape motion were similar in both a) and b).The case of b) was closer to the sled tests.

Repeatability of Calibration tests

- As for the reproducibility of dummies, the item in which C.V. exceeded 10% had become LowerNeck-FZ of b) and LowerNeck-MY (Flx) of a). However, they had become 20% or less on the injury criteria（WAD2+ Risk 95% value）.

Comparison of sled test and calibration test

- Compared with sled test results, the peak value of a) and b) were small. However the waveform configuration of b) were close to the sled test.

Brief summary table for comparison of the different probe weights

			Light Probe (LP)	Heavy Probe (HP)	Remark
Sled Spped			Low	High	HP similar to Sled testing
Motion of Head・Neck			Similar to sled testing	Similar to sled testing	HP similar to Sled testing
T1 Acceleration		Peak Value	-175.9	-114.7	HP similar to Sled testing
		C.V.	1.1	2.6	HP is larger.
UpperNeck	FX	Peak Value	127.2	53.0	HP similar to Sled testing
		C.V.	3.8	5.2	HP is larger.
	FZ	Peak Value	221.5	386.4	HP similar to Sled testing
		C.V.	1.8	1.8	No change
	MY(F)	Peak Value	11.9	21.9	HP similar to Sled testing
		C.V.	4.2	9.3	HP is larger.
	MY(E)	Peak Value	-7.1	-9.1	HP similar to Sled testing
		C.V.	1.9	3.9	HP is larger.
LowerNeck	FX	Peak Value	178.0	292.0	HP similar to Sled testing
		C.V.	1.8	2.4	HP is larger.
	FZ	Peak Value	153.5	132.4	HP similar to Sled testing
		C.V.	3.8	22.8	HP is larger.
	MY(F)	Peak Value	3.9	1.3	HP similar to Sled testing
		C.V.	18.8	9	Light Probe is larger.
	MY(E)	Peak Value	-11.5	-13.3	HP similar to Sled testing
		C.V.	3.1	3.7	HP is larger.

Preliminary findings

The output level of waveform under the calibration test

The waveform of the heavy probe test was close to that of the sled test. However, compared with the sled test, the peak value was small.

Reproducibility of dummies (Neck Force and Moment)

Large Variation of the neck force and moment has been pointed out in the sled test, especially for UpperNeck-FX. According to this background, the calibration test with a heavy probe impactor will be required in order to show a more apparent variation in the neck force and moment.

Usability of Heavy probe

Considering the ease of calibration test, the light probe was more desirable. But the heavy probe was somewhat needed in order to reproduce the phenomenon close to sled testing.

Preliminary findings (continued)

As a result, b)（Heavy Probe） in which the peak value and variation has become more apparent will be chosen as the calibration test for suppressing the variation of the impact responses of the dummy.

Acknowledgments

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We would like also to thank the teams of the Japan branch office of Humanetics for the technical support.