TEG-048
29 Nov. 2007
JAMA-JARI

Review of Injury Criteria and Injury Thresholds for Flex-PLI

Flex-GT Tentative Threshold Values

Human value

Body regions		50% injury risk level of AM50 (tentative) Human value	References
Leg	(Tibia)	BM (312 - 350 Nm)	BM (312 Nm): Kerrigan et al., 2004 BM (350 Nm): INF GR/PS/82
Knee	(MCL)	BA (18 - 20 deg)	BA (18 deg).: Ivarsson et al., 2004 BA (20 deg).: INF GR/PS/82

AM50: 50 percentile of american male

BM: Bending moment, BA: Bending angle, EL: Elongation, SD: Shearing displacement.

Convert: Human value >>> Flex-GT value

Human	Human Model	Flex-GT Model	Flex-GT
Tibia bending moment	Tibia bending moment	Tibia bending moment	Tibia bending moment
H_{TBM} (Nm)	HM_{TBM} (Nm)	$FGTM_{TBM}$ (Nm)	FGT_{TBM} (Nm)
312	312	299	299
350	350	337	337

Tentative threshold values

assumption: $H_{TBM} = HM_{TBM.}$ $FGT_{MTBM} = FGT_{TBM}$

$FGT_{MTBM} = 0.9977 * HM_{TBM} - 12.325$ (from reguration curve)

Human	Human Model	Human Model	Flex-GT model	Flex-GT
Knee bending angle	Knee bending angle	Knee MCL elongation	Knee MCL elongation	Knee MCL elongation
H_{KBA} (deg.)	HM_{KBA} (deg.)	HM_{MCL} (mm)	$FGTM_{MCL}$ (mm)	FGT_{MCL} (mm)
18	18	15	18	18
20	20	17	20	20

assumption: $H_{KBA} = HM_{KBA.}$ $FGT_{MMCL} = FGT_{MCL}$

$HM_{MCL} = 0.835 * HM_{KBA}$ (from human model output)

$FGTM_{MCL} = 0.6924 * HM_{MCL} + 8.0156$ (from reguration curve)

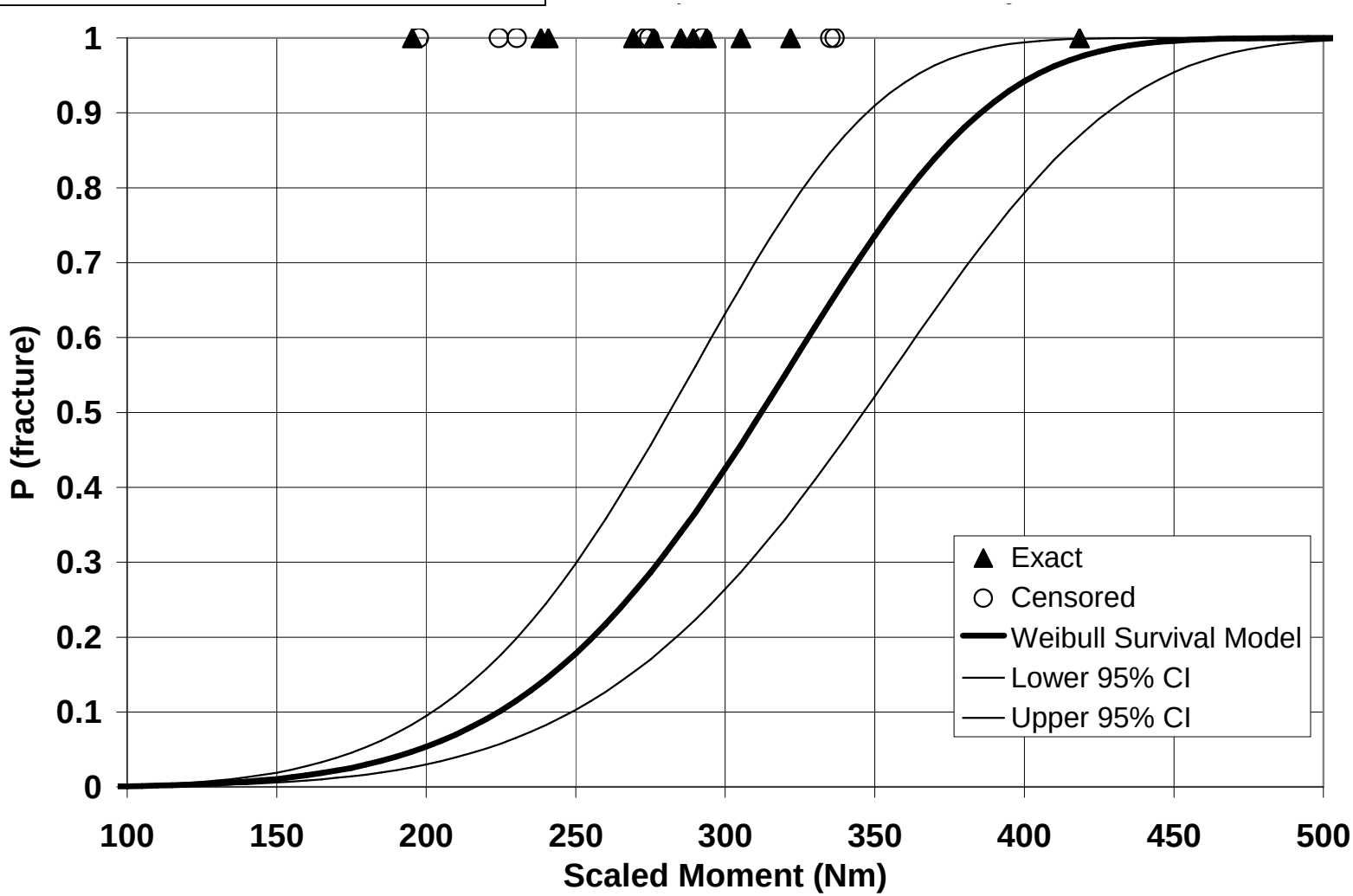
Convert human tolerance values to the Flex-GT ones (use correlation ratio/formula)

References

References (referred contents)

Human value

Injury Risk Curve for Mid-Leg



- Kerrigan, J.R., Drinkwater, D.C., Kam, C.Y., Murphy, D.B., Ivarsson, B.J., Crandall, J.R., Patrie, J. (2004) Tolerance of the Human Leg and Thigh in Dynamic Latero-Medial Bending, ICRASH 2004.

References (referred contents)

Human value

Injury Risk Curve for Mid-Leg

Tibia Bending Strength and Response
Nyquist G. W. et al, 1985 (SAE, Paper No. 851728)

Tibia Bending: Strength and Response
Nyquist G. W. et al, 1985 (SAE 851728)

TestNo.	CadaverNo.	Sex	Age (years)	Stature (m)	Body Mass (kg)	Impact Speed (m/s)	Direction of Loading	Peak Bending Moment at Midspan (Nm) *
118	458	M	54	1.82	68	3.5	LM	395
124	406	M	64	1.77	82	4.2	LM	287
126	375	M	58	1.74	73	4.2	LM	224
127	404	M	56	1.76	79	3.7	LM	237
129	395	M	57	1.78	99	3.7	LM	349
132	525	M	57	1.87	45	3.8	LM	264
147	400	M	57	1.78	84	2.9	LM	431

Ave.	10%up
312.4	**343.7**

* The peak values were attenuated by 10 % by filtering (CFC 60) procedure.

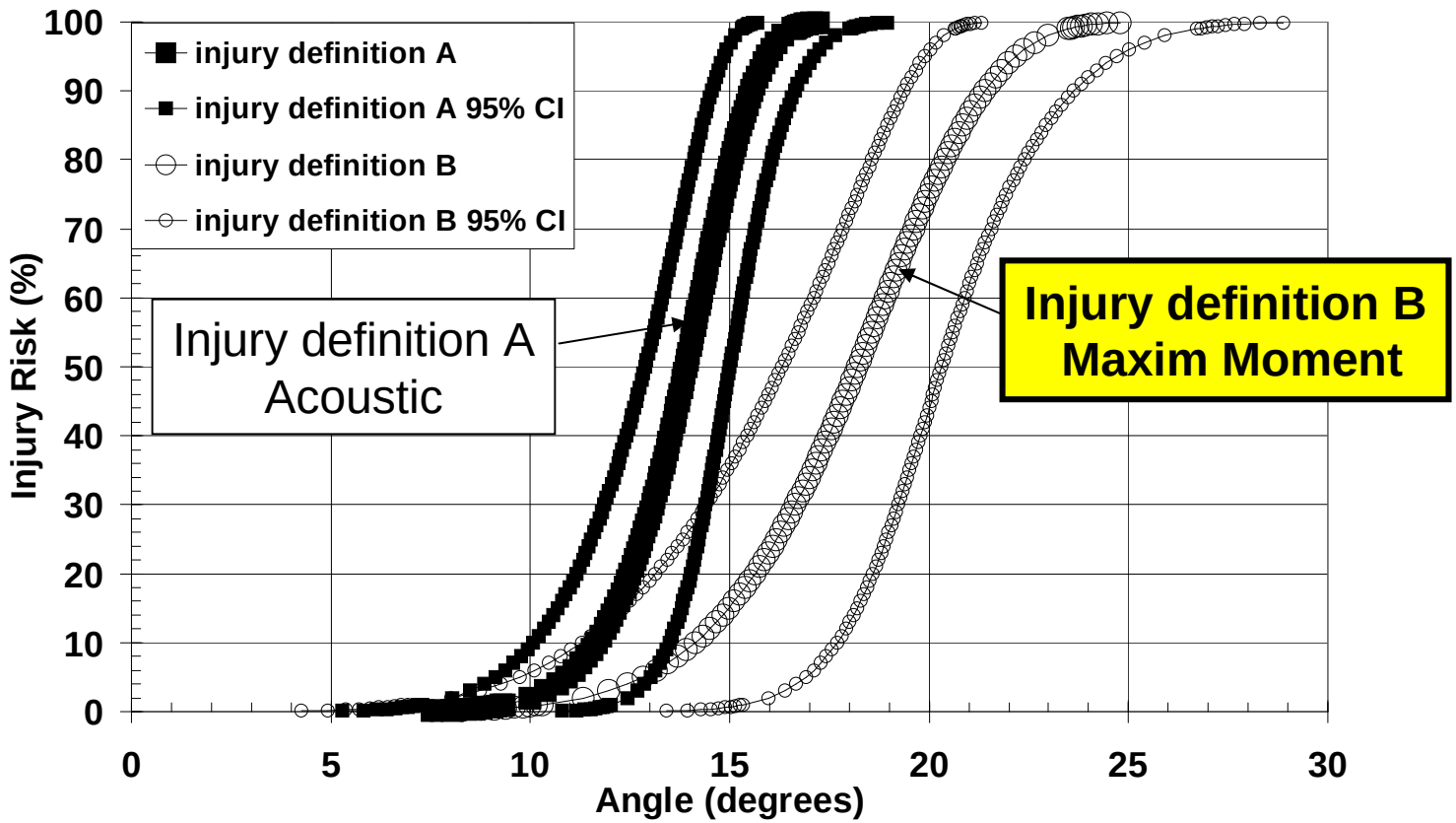
Proposed injury threshold for tibia bending: 350 Nm

- ECE/TRANS/WP.29/GRSP/INF GR PS (2004) Discussion on Injury Threshold for Pedestrian Legform Test, INF/GR/PS/82, P. 2.

References (referred contents)

Human value

Injury Risk Curve for Knee (Bending)



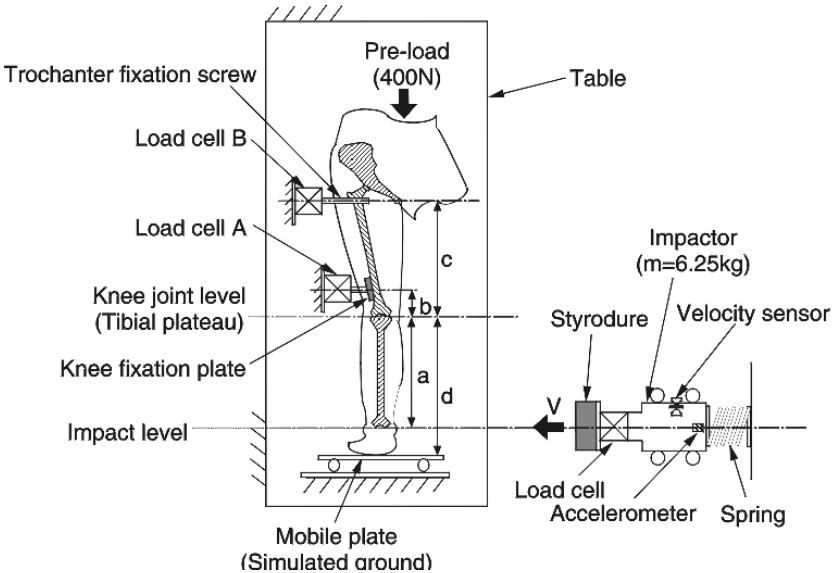
- Ivarsson, B.J., Lessley, D., Kerrigan, J.R., Bhalla, K.S., Bose, D., Crandall, J.R., Kent, R.（2004）Dynamic Response Corridors and Injury Thresholds of the Pedestrian Lower Extremities, Proc. International IRCOBI Conference on the Biomechanics of Impacts, pp. 179-191.

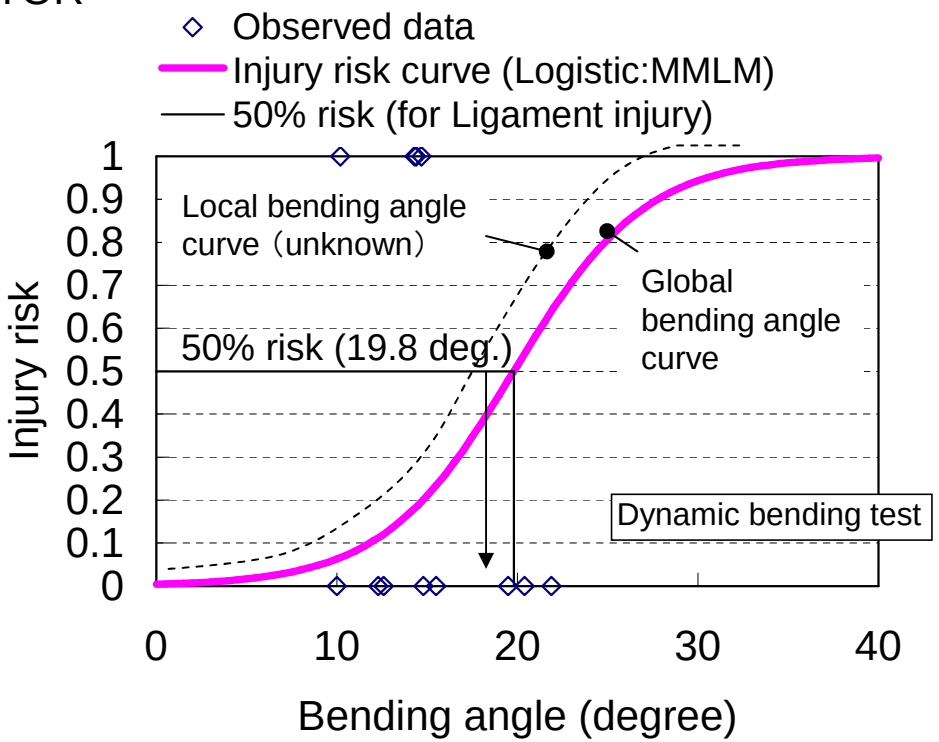
References (referred contents)

Human value

Injury Risk Curve for Knee (Bending)

RECONSIDERATION OF INJURY CRITERIA FOR PEDESTRIAN SUBSYSTEM LEGFORM TEST
- PROBLEMS OF RIGID LEGFORM IMPACTOR -
Konosu A. et al, 2001 (ESV, Paper No. 263)





Proposed injury threshold for Knee bending: 20 deg.

Local bending angle: Exclude Long Bone Bending Angle
Global bending angle: Include Long Bone Bending Angle

- ECE/TRANS/WP.29/GRSP/INF GR PS (2004) Discussion on Injury Threshold for Pedestrian Legform Test, INF/GR/PS/82, P. 2.

References (referred contents)

Human model value

Injury Risk Curve for Knee (Shearing)

IHRA/PS/309

2) Knee injury risk curve for shearing

No injury risk curve is set by IHRA/PS because of its priority is low from the accident. IHRA/PS just described an example 10 mm from the Dr. Cesari's computer simulation analysis.

- International Harmonized Research Activity/Pedestrian Safety Working Group（2004）IHRA/PS Decisions for the IHRA/PS Legform Test Procedures, IHRA/PS/309.

References (referred contents)

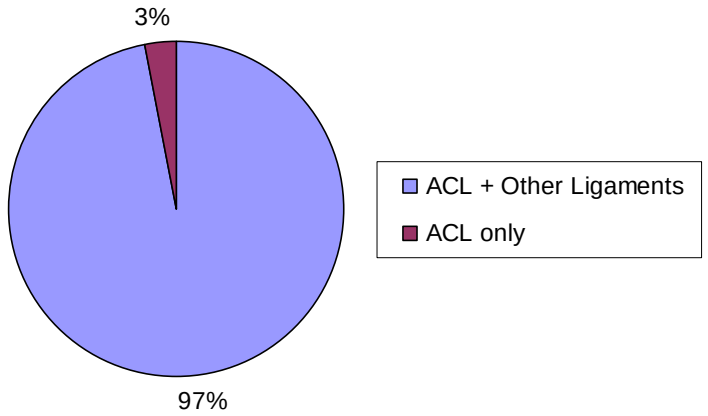
Accident data

G. Teresinski et al., Knee joint injuries as a reconstructive factors in car-to-pedestrian accidents, Forensic Science International 124 (2001) 74-82.

Table 1
Frequencies of knee injuries before and after cutting through the tibial and femoral epiphyses (additionally, the frequency of isolated injuries to the anterior cruciate ligament was included)

	Impact side					Run over only	Total
	From front	From rear	From lateral	From medial	Not determined		
Number of victims	24	87	165		37	44	357
Percentage (%) of victims with knee injuries (visible before the cross-sections were performed)	79	51	81		32	11	60
Number of victims with the cross-sections of the knee epiphyses	18	47	139		25	20	249
Percentage (%) of victims with knee injuries	89	72	94		64	15	80
Number of isolated injuries to the anterior cruciate ligament	1	13	2	2	0	2	20

Under the lateral or medial side impact, only ACL injured case is quite rear (3%). Most of all (97%) case accompany with other ligament injuries.



References (referred contents)

Injury Mechanism

G. Teresinski et al., Knee joint injuries as a reconstructive factors in car-to-pedestrian accidents, Forensic Science International 124 (2001) 74-82.

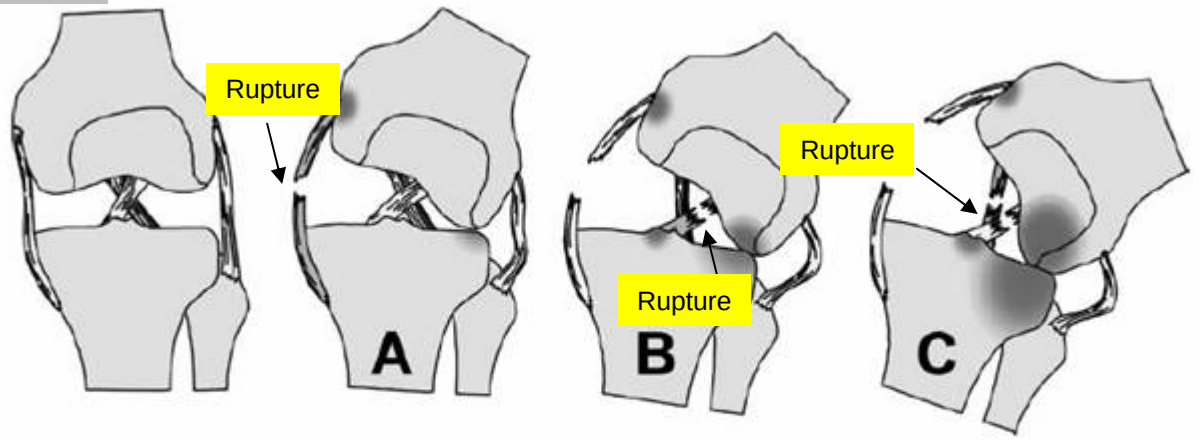


Fig. 8. Stages of the left knee injury (frontal view) in the mechanism of valgus flexion. (A) Avulsion of the medial collateral ligament; (B) avulsion of the anterior cruciate ligament; (C) avulsion of the posterior cruciate ligament. A → C increasing compression of the lateral tibial and femoral condyles.

78 G. Teresiński, R. Mądro / Forensic Science International 124 (2001) 74–82