JAPAN Research Status for Bio-RID II Injury Parameters on Head Restraints GTR

September '05

JAPAN MLIT

Proper Evaluation for Reduction of the Risk of Whiplash Injury

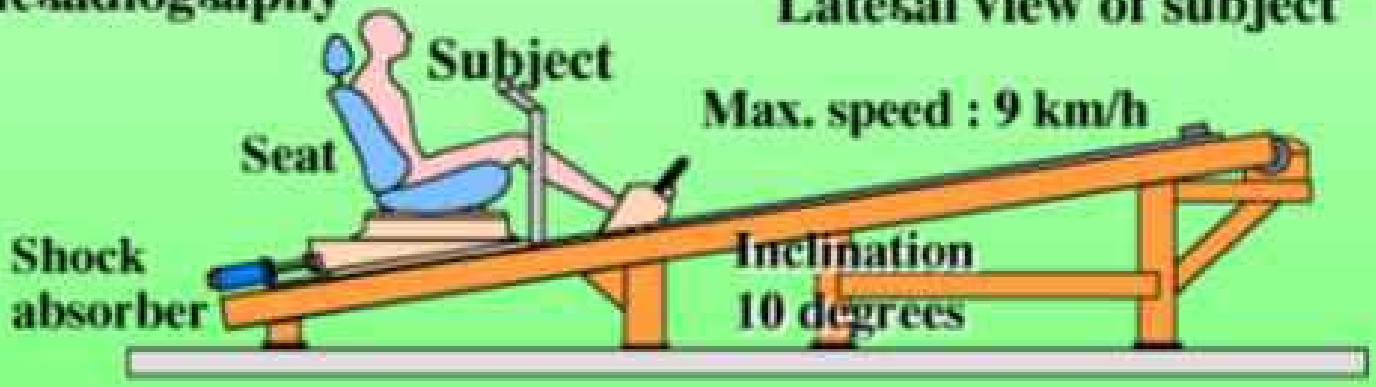
Proper Evaluation for Reduction of the Risk of Whiplash Injury has been deduced from the researches done by Ono et. al. from ’96 to ’03 and also from the many researches published in the past.

Spinal Movement Due to Impact

For Whiplash Injury Mechanism Based on Human Volunteer Test

Cinesadiogsaphy

Latesal view of subject



Test Set-up

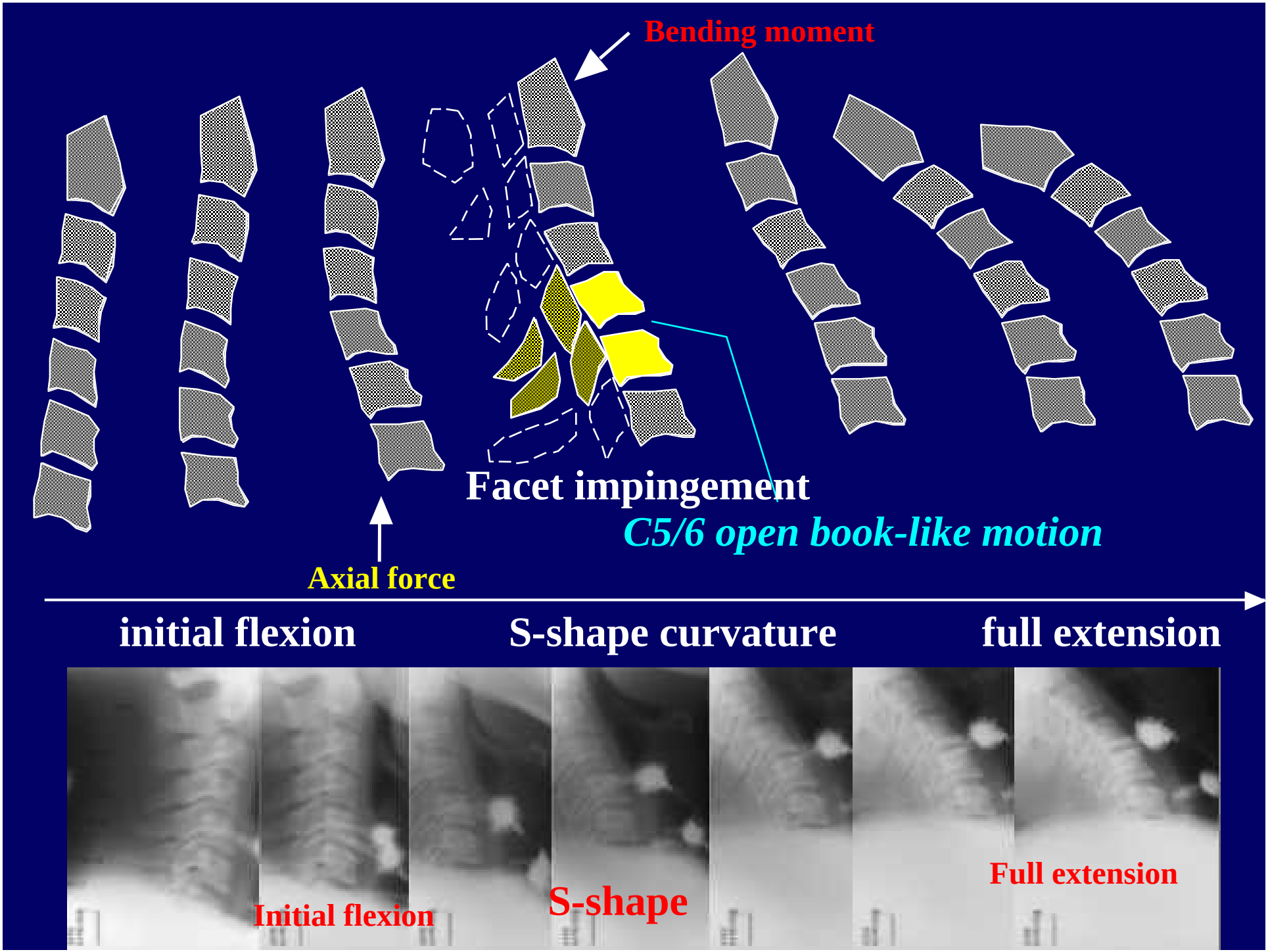
Whole Spine Motion During Rear Impact

Rear-End Impact

Female, Velocity: 6 km/h

Head·T1·Pelvis accelerations

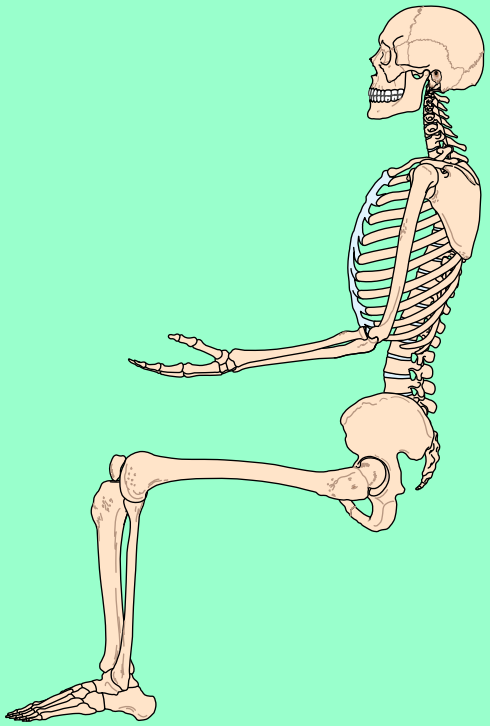
EMG(SCM, PVM, VMRA, M_OEA, M_LD)


Bending moment
Facet impingement
C5/6 open book-like motion
Axial force
initial flexion
S-shape curvature
full extension
Initial flexion
S-shape
Full extension

Whiplash Injury

Not only neck motion

The whole spine motion should be considered



S-shape deformation
(Vertical, Horizontal Motion)

Cervical spine motion

Straightening of spine

Ramping-up

Current Evaluation (Inadequate)
Upper neck
1) Head rotation
2) Upper neck moment

Neck angle

Parameters to be included

Lower neck
1) Axial, shear forces
2) Neck angle wrt T1

New index ; NIC ?

To be proposed as a new neck injury indications

Proper Evaluation for Reduction of the Risk of Whiplash Injury

Current Proposed Evaluation Parameters

Proposed Injury Parameters

Name	Proposer	Year	Formula or Description
NIC	Bostrom	'96	$NIC = a_{rel} \cdot 0.2 + v_{rel}^{\ 2} < 15 m^2/s^2$
IV-NIC	Panjabi	'99	$IV\text{-}NIC_i = \theta_{trauma,\ i} / \theta_{physiological,\ i}$
Velocity of T1 (Rebound)	Muser	'00	(1) el : Approximate ratio of kinematic energy before and after the contact of head and head restraint. $el = \left[\frac{v_{peak}}{v_{peak}'}\right]^2$
			(2) Δt : Time difference between zero points of head velocity and T1 velocity.
			(3) vch : T1 velocity relative to the sled when the rearward displacement of the head relative to T1 is maximum.
			(4) vrel+ : Peak relative velocity between head and T1 along x axis after contacting the head restraint.
			(5) vhead+, vT1+ : Velocity of head and T1 before the seat belt starts restraining the occupant.
			(6) Dynamic and residual deflections of seatback
NDC	Viano	'01	$Nd_{distruction} = \frac{Z_{OC-T1}}{-15mm}$ $Nd_{extentisio\ n} = \frac{\theta_{OC-T1}}{25°}$ $Nd_{shear} = \frac{X_{OC-T1}}{35mm}$
Nkm	Schmitt	'02	$N_{km}(t) = \frac{F_x(t)}{F_{\text{int}}} + \frac{M_y(t)}{M_{\text{int}}}$
LNL	Heitplatz	'03	$LNL-index(t) = \left\lvert\frac{\sqrt{My_{lower}(t)^2 + Mx_{lower}(t)^2}}{C_{moment}}\right\rvert + \left\lvert\frac{\sqrt{Fx_{lower}(t)^2 + Fy_{lower}(t)^2}}{C_{shear}}\right\rvert + \left\lvert\frac{Fz_{lower}(t)}{C_{tension}}\right\rvert$
MIX	Kullgren	'03	$MIX = \sqrt{\left(\frac{NIC_{\max}}{NIC_{av}}\right)^2 + \left(\frac{N_{km}}{N_{av}}\right)^2}$
WIC	Muñoz	'05	$WIC = M_{yOC} - M_{ylw}$

Conclusion : This proper evaluation of S-shape deformation of cervical spine is more reliable for assessment on the upper part (Occipital Condyle) and the lower part (T1) of cervical spine.

<Tentative Proposed Injury Parameters>

T1 maximum acceleration

Upper neck shear force

Upper neck axial force

Time phase is limited within the phase of neck s-shape. The above tentative proposed evaluation parameters are induced from Japan based on the research of the biomechanical responses on human volunteer and relevant tests.

Thank you for your attention !!