Tentative Draft Proposal on Evaluation of Injury Parameters and Injury Risk Curve, a collaborative undertaking between NHTSA and Japan

Part II

JAPAN
JMLIT/JASIC/JARI
Injury evaluation parameters: Strain

Injury evaluation parameters: IV-NIC(R)

Correlation between AIS and IV-NIC(R)

Correlation among Intervertebral Rotation, NDC, IV-NIC, and NFM

Common injury evaluation parameter: IV-NIC(R) • Flexion

*Human Volunteer Test (~6km/h)
*20 accident cases of FE Simulation (8~28km/h)

Injury Scale: WAD

Injury evaluation parameters: Strain

Correlation between WAD and Strain

Correlation among Strain and NIC, NFM

PMHS Test (16, 17.3, 17.6, 24km/h)

Injury Scale: AIS

Injury evaluation parameters: IV-NIC(R)

Correlation between AIS and IV-NIC(R)

Correlation among Intervertebral Rotation, NDC, IV-NIC, and NFM

Injury Evaluation Parameters and Injury Criteria for GTR7 (Proposal)
Injury evaluation parameters for BioRID-II:
- NIC
- UpperNeck-FX
- UpperNeck-FZ
- UpperNeck-MY(Ext)
- UpperNeck-MY(Flx)
- LowerNeck-FX
- LowerNeck-FZ
- LowerNeck-MY(Ext)
- LowerNeck-MY(Flx)

Common Indicator - IV-NIC(R) • Flexion value = 1.1

AIS 1+ = 50%

WAD 2+ = 82.9%

Injury evaluation parameters for BioRID-II:
- NIC
- IV-NIC (R) • Flexion
- Intervertebral Rotation • Flexion
- NDCrot
- NDCx

Neck Forces/Moments In progress

Harmonization
(Suggest Alternatives Or Agree to a Common Criteria)

Human Volunteer/Accident Reconstruction
Injury scale : WAD
Injury Evaluation Parameters
Neck Forces/Moment, NIC

PMHS tests
Injury scale : AIS
Injury Evaluation Parameters
Intervertebral Rotation, IV-NIC, NDC, NFM
Setting methods of neck injury criteria

Fig. 1 shows that IV-NIC value corresponding to the AIS1+ 50% on the risk curve obtained by the PMHS Tests (Production seat).

The IV-NIC value 1.1 corresponds to the AIS1+50% on the risk curve obtained by the PMHS tests shown in Fig.1. This IV-NIC value 1.1 also corresponds to 82.9% of WAD2+ risk curve wrt the IV-NIC.

The IC of NFM and NIC will be created by WAD2+82.9% based on the risk curve of WAD2+ wrt IV-NIC (see Table 1 on the next page).
<table>
<thead>
<tr>
<th>Injury Criteria</th>
<th>WAD2+ 82.9% Value (IV-NIC=1.1)</th>
<th>AIS1+ 50.0% Value (IV-NIC=1.1)</th>
<th>Literature Human Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Rotation</td>
<td>?</td>
<td>3.7 deg.</td>
<td></td>
</tr>
<tr>
<td>NDCrot</td>
<td>12.0 deg</td>
<td>12.2 deg.</td>
<td></td>
</tr>
<tr>
<td>NDCx</td>
<td>30.5 mm</td>
<td>117.8 mm</td>
<td></td>
</tr>
<tr>
<td>NIC Max</td>
<td>23.2</td>
<td>29.7</td>
<td>-</td>
</tr>
<tr>
<td>Upper Neck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FX</td>
<td>636.5</td>
<td>?</td>
<td>845 1), 2)</td>
</tr>
<tr>
<td>FZ</td>
<td>979.2</td>
<td>?</td>
<td>1134 1), 2)</td>
</tr>
<tr>
<td>MY(FLx)</td>
<td>33.5</td>
<td>?</td>
<td>50.2 2)</td>
</tr>
<tr>
<td>MY(Ext)</td>
<td>33.5</td>
<td>?</td>
<td>20.3 2)</td>
</tr>
<tr>
<td>Lower Neck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FX</td>
<td>636.5</td>
<td>?</td>
<td>600 ~ 800 3)</td>
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<tr>
<td>FZ</td>
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<tr>
<td>MY(FLx)</td>
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<td>-</td>
</tr>
<tr>
<td>MY(Ext)</td>
<td>33.5</td>
<td>?</td>
<td>-</td>
</tr>
</tbody>
</table>

References:
1) Mertz, 1971, Strength and Response of the Human Neck, 15th STAPP
2) SAE J885, 2003, Human Tolerance to Impact Condition as related to Motor Vehicle Design
3) Stemper, 2009, Verification of Lower Neck Shear Force as a Rear Impact Injury Criterion

Units:
Force (N)
Moment (Nm)
Conclusion

Tentative draft proposal on injury evaluation of parameters and injury risk curve, a collaborative undertaking between NHTSA and Japan was reported.

Until the next meeting on December, 2013, it should be refined and reviewed carefully, and it should also be updated/revised as the final proposal on the neck injury evaluation parameters and the neck injury criteria for the informal GTR7.
Further discussion (if needed)
### Classification on WAD and AIS

- **WAD** is applied for HVT and CAE.
- **AIS** is applied for PMHS.
- As shown below, AIS & WAD are essentially different injury scales.
- Based on the proper different definitions of AIS and WAD, the conversion between AIS and WAD through IV-NIC as the common factor will be done.

<table>
<thead>
<tr>
<th>WAD (for CAE)</th>
<th>AIS (for PMHS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade</strong></td>
<td><strong>Clinical classification</strong></td>
</tr>
<tr>
<td>0</td>
<td>The neck has no symptoms, and the physical finding is normal.</td>
</tr>
</tbody>
</table>
| 1            | The neck has pain and stiffness, but the physical finding is normal. | 1 | • Strain, acute with no fracture or dislocation  
| | | | • Interspinous ligament laceration |
| 2            | In addition to neck symptoms, there is a limit of motion space of the cervical vertebra and a localized tender point, suggesting neck symptoms from the musculoskeletal system. | 2 | • Dislocation (subluxation) without fracture facet unilateral  
| | | | • Disc injury |
| 3            | In addition to neck symptoms, there are neurological findings such as the tendon reflex disorder, adynamia, and perception disorder. | 3 | • Dislocation (subluxation) without fracture facet bilateral |
| 4            | Dislocation and fracture of the cervical vertebra. | | |
Fig. A Scattering Diagram on WAD wrt IV-NIC

Fig. B WAD2+ risk curve wrt IV-NIC
JNCAP
Risk Curve of NIC/Neck Force/Moment and reference values in Japan

Substitution of Lower Neck Fx HeadRear

Substitution of Upper Neck My Flexion

Substitution of Upper Neck My Flexion

Substitution of Lower Neck Fx HeadRear

Upper Neck Fx HeadRear

Upper Neck Fz Tension

Upper Neck My Extension

Lower Neck Fx HeadRear

Lower Neck Fz Tension

Upper Neck My Flexion

Upper Neck My Extension

Lower Neck My Flexion

Lower Neck My Extension

Substitution of Upper Neck My Flexion

Upper Neck My Flexion

Lower Neck My Flexion

Lower Neck My Extension

Injury Criteria | WAD2+ 5% Value | 95% Value |
---|---|---|
NIC Max | 8 | 30 |
Upper Neck | FX | 340 | 730 |
| FZ | 475 | 1130 |
| MY(Flx) | 12 | 40 |
| MY(Ext) | 12 | 40 |
Lower Neck | FX | 340 | 730 |
| FZ | 257 | 1480 |
| MY(Flx) | 12 | 40 |
| MY(Ext) | 12 | 40 |