

Informal document GRSP-49-24
(49th GRSP, 16-20 May 2011,
agenda items 4(a))

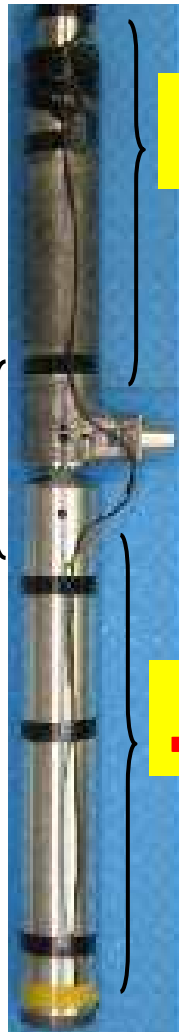
**Difference of TRL legform impactor/injury criteria
and Flex pedestrian legform impactor/injury criteria**

Difference of Structure

TRL Legform Impactor

Structure

Main unit

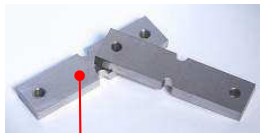


Femur

■ **RIGID**

Knee

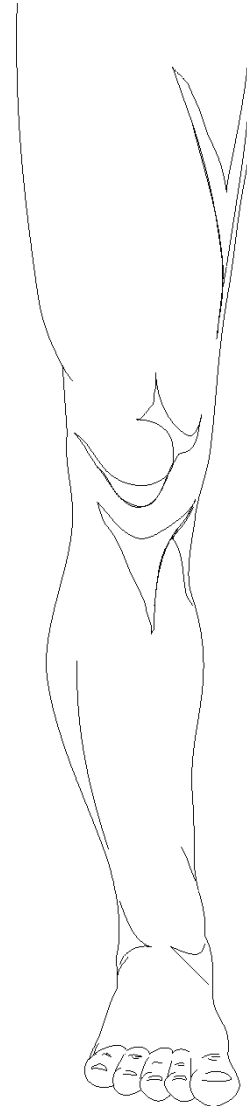
■ **Steel Plate**



Knee Ligaments
(Steel plate)

Tibia

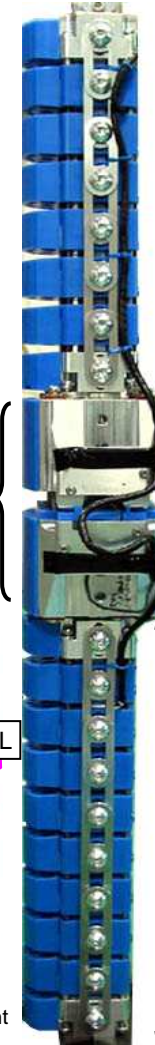
■ **RIGID**



Flexible Pedestrian Legform Impactor

Structure

Main unit

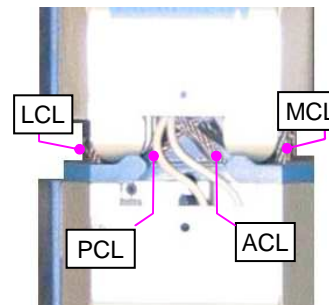


Femur

✓ **Flexible**
like
human
bone

Knee

✓ **Ligaments**
like human
knee



Tibia

✓ **Flexible**
like
human
bone

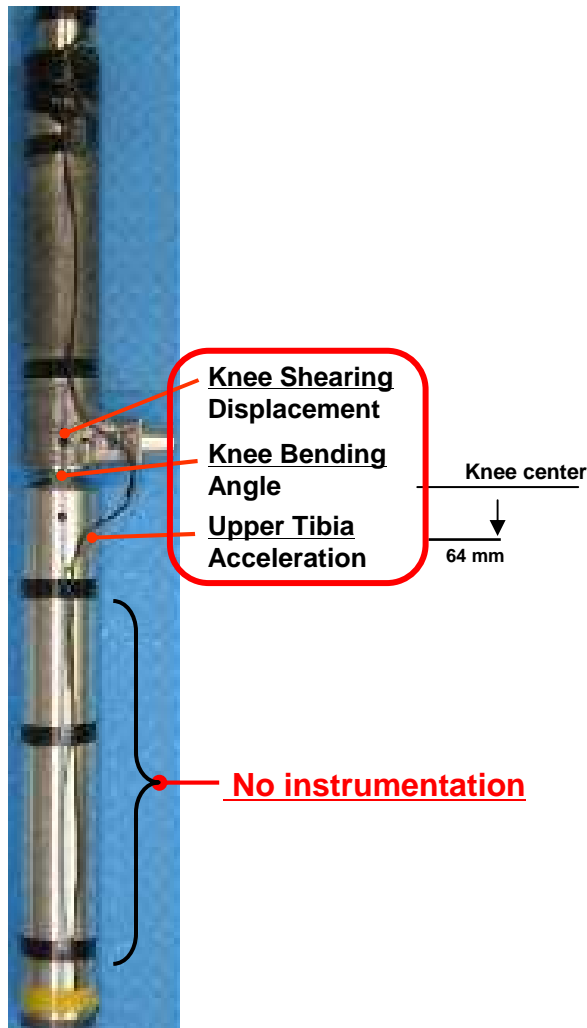
MCL: Medial Collateral Ligament
ACL: Anterior Cruciate Ligament
PCL: Posterior Cruciate Ligament
LCL: Lateral Collateral Ligament

Difference of Instrumentation/Injury Criteria

TRL Legform Impactor

Instrumentation

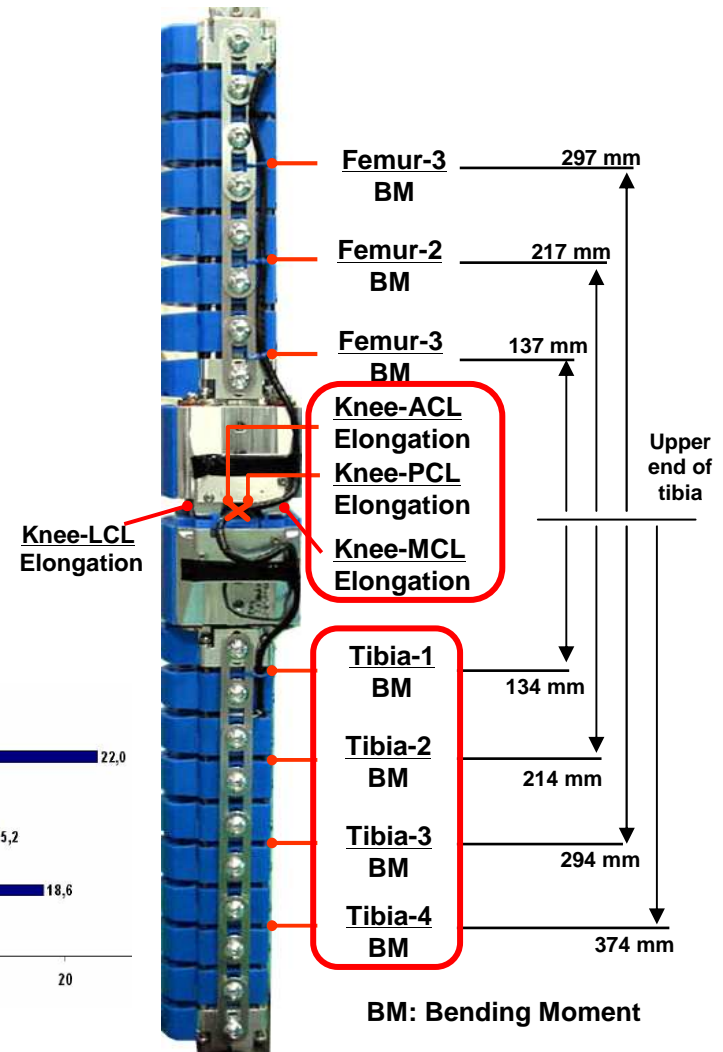
Injury Criteria



Flexible Pedestrian Legform Impactor

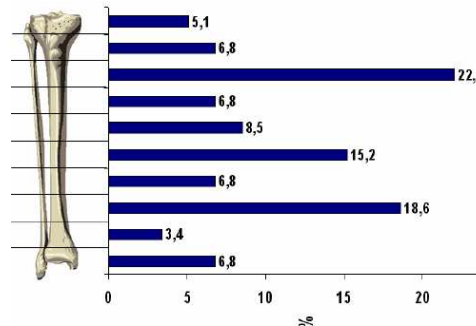
Instrumentation

Injury Criteria



Real-world Accident Analysis

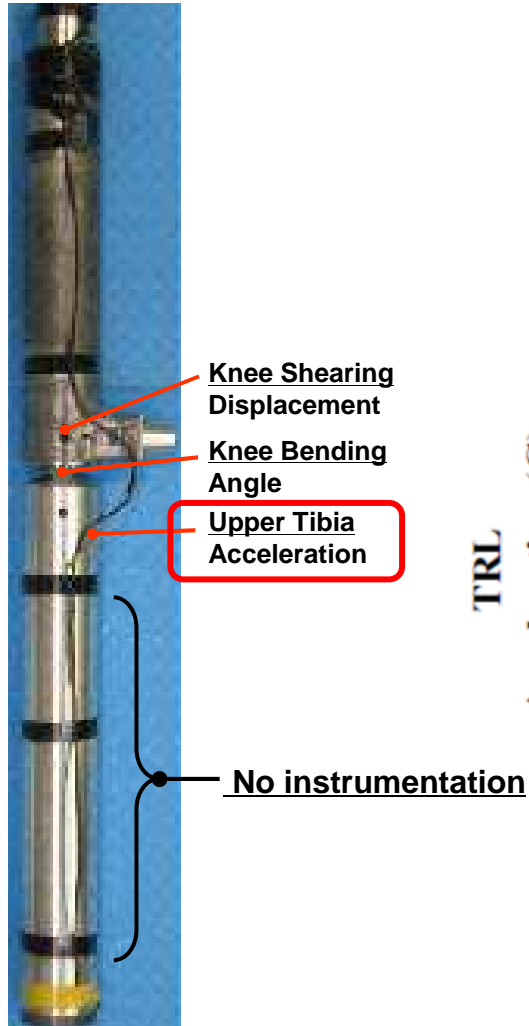
Otte et al, 2007



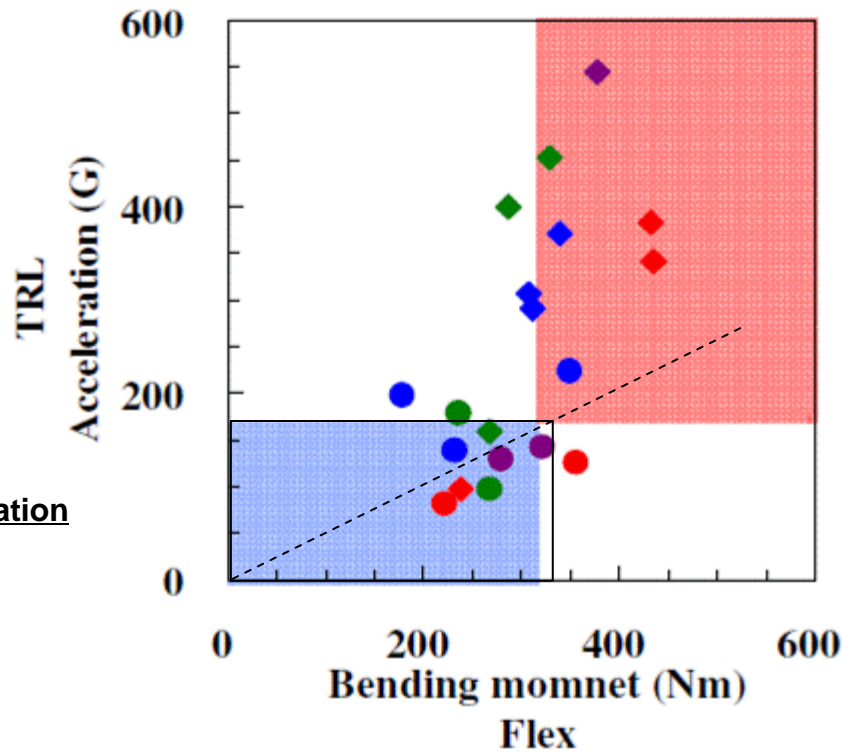
Difference of Tibia Injury Assessment

Instrumentation

Injury Assessment Items



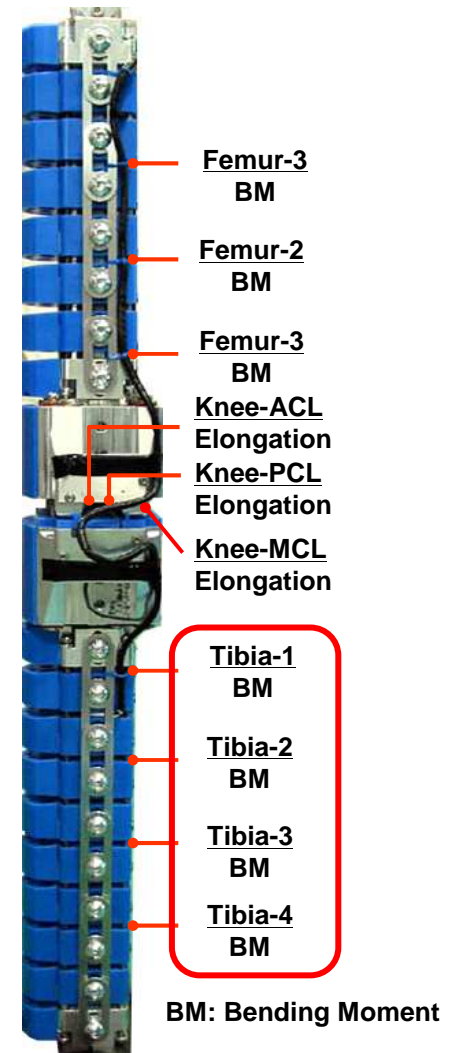
- Basically, TRL acceleration and Flex bending moment has low relationship.
- TRL acceleration tends to show higher value especially when bumper bottoming out happened, however it is because of lack of biofidelity of long bone and using acceleration as for injury criterion.
- Beside, Flex has bending stopper cable especially to avoid high bending, so its influence also shall be considered.



(1) Tibia fracture risk assessment

Instrumentation

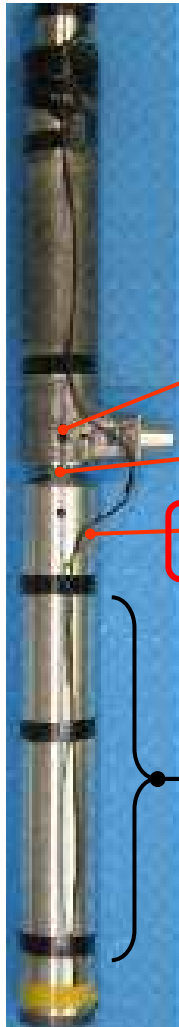
Injury Assessment Items



Difference of Tibia Injury Assessment

Instrumentation

Injury Assessment Items



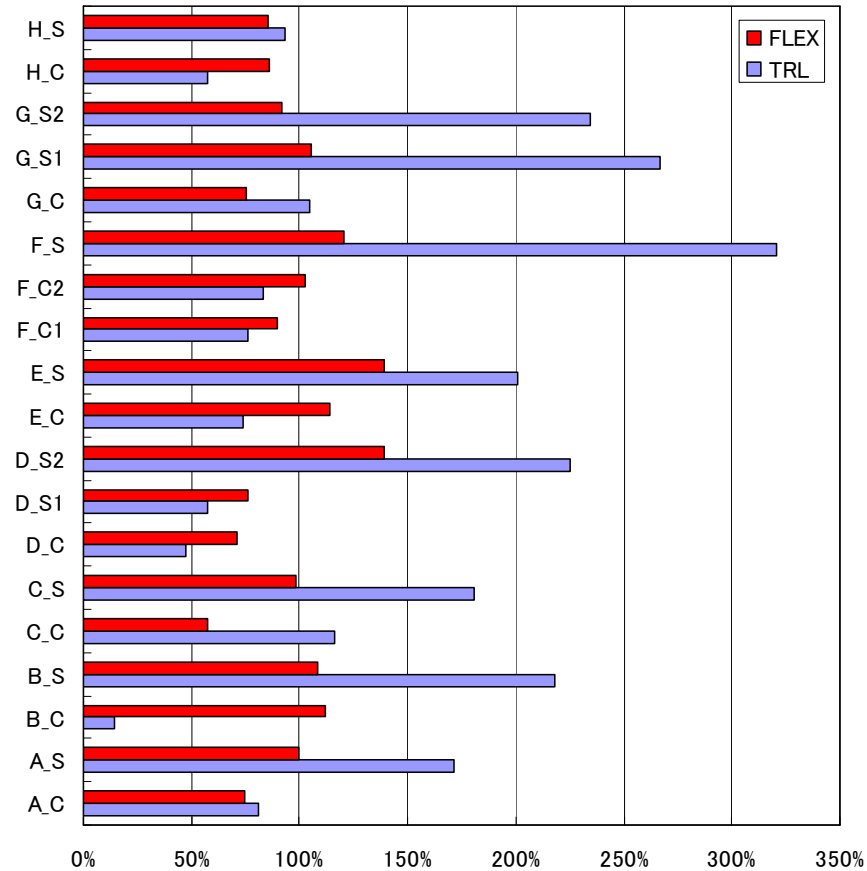
Knee Shearing Displacement

Knee Bending Angle

Upper Tibia Acceleration

No instrumentation

- TRL tends to show higher value when bottoming out happened.
- However, except those cases, not always either impactor is higher than other.



Instrumentation

Injury Assessment Items



Femur-3 BM

Femur-2 BM

Femur-3 BM

Knee-ACL Elongation

Knee-PCL Elongation

Knee-MCL Elongation

Tibia-1 BM

Tibia-2 BM

Tibia-3 BM

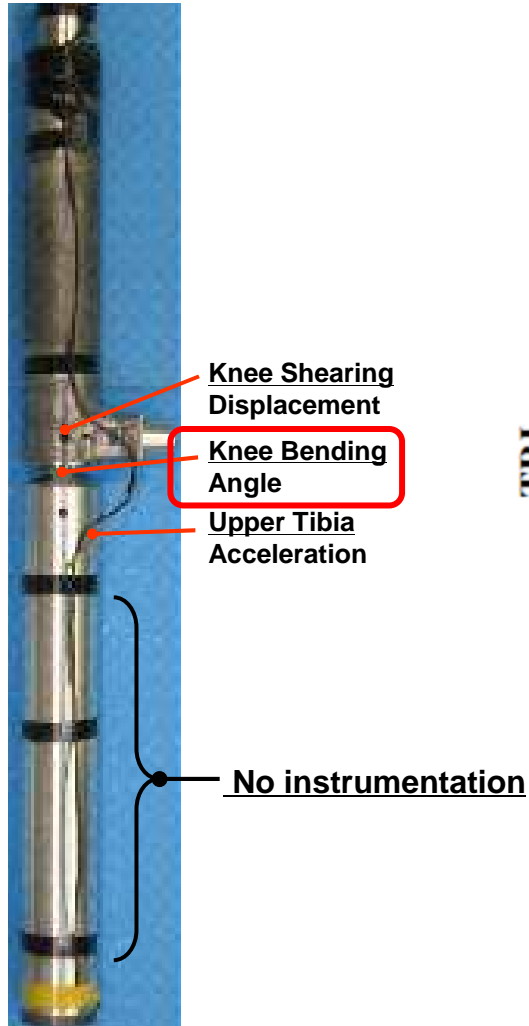
Tibia-4 BM

BM: Bending Moment

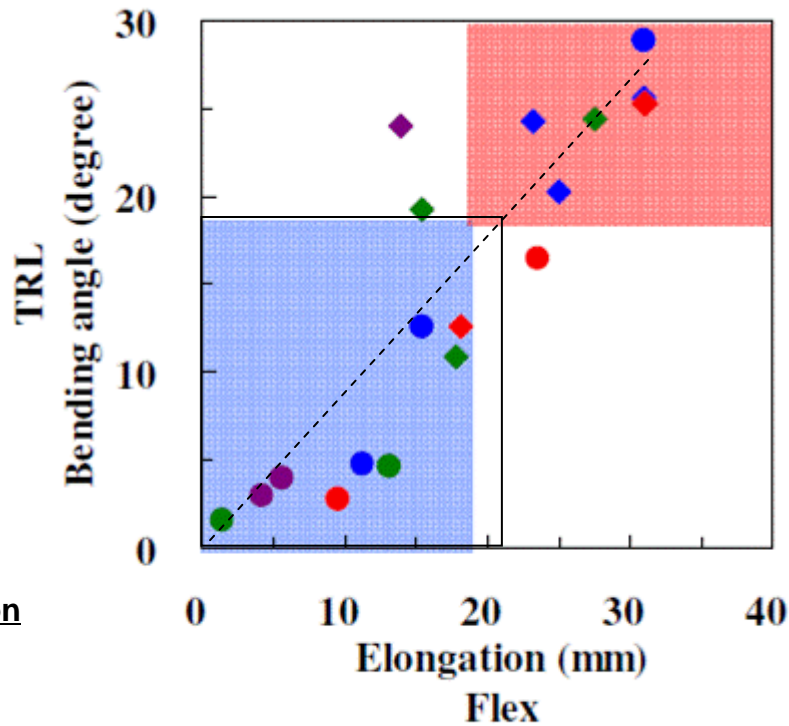
Difference of Knee MCL Injury Assessment

Instrumentation

Injury Assessment Items



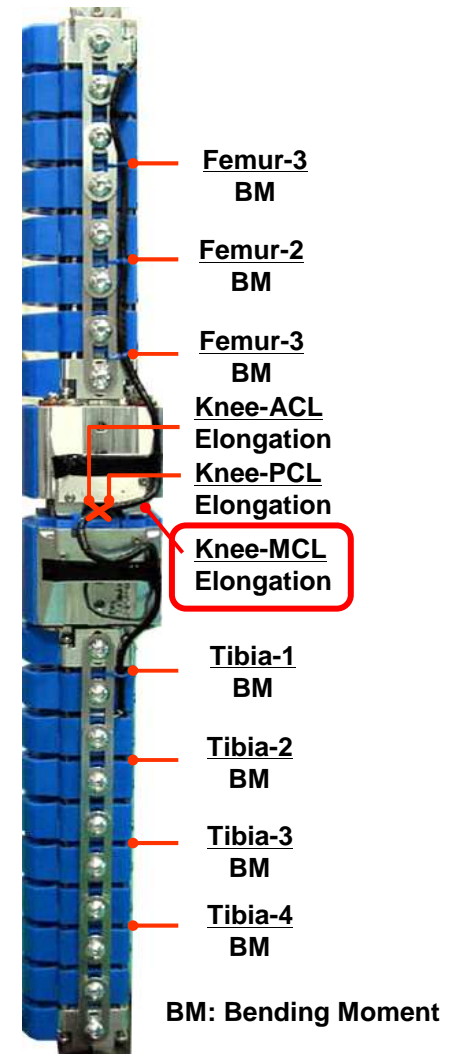
- In this research, Flex MCL elongation is slightly higher values than TRL bending angle.
- However, it has a chance that the relationship can be changed by car stiffness and/or geometry.



(4) MCL injury risk assessment

Instrumentation

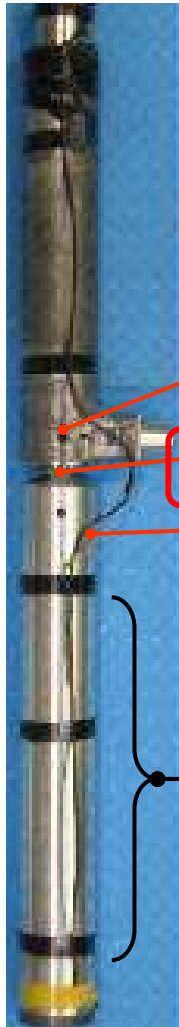
Injury Assessment Items



Difference of Knee MCL Injury Assessment

Instrumentation

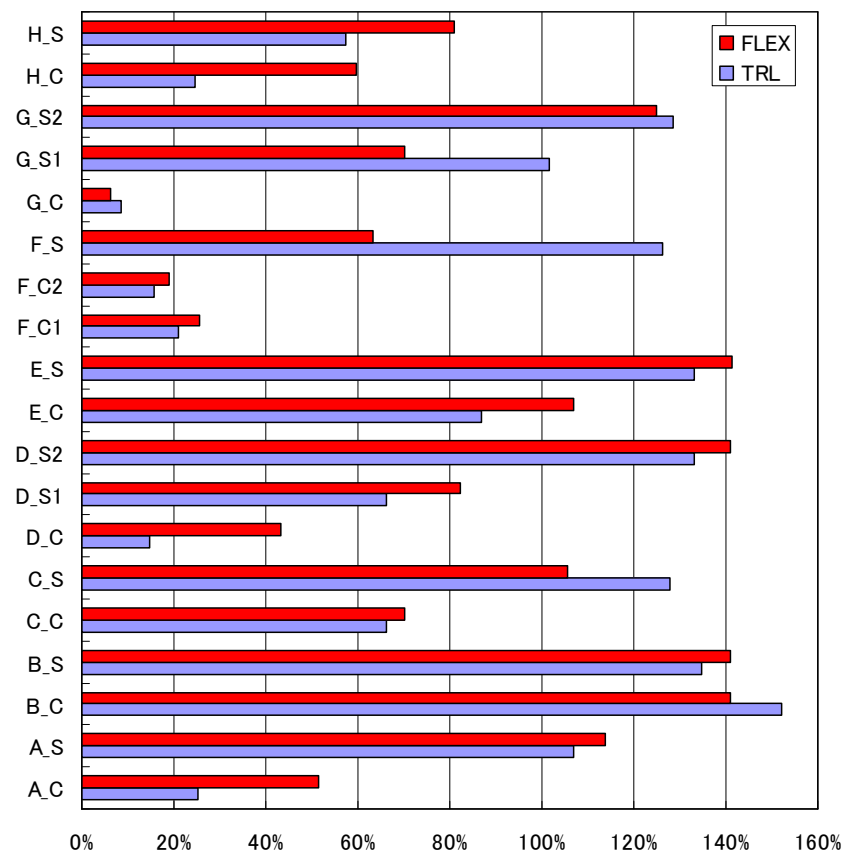
Injury Assessment Items



Knee Shearing Displacement
Knee Bending Angle
Upper Tibia Acceleration

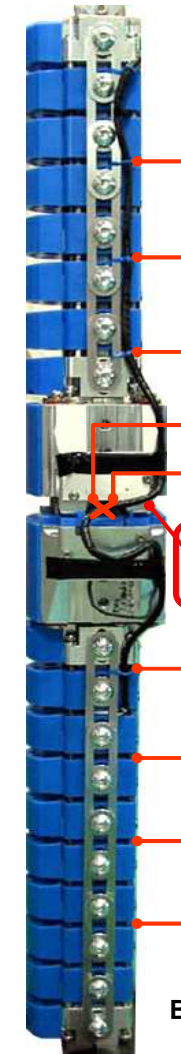
No instrumentation

• Not always either impactor is higher than other.



Instrumentation

Injury Assessment Items



Femur-3 BM
Femur-2 BM
Femur-3 BM
Knee-ACL Elongation
Knee-PCL Elongation
Knee-MCL Elongation

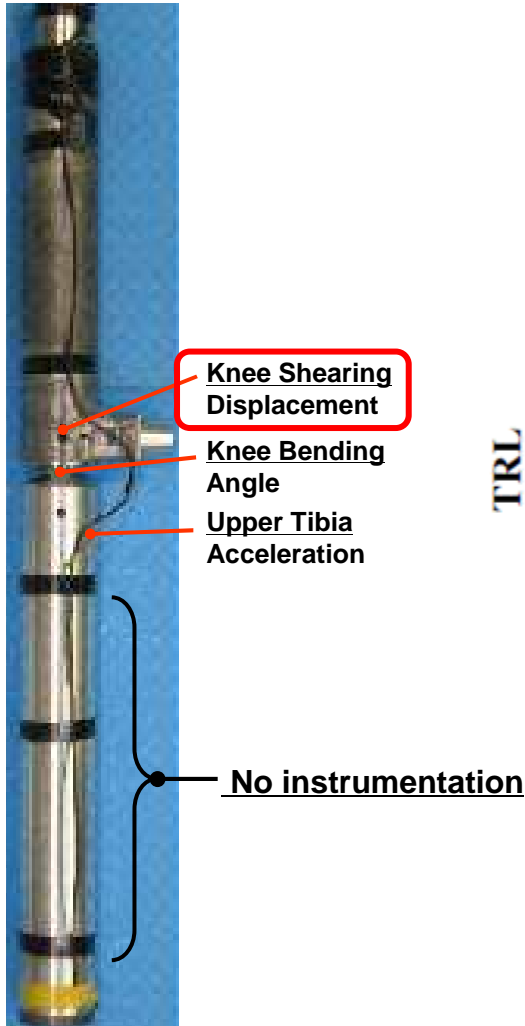
Tibia-1 BM
Tibia-2 BM
Tibia-3 BM
Tibia-4 BM

BM: Bending Moment

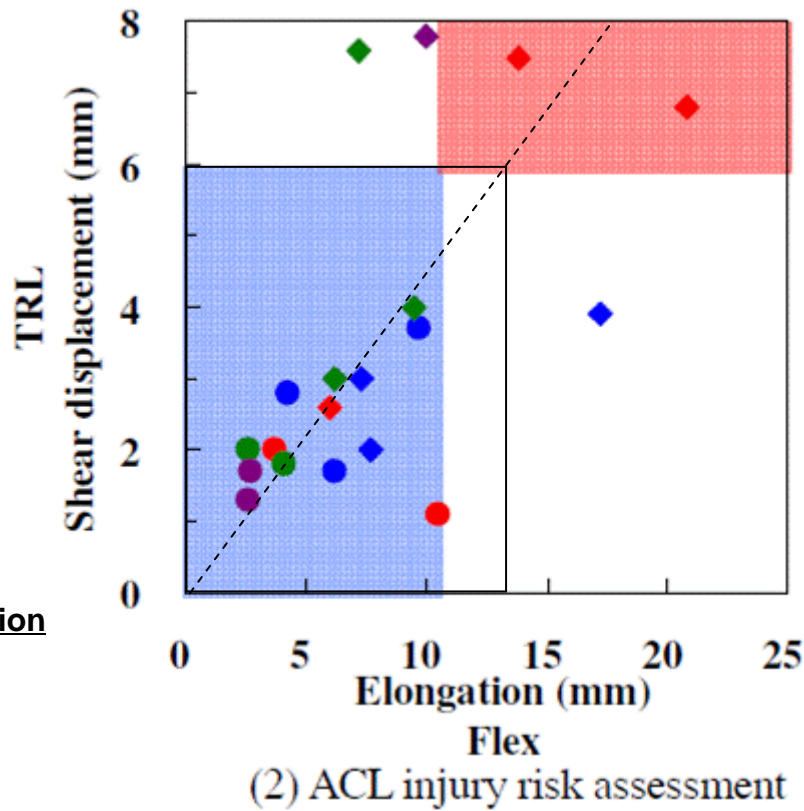
Difference of Knee ACL Injury Assessment

Instrumentation

Injury Assessment Items

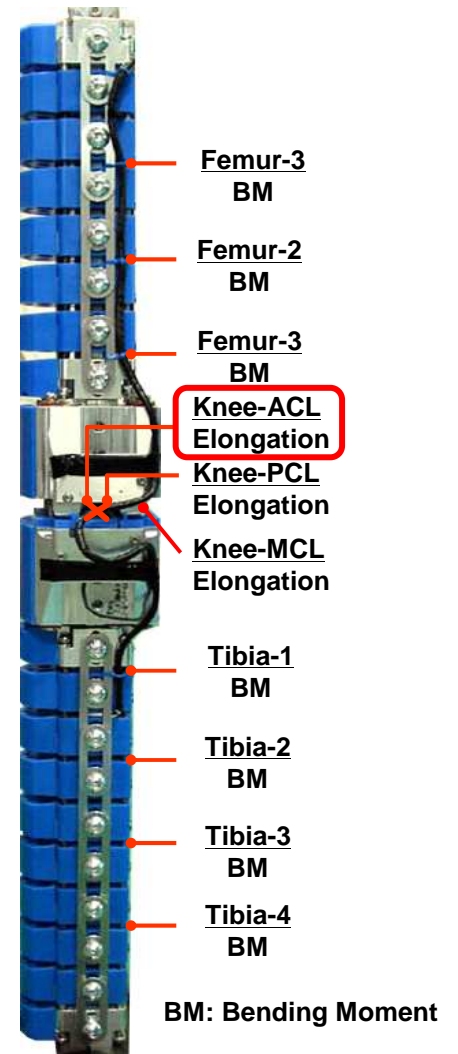


- Basically, Flex ACL elongation and TRL shearing displacement has not clear relationship.
- It has a chance that the relationship can be changed by car stiffness and/or geometry.



Instrumentation

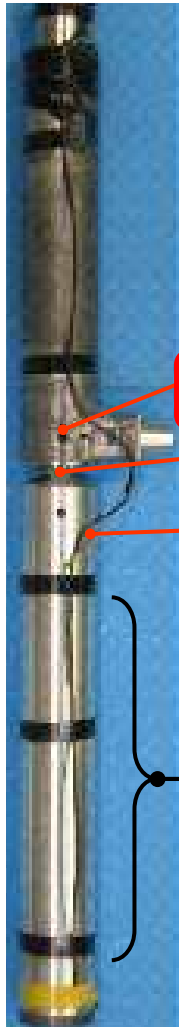
Injury Assessment Items



Difference of Knee ACL Injury Assessment

Instrumentation

Injury Assessment Items



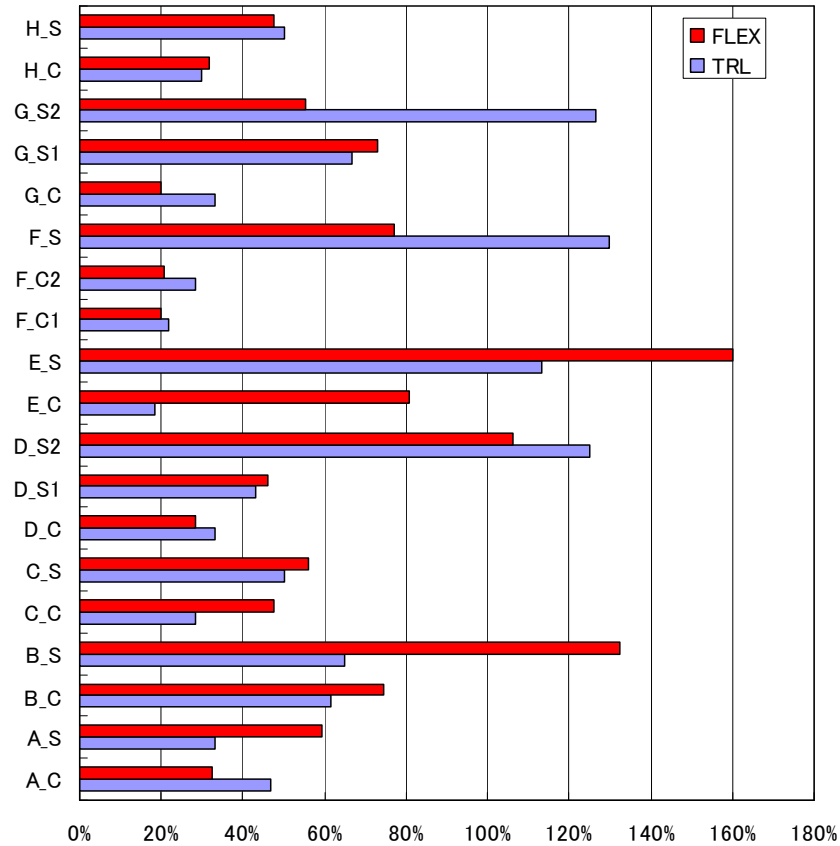
Knee Shearing Displacement

Knee Bending Angle

Upper Tibia Acceleration

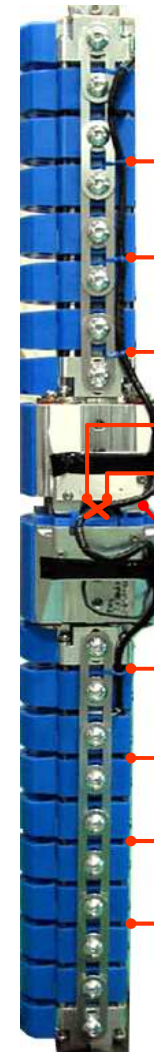
No instrumentation

• Not always either impactor is higher than other.



Instrumentation

Injury Assessment Items



Femur-3 BM

Femur-2 BM

Femur-3 BM

Knee-ACL Elongation

Knee-PCL Elongation

Knee-MCL Elongation

Tibia-1 BM

Tibia-2 BM

Tibia-3 BM

Tibia-4 BM

BM: Bending Moment

Comments from Japan

- Basically, TRL legform impactor and Flex pedestrian legform impactor have **totally different structure and injury criteria.**
- Therefore, **direct comparison tends to lead not clear relationship.**
- Basically, to make a regulation using impactor, following items are needed.
 - **Impactor shall have high biofidelity.**
 - **Injury criteria shall have good relationship with human one.**
- Otherwise, some **misunderstandings and/or misleading results will be obtained.**