



Lumbo-sacral destruction fixation biomechanics

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Background

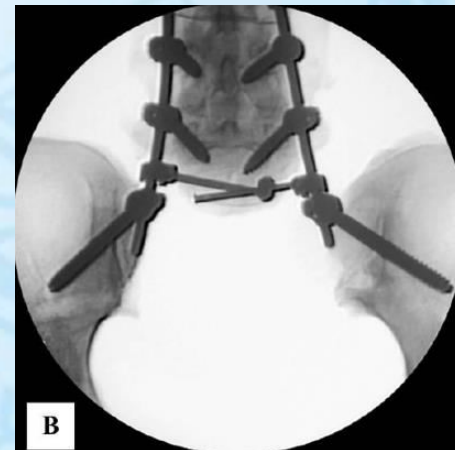
Spinal stabilisation in the face of a lumbo-sacral deficiency is a challenge



Dunn McCarthy hooks



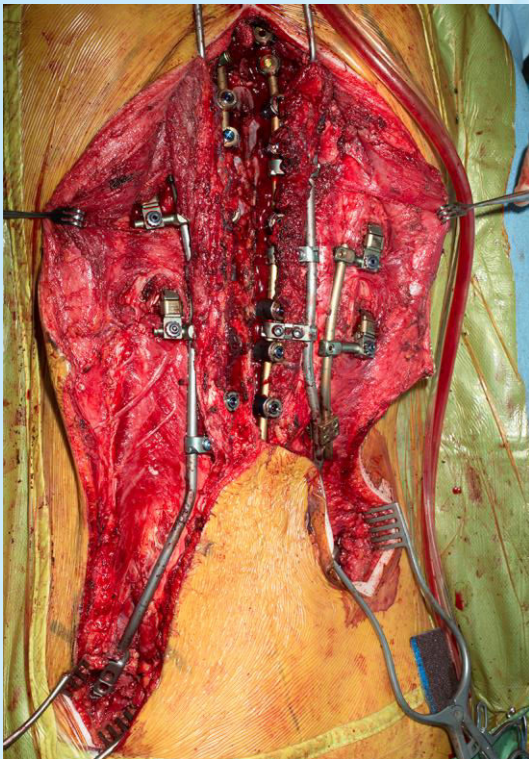
Galveston



Iliac screws

Tuning fork plate

- Idea started with a variable screw placement (VSP) system
- Providing a strong distal fix with screws.
- Fix in the thoracic and lumbar spine proximally.
- Have used in 4 cases (3 sacral agenesis, 1 Neurofibromatosis)



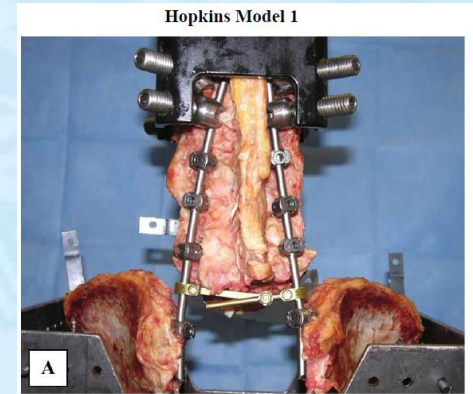
Aim of the study

Assess the bio-mechanical profile of the tuning fork plate compared to iliac screw fixation in a lumbo-sacral deficient model.

Would help clarify indications and future clinical profiling for the use of the tuning fork plate – a new concept.

Methodology

Validation of a sacrectomy model
L2 – L5 and sacrum
Hopkins model 1



Finite Element Model Analyses using our FE platform
technology

Sacrectomy model
stabilized with Dual
iliac screw fixation



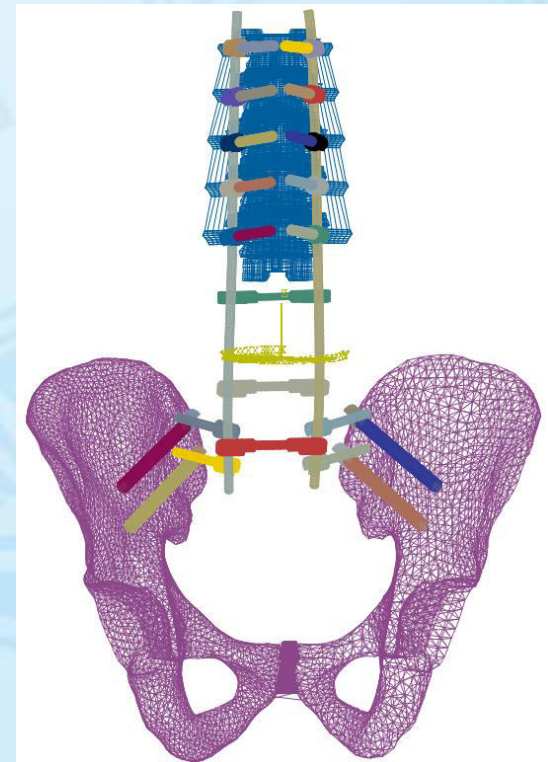
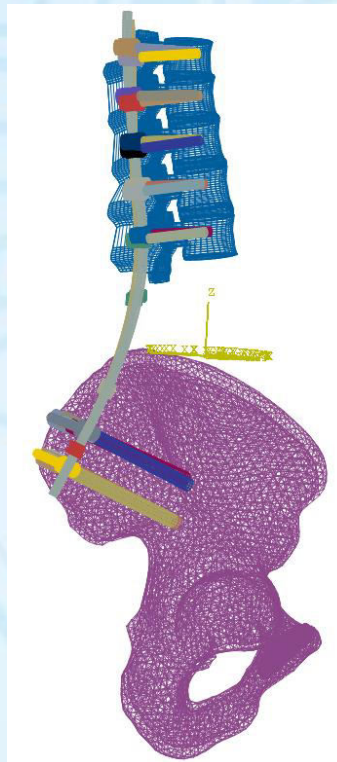
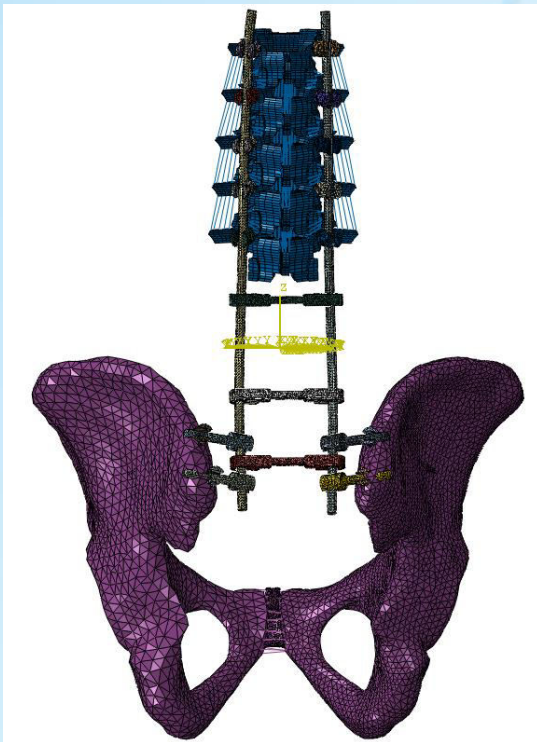
Sacrectomy model
stabilized with Tuning
fork plate

Methodology: Material properties and element types

Component	Elastic modulus (MPa)	Poisson ratio	Element Type
Vertebral cortical bone	12000	0.3	8-Node hex
Vertebral cancellous bone	100	0.2	8-Node hex
Ground substance of annulus fibrosis	Hyperelastic, neo-Hookean,		Rebar
Nucleus Pulposus	1	Incompressible	Fluid
Ligaments	Non-linear, no compression		Truss
Cartilage of facet joint	Softened contact		
Ilium cortical bone	17000	0.3	4-node tet
Ilium cancellous bone	70	0.2	4-node tet

Methodology: Dual iliac screws

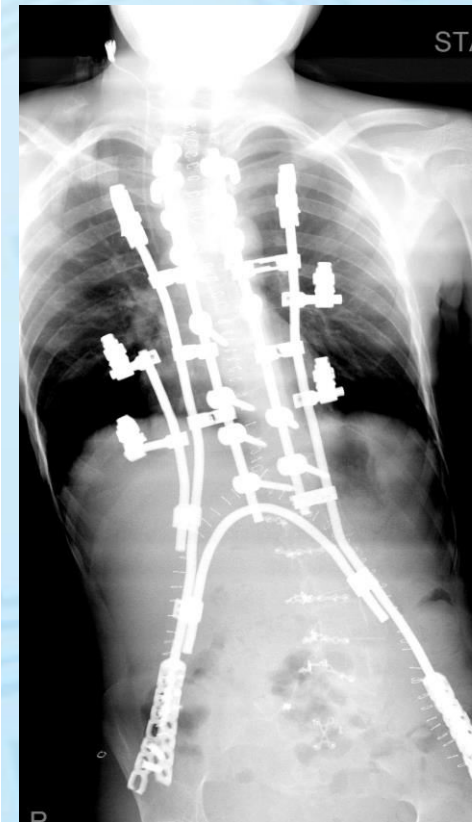
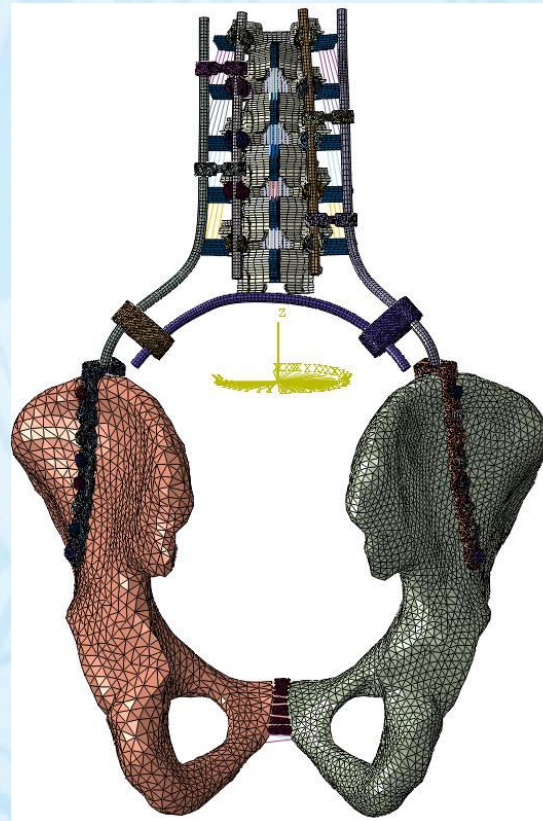
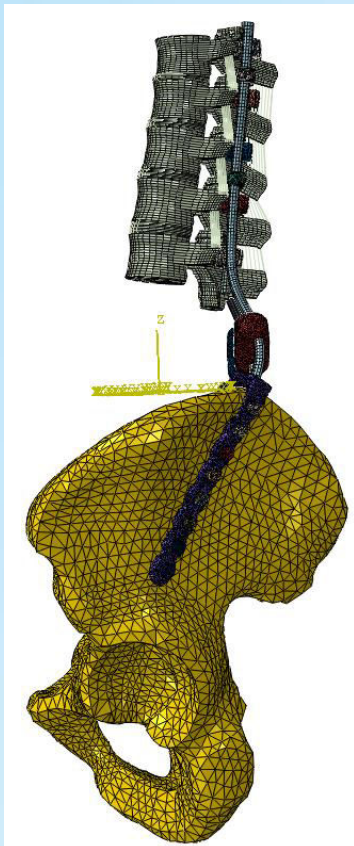
- 5.5 mm Pedicle screws T10 to L2
- 8.5 mm Iliac screws into the pelvis bilaterally
- 6.0 mm Ti rod



Number of Elements: 219,256 elements

Methodology: Tuning fork plate

- 5.5 mm Pedicle screws T10 to L2
- 6.0 mm Ti rods



Elements: 596,139 elements

Methodology: Force simulations

Contacts:

- Screws-Bone
 - Screws-Rod
 - Crosslink-Rod
- } Tie constraint

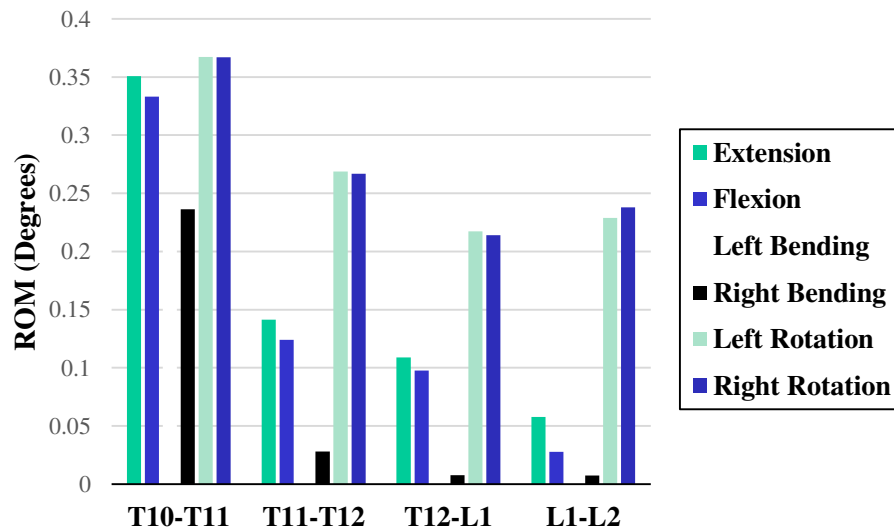
Boundary Conditions:

- Hip joint is fixed
- Follower Load:
400 N to simulate muscle forces and trunk weight
- Moment:
10 Nm to simulate spine motions

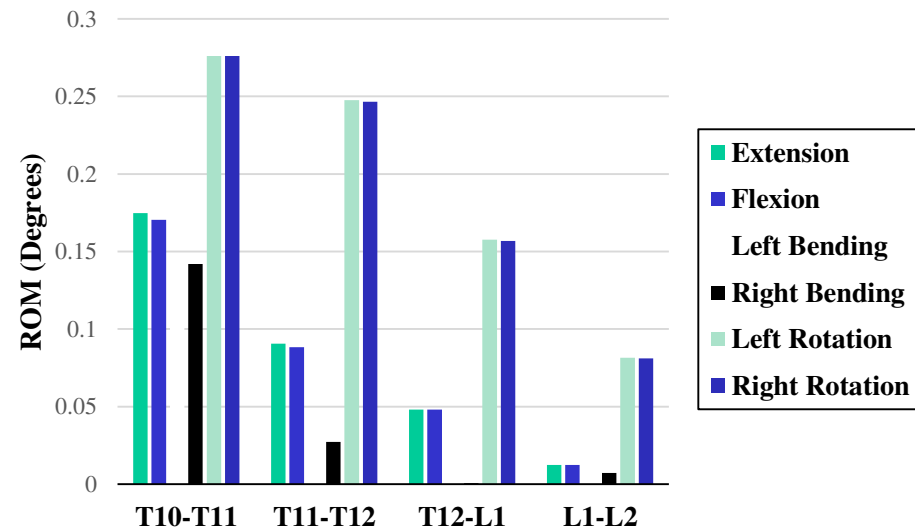
Results: Iliac screws v Tuning fork plate

ROM of all levels decreased under different loadings compared to intact model.

Spine ROM for Dual Iliac Screw Fixation



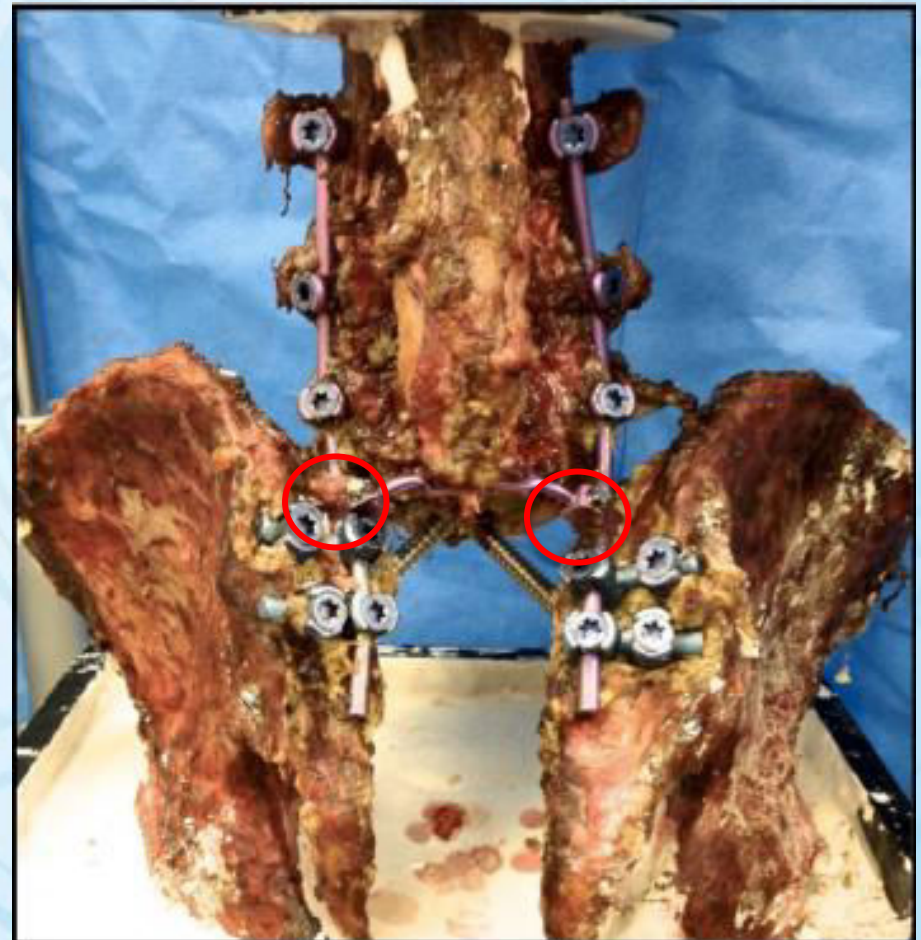
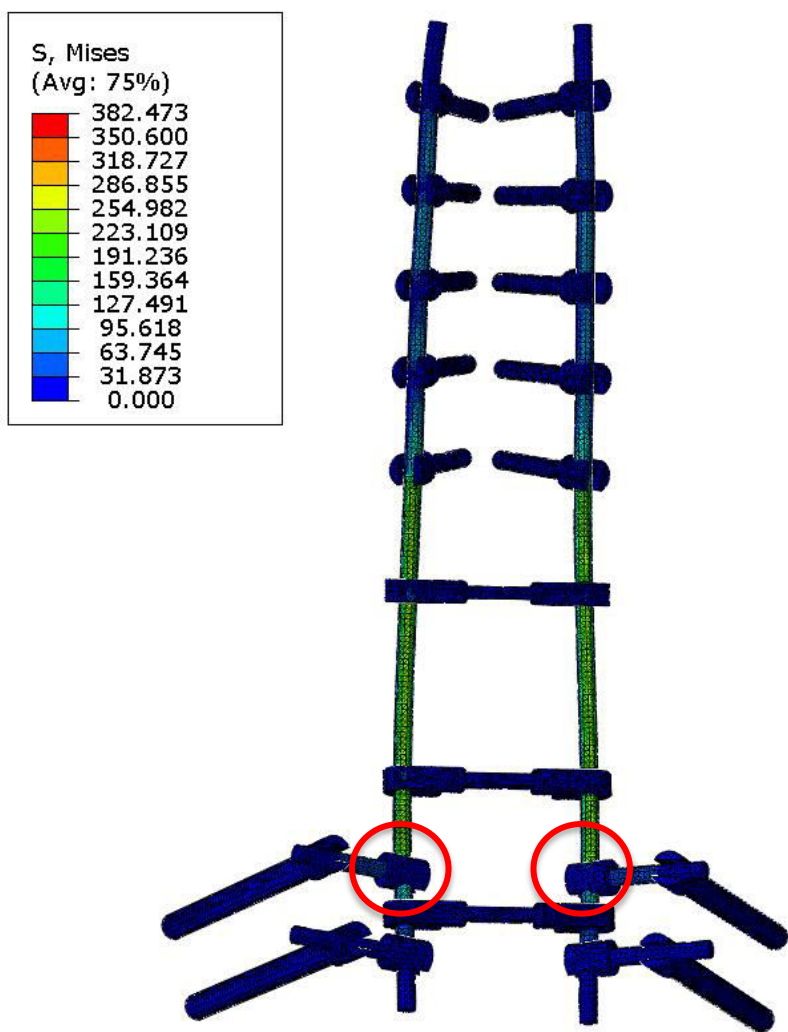
Spine ROM for Fork Plate Fixation



Results: Stress values on the dual Iliac screw fixation

Motion	Maximum von Mises Stress (MPa)	Location
Flexion	382	Rod-Adjacent to the iliac screws connectors
Extension	381	Rod-Adjacent to the iliac screws connectors
Left Bending	111	Rod-Adjacent to the iliac screws connectors
Right Bending	121	Rod-Adjacent to the iliac screws connectors
Left Rotation	264	Rod-Adjacent to the iliac screws connectors
Right Rotation	264	Rod-Adjacent to the iliac screws connectors

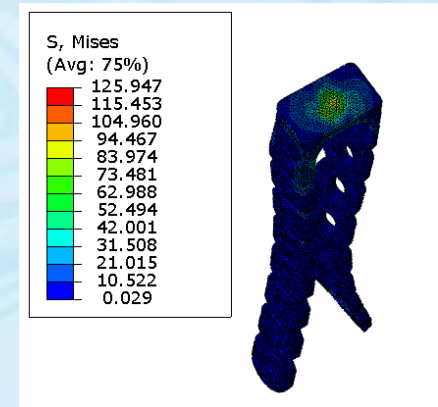
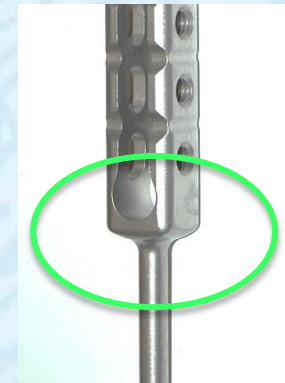
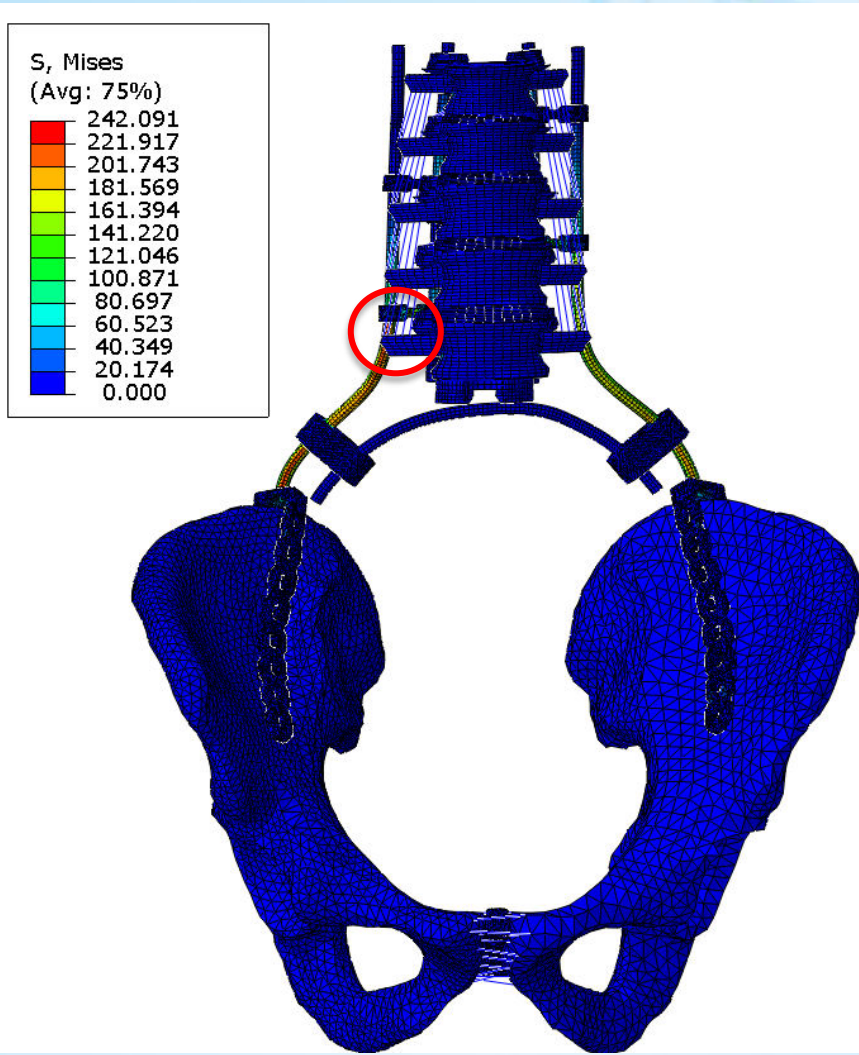
Results: Location of the Stress on the dual Iliac screw fixation



Results: Stress values on the tuning fork plate

Motion	Maximum von Mises Stress (MPa)	Location
Flexion	242	Outer Rod
Extension	245	Outer Rod
Left Bending	89	Outer Rod + Crosslink
Right Bending	86	Outer Rod + Crosslink
Left Rotation	208	Crosslink
Right Rotation	226	Crosslink

Results: Location of the Stress on the tuning fork plate



Motion	Maximum von Mises Stress (MPa)
Flexion	126
Extension	120
Left Bending	20
Right Bending	20
Left Rotation	62
Right Rotation	69

Results: Stress comparison

Motion	Maximum von Mises Stress on Fork Plate (MPa)	Maximum von Mises Stress on Dual Iliac Screw (MPa)	Factor of Safety (Fork Plate)	Factor of Safety (Dual Iliac Screw)
Flexion	242	382	3.55	2.25
Extension	245	381	3.51	2.25
Left Bending	89	111	9.66	7.74
Right Bending	86	121	10	7.1
Left Rotation	208	264	4.13	3.25
Right Rotation	226	264	3.80	3.25

Conclusion

Stress values on the fork plate fixation was lower (22% to 45%) than dual screw fixation which might lead to less implant failure in the fork plate fixation.

Would help clarify indications and future clinical profiling for the use of the tuning fork plate