

# The use of sublaminar wires to create semi-rigid junctional fixation in surgical correction of adult degenerative scoliosis

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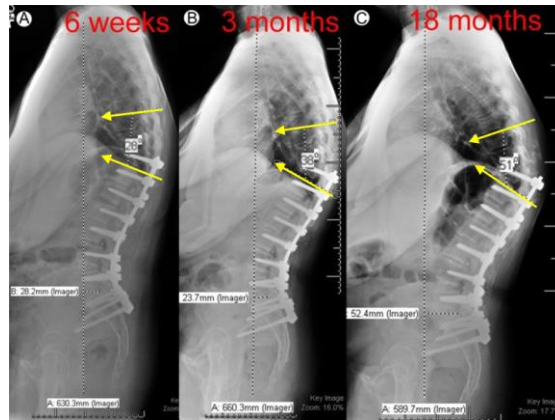


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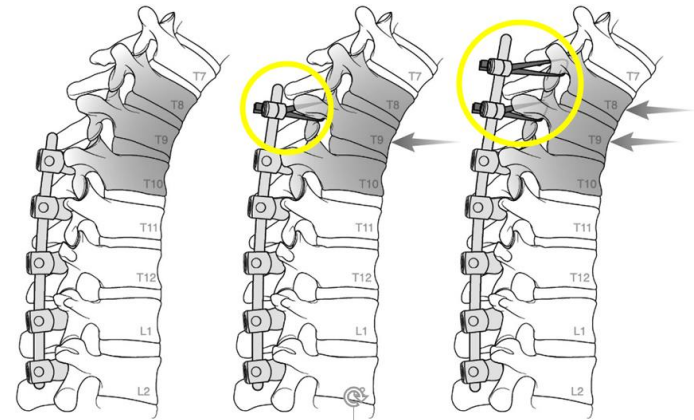
Biomedical materials

# Scoliosis and proximal junctional kyphosis

- ◆ Pedicle screw fixation (PSF) is the mainstay surgical correction of adult degenerative scoliosis
  - Proximal junctional kyphosis (PJK) and failure (PJF) are relatively common serious complications
- ◆ Semi-rigid junctional fixation with ultra-high molecular weight polyethylene (UHMWPE) tapes
  - Relatively strong fixation in osteoporotic bone as compared to PSF
  - High fatigue strength
  - Gradual transition in range of motion (ROM) at the proximal end of instrumentation
- ◆ Goal: to define the extent to which the UHMWPE tapes lead to a gradual ROM transition *ex vivo* and to generate & validate a finite element (FE) model



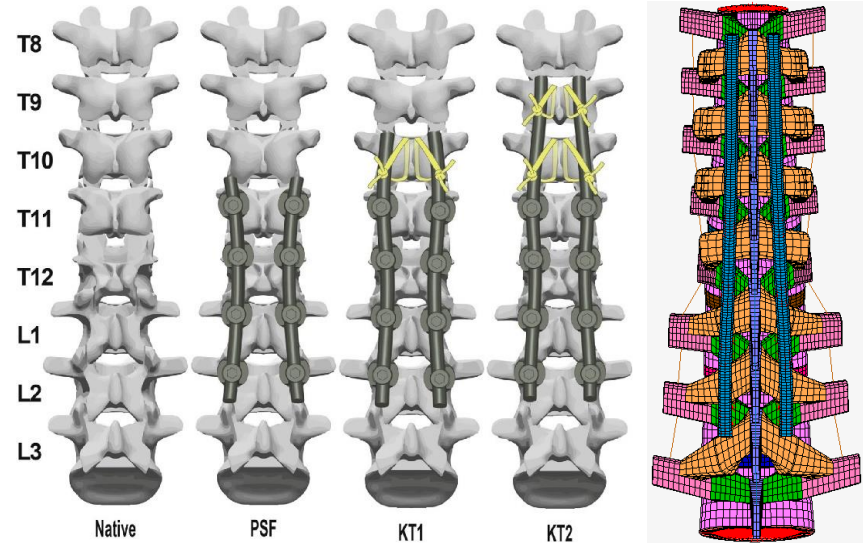
Sagittal radiographs of development of proximal junctional kyphosis in a patient at a) 6 weeks, b) 3 months and c) 18 months postoperatively



Schematic diagram of PSF only, and PSF with 1- and 2-level clamped tape. The spinal units at the proximal junction exposed to high stresses are shaded

# One- and two-level semi-rigid junctional fixation

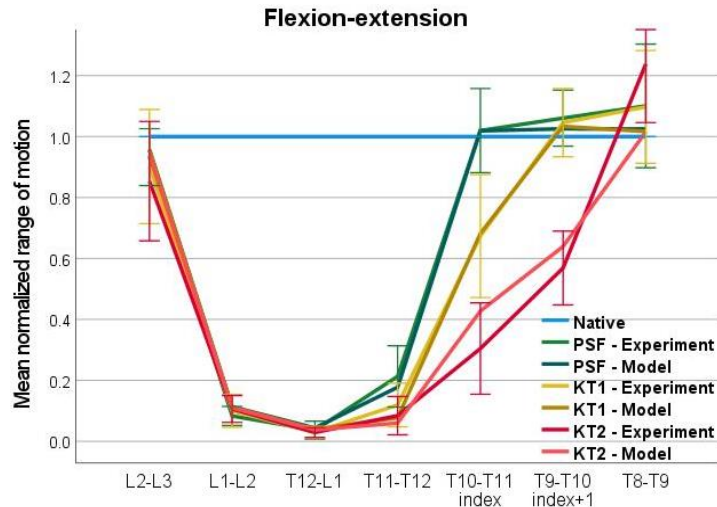
- ◆ *Ex vivo*: seven human cadaveric spine segments (T8-L3) tested
  - Level of IVD degeneration graded
  - Flexion-extension and lateral bending tested in spine tester ( $\pm 5N$ )
  - Three-level PSF, and PSF with one- and two-level knotted sublaminar tape (KT1 and KT2)
- ◆ FE model: simulate all *ex vivo* tests, including IVD degeneration
  - Validated using *ex vivo* ROM
  - Able to test multiple instrumentations
  - Calculate stresses in bone/IVD in ultimate flexion



a) Test set-up with three-level pedicle screw fixation (PSF) plus one- and two-level knotted sublaminar tape (KT1 and KT2). b) Finite element model including PSF topped-off with KT2.

# Results & conclusion

- ◆ KT1 and KT2 result in a more gradual increase in ROM compared to transitional level in PSF only
- ◆ FE model is validated with *ex vivo* results



Comparison of the normalized range of motion of the biomechanical experiment and finite element model instrumented with PSF, KT1 and KT2.

- ◆ A gradual change in ROM  $\neq$  reduced stresses in junctional zone *in silico*



	ISL/SSL complex	Nucleus pulposus	Annulus fibers	Endplate	Vertebral body
PSF	✓	✓	✓	✓	✓
KT1	✓	✓	✗	✗	✓
KT2	✓	✗	✗	✗	✗

- ◆ Semi-rigid junctional fixation possibly a limited effect on reducing PJK
  - Further *ex vivo* research needed to measure disc pressure with e.g. strain gauges
- ◆ FE model may be used to evaluate other designs
- ◆ FE model may be used to aid the spinal surgeon in composing the ideal instrumentation construct on a patient specific basis

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None of the authors has any potential conflict of interest

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