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ICEOS 2014

Flexible Growing Rods:

Polymer rods provide stability to skeletally immature spines

Bylski-Austrow DI, Glos DL, Carvalho FM, Bonifas AC, Coombs MT, Sturm PF

No financial disclosures with respect to this work

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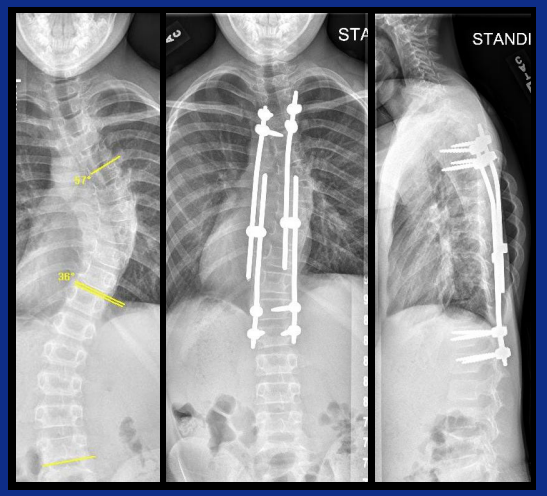
Early Onset Scoliosis (EOS)

- High morbidity
- Treatments
  - Conservative
    - Casting, bracing
  - Surgical
    - Rib expansion (VEPTR)
    - Spine distraction (GR)
      - Complications
        - » Infections
        - » Rod breakage
        - » Screw pull-out
        - » Auto-fusion
        - » Junctional issues JK / JF

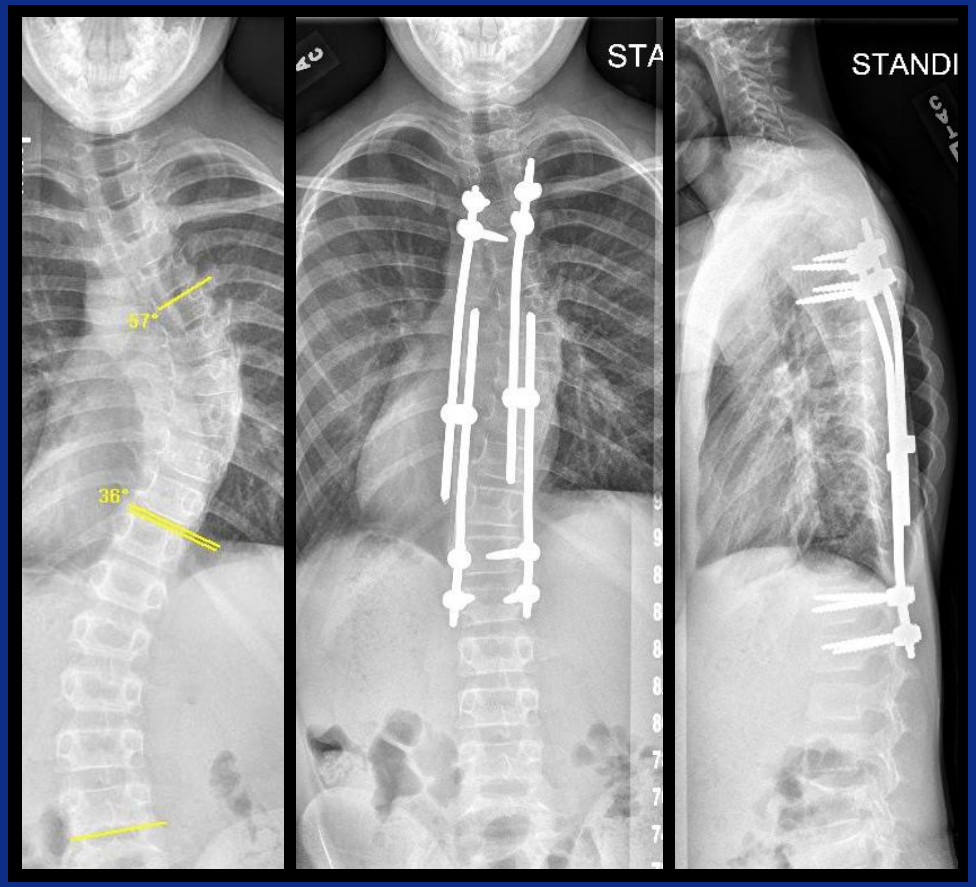


- GRs: Magnetic
  - Reduce # surgeries
  - Complications remain
    - » Proximal failures
    - » Stiff core
    - » Flat back
    - » MRI contraindicated

Akbarnia, Yacizi, Thompson
The Growing Spine 2011

Conventional growing rods

- Rods: Co-Cr
  - Stiff
    - Complications
- Feasibility study
  - Material change
  - Polymer rods
  - Polyetheretherketone (PEEK)
- Other design changes
  - Tapered rod diameter
  - Composite structures
  - Connector design
  - . . .



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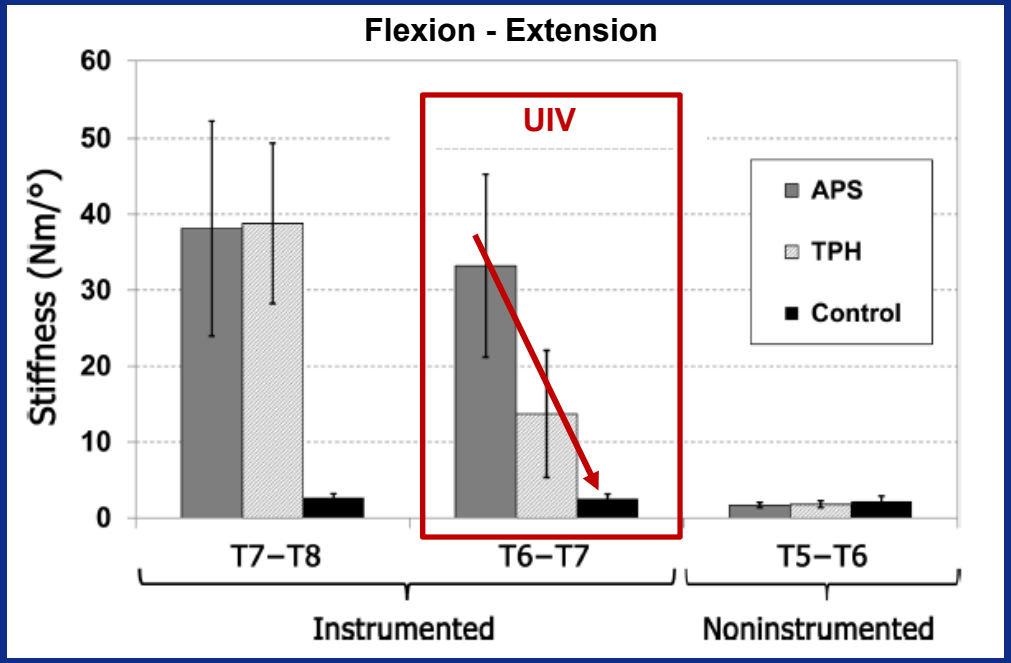
Previous biomechanical study



- Top anchors in long PSF-SSI constructs affect ROM across proximal junction
  - Thawrani et al 2014

Spine
SPINE Volume 39, Number 14, pp E826-E832

BIOMECHANICS

Transverse Process Hooks at Upper Instrumented Vertebra Provide More Gradual Motion Transition Than Pedicle Screws

Dinesh P. Thawrani, MD,*† David L. Glos, BSE,* Matthew T. Coombs, MS,† Donita I. Bylski-Austrow, PhD,*† and Peter F. Sturm, MD*†

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Purpose

Determine biomechanical property differences between non-instrumented control spines and spines instrumented with PEEK or metal growing rods

Hypothesis

ROM: Control > PEEK > > Co-Cr

PEEK closer to control than metal

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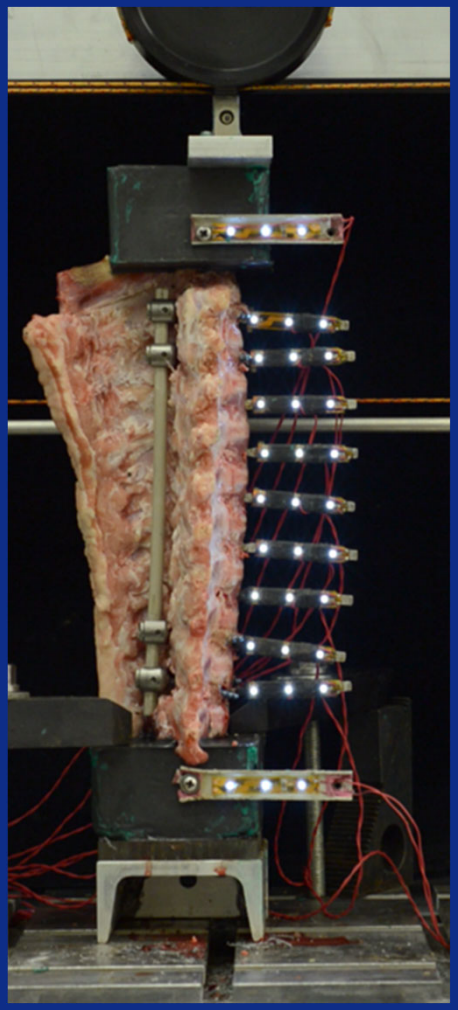
Methods

- Six porcine thoracic spines
  - Skeletally immature ~40 kg
- Repeated measures
  1. Control non-instrumented
  2. PEEK rods, 6.25 mm dia
  3. Ti alloy, 4 mm dia
  4. Co-Cr alloy, 5 mm dia
- Moments applied
  - Lateral bending
  - Flexion-Extension
- ROM measured at each level



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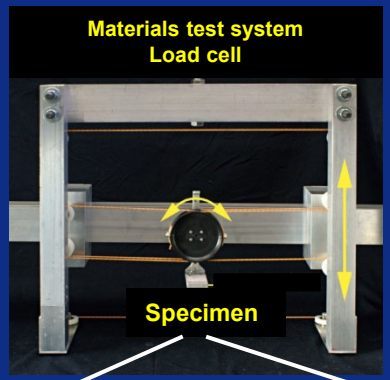
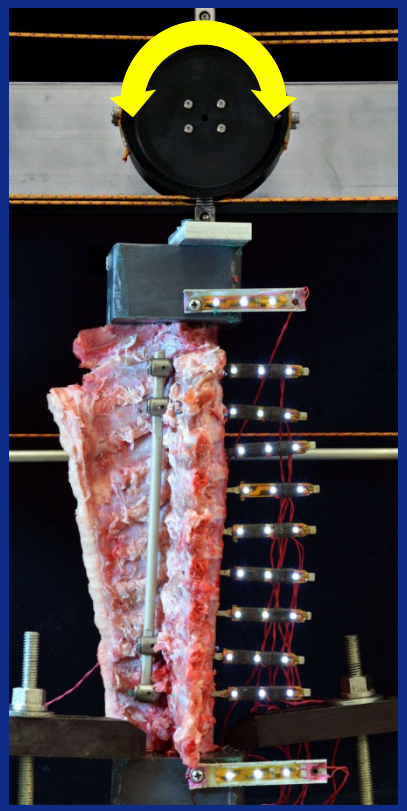
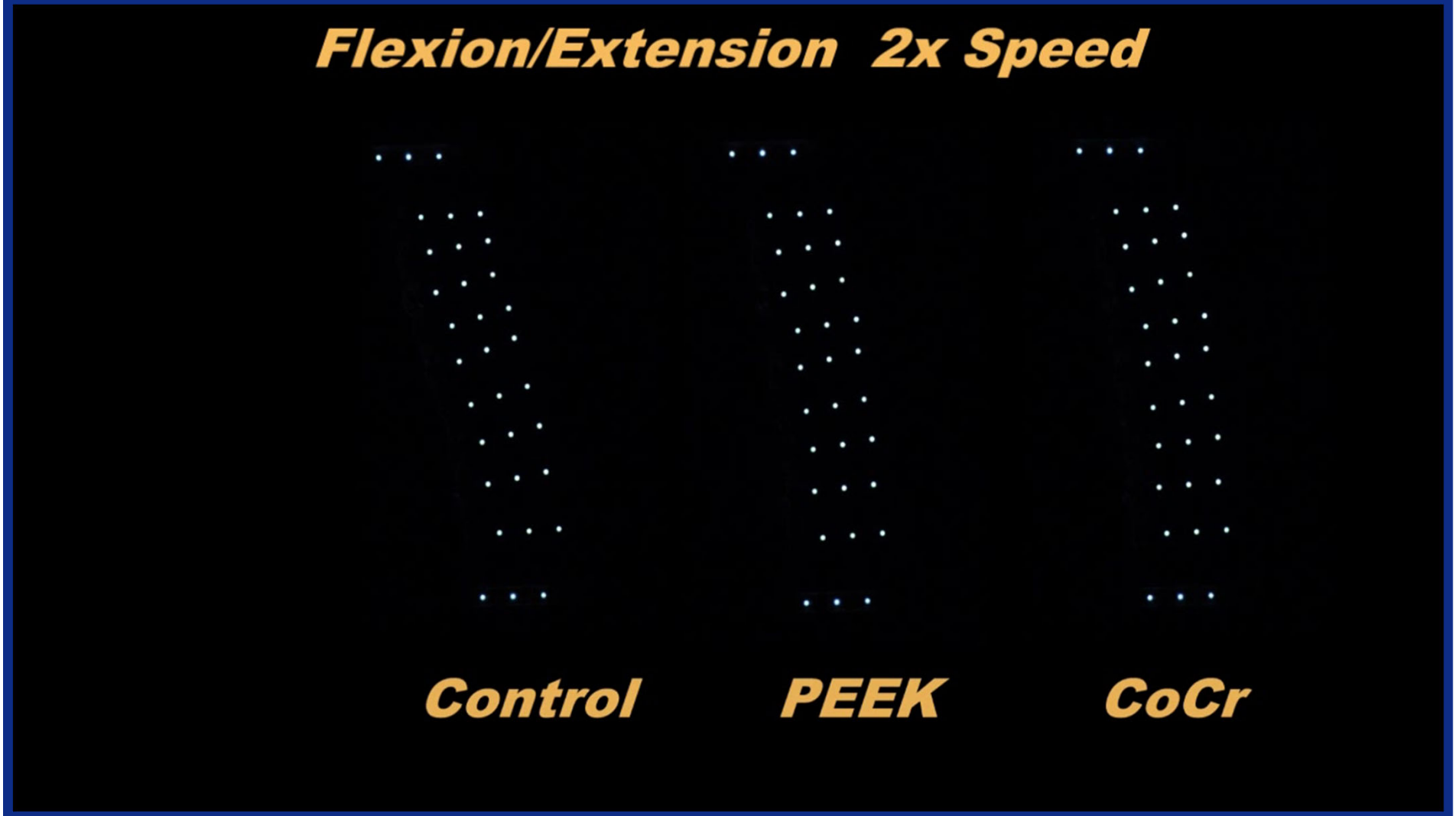




Methods

- Cyclic moments > ± 4 Nm
  - Materials test system
  - Continuous through ± ROM
    - Custom pulley-cable fixture
    - 5 cycles, 4th analyzed
- Rotations measured
  - Every level from T2-T11
    - Customized MATLAB program
- Statistics: t-tests, paired, two-tailed
  - Control vs PEEK (n=6)
  - PEEK vs CoCr (n=4)
    - Total ROM instrumented region
      - 4 primary comparisons
        - » $\alpha = 0.05/4 = 0.125$

Test videos



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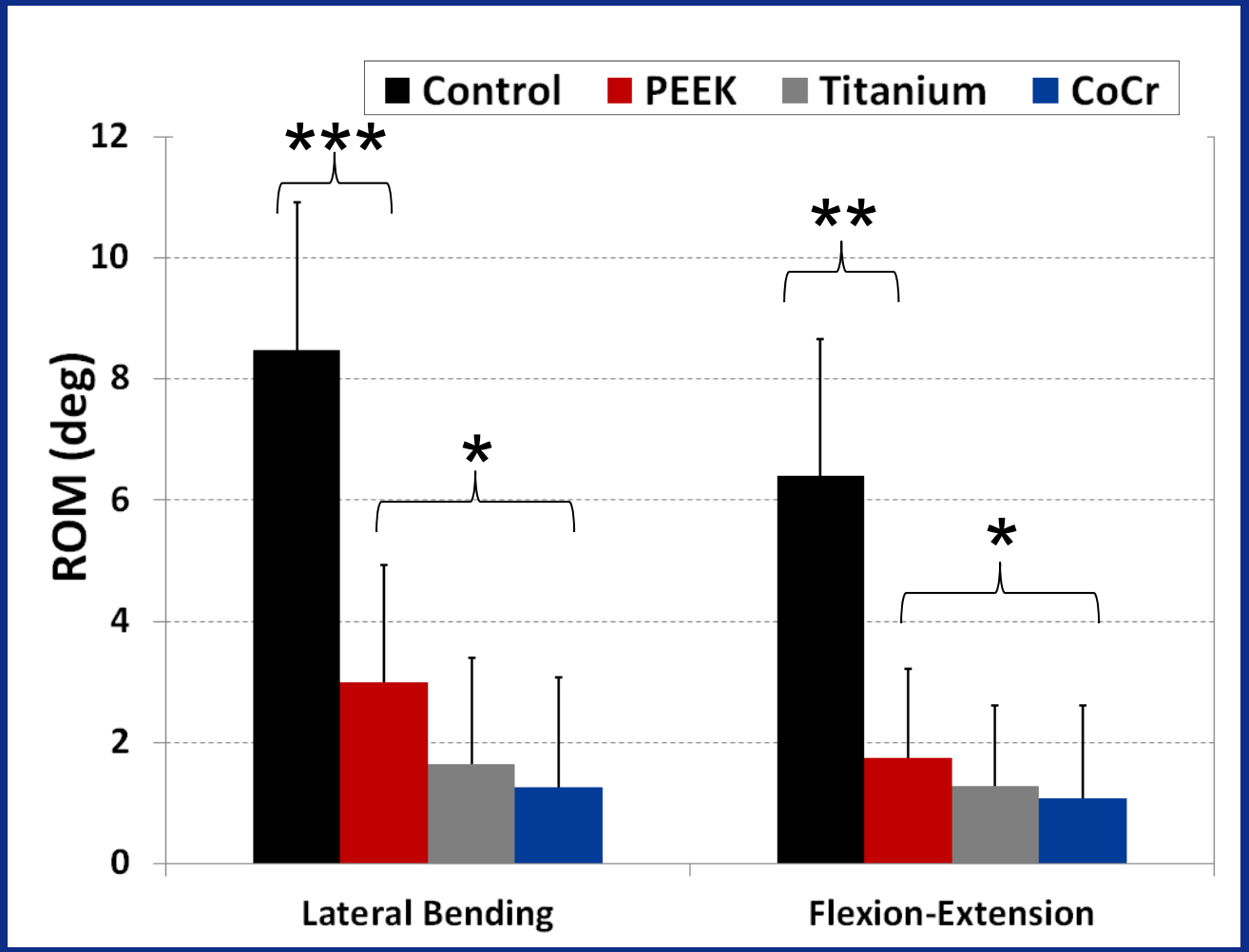
Results
ROM over entire instrumented region



* $p < 0.05$
** $p < 0.005$
*** $p < 0.00005$

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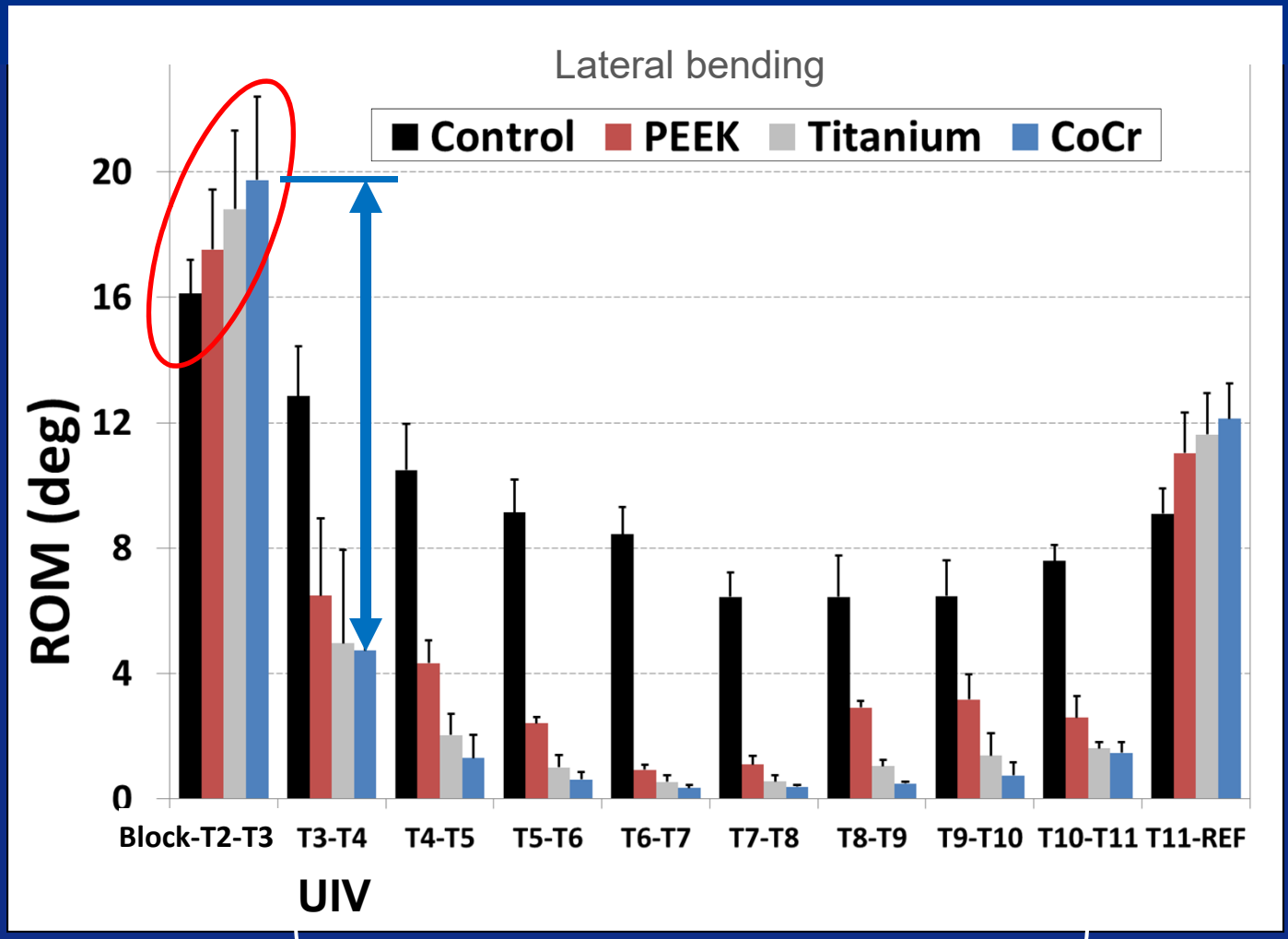
Results: ROM by level



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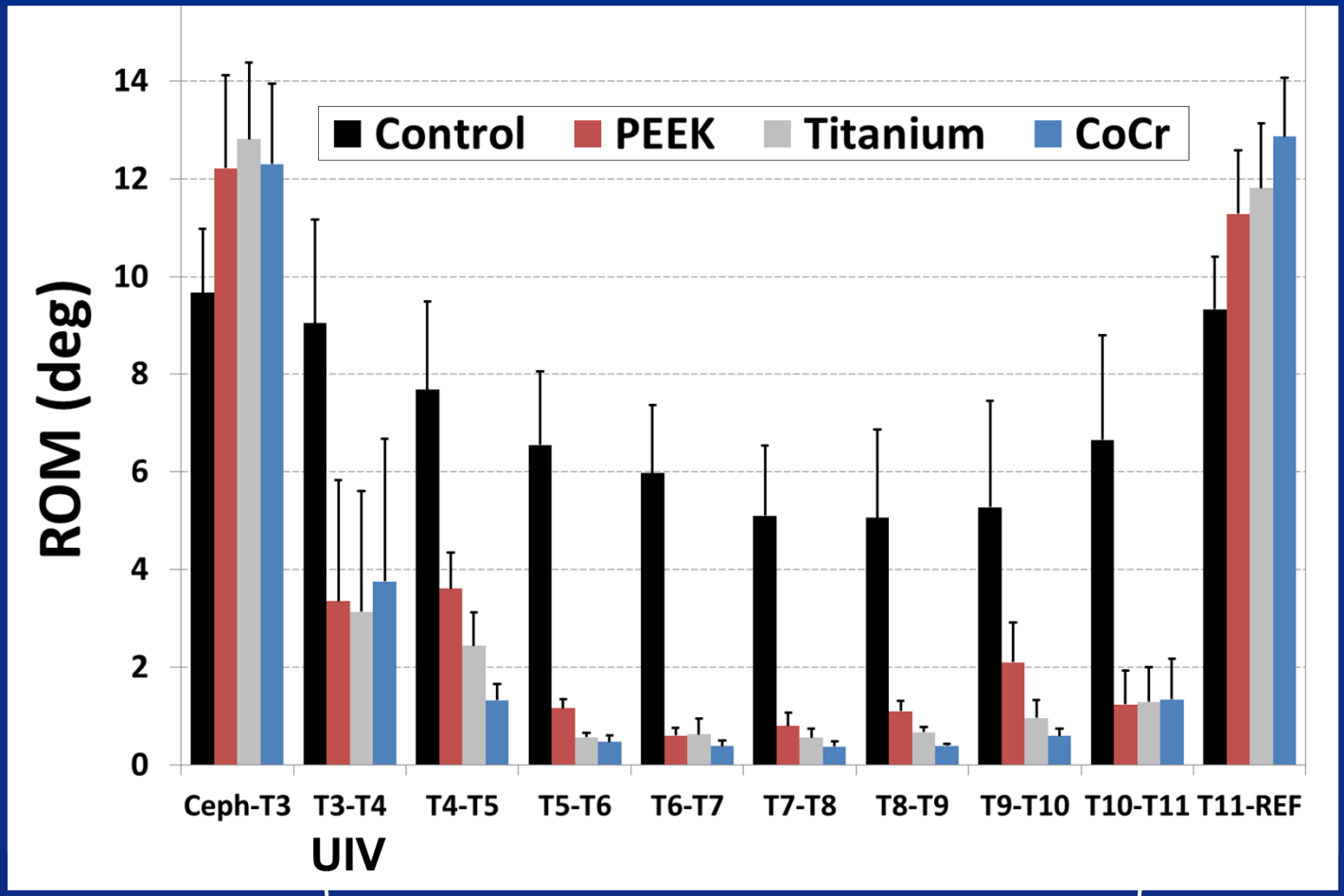
Results: ROM by level
Flexion-Extension



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Spine motion with PEEK rods
Closer to metal than control

ROM: Control > > PEEK > Co-Cr

LB: PEEK = 27% Control PEEK = 2.7 x Co-Cr

FE: PEEK = 35% Control PEEK = 1.8 x Co-Cr

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Limitations / Comparisons

- **Early feasibility**
  - Intact straight rods, no distraction mechanism
  - No torsion, buckling, fatigue strength
  - Normalize by specimen and applied moment
- **Design: Many possible changes**
  - Composite structures, connector designs
- **Physiological loads?**
  - Small children, severe NM . . .
- **First biomechanical tests of polymers for growing rods**

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Conclusions

- **Simulated growing rod constructs using PEEK rods provided**
  - **Greater stability *vs* non-instrumented controls**
  - **Greater flexibility *vs* CoCr rods**
  - **More gradual motion & stiffness transition at junction**
- **Polymers may become a part of better treatment options for EOS**
  - **More studies warranted and required**

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Thank you

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