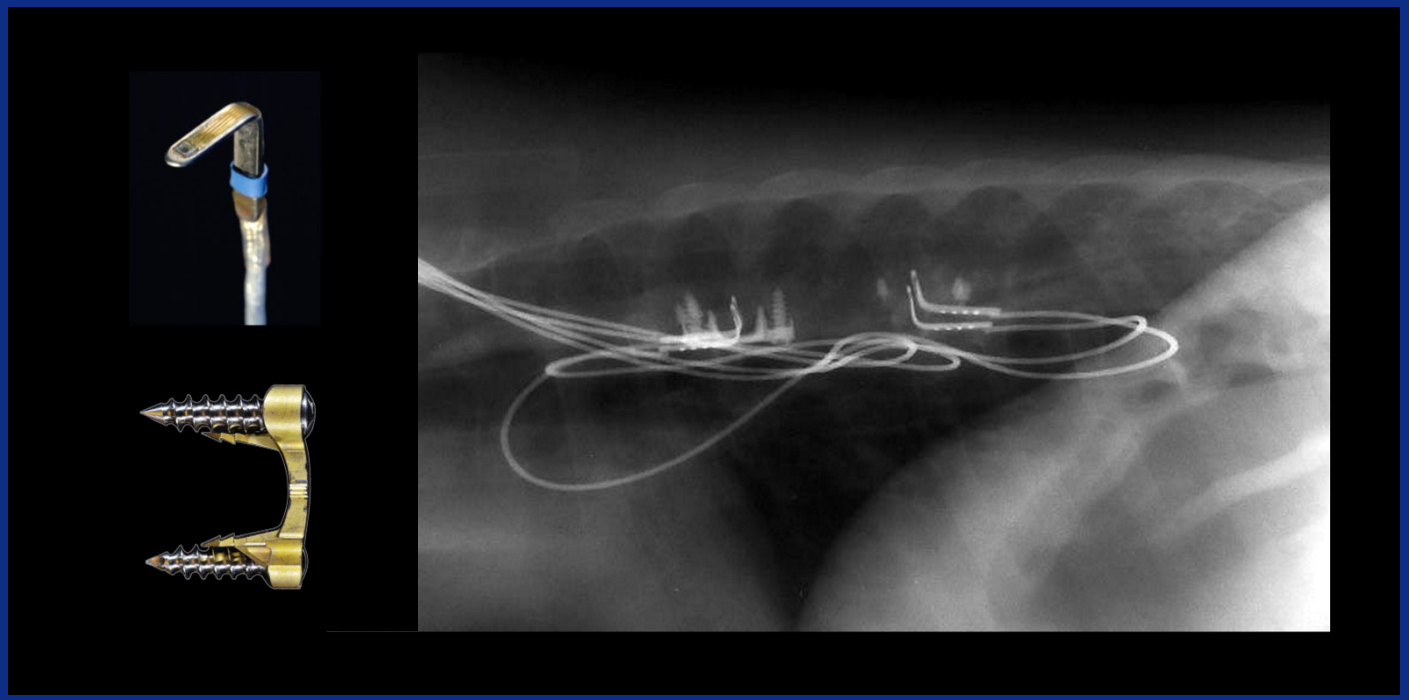
ICEOS 2011

Dynamic Compressive Stresses in the Disc Annulus

Effect of Staple Hemiepiphysiodesis

Bylski-Austrow DI, Wall EJ, Crawford AH, Jain VV, Sauser FE , Glos DL



Cincinnati Children's®

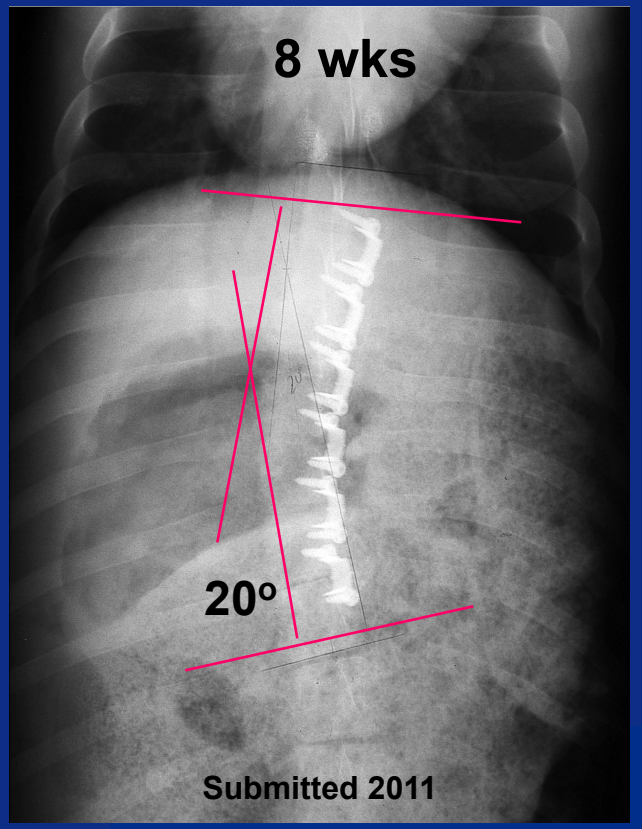
Disclosures / Acknowledgments

- **Non-financial research support**
  - SpineForm, LLC
    - Institutional ownership, IP agreement
  - Univ Cincinnati Micro/Nano Fabrication Engineering Research Center
- **Grant funding**
  - Scoliosis Research Society SRS
  - CCHRF Trustees
  - CCHMC Surgery Invest in Excellence
  - UOREF
  - NSF / UC: CCC
  - NIH/UC Clinical & Translational Science Award

Cincinnati Children's®

Spine growth modification
Compression-based

- Compressive stress increase
  - Mechanism of growth inhibition
  - Redistribution of stresses
- Quantification of stresses important
  - Efficacy
  - Disc health
- Titanium staple construct
  - Growth altered consistently
    - Approved for prospective clinical trial



Purpose

Develop model capable of determining

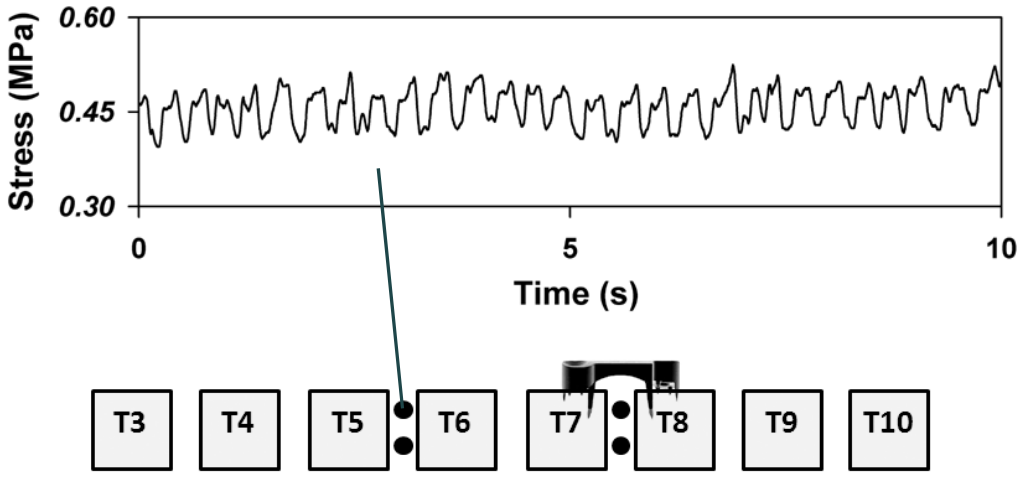
- Physiologic compressive stresses, mean and dynamic
- Stresses due to implant

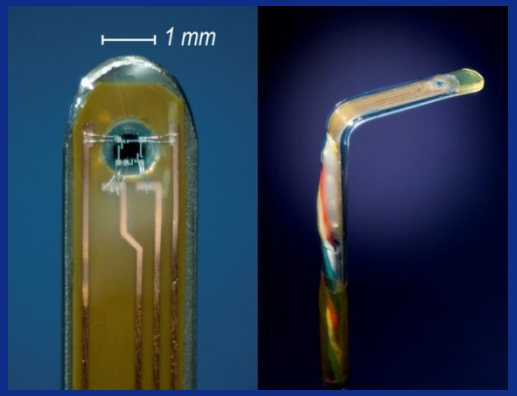
What are normal annular stresses?

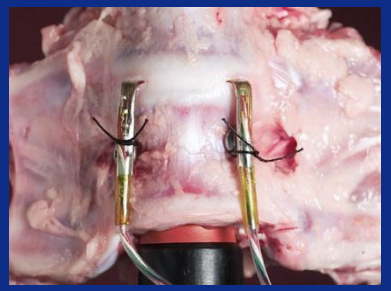
Do mean stresses become asymmetric?

Cincinnati Children's®

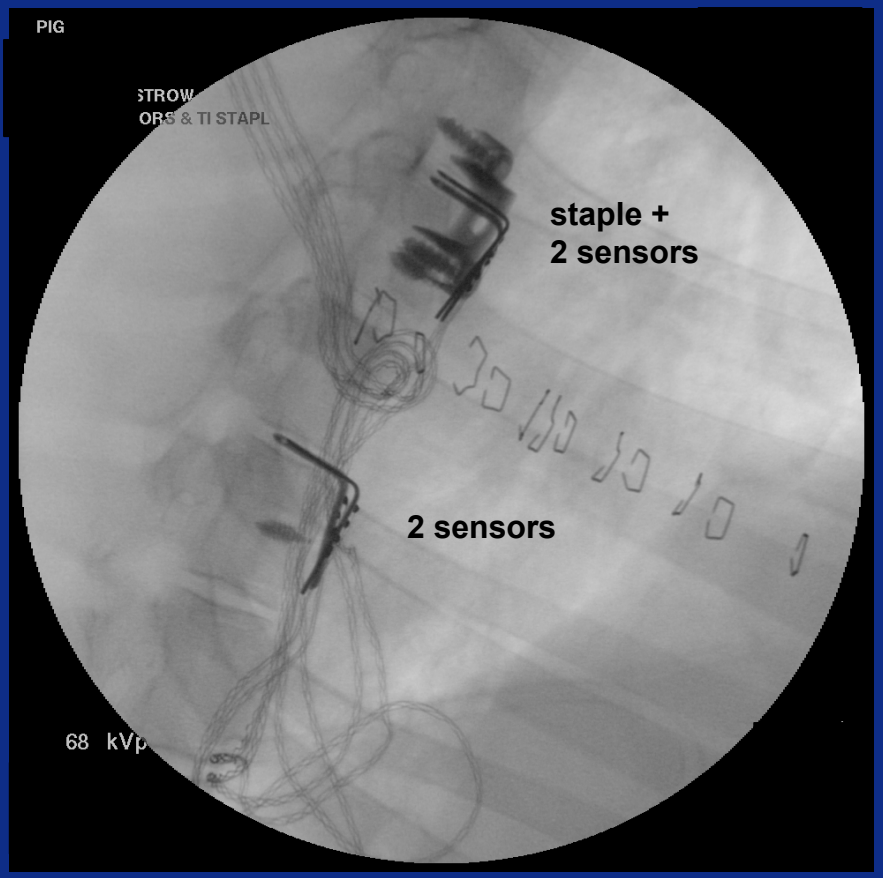
Experimental design







Methods: Intra-operative

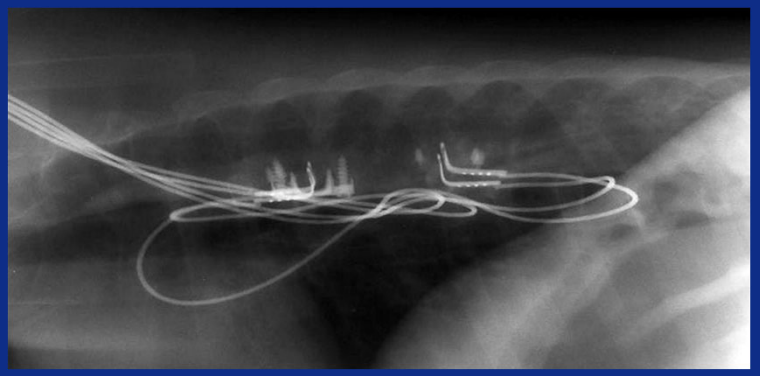


Fluoro - Sagittal view

- 6 pigs
  - Skeletally immature
    - 2-3 months, 30 kg
  - Thoracotomy
  - Sensors and protocol developed
  - Stresses measured during procedures
    - Approved by IACUC

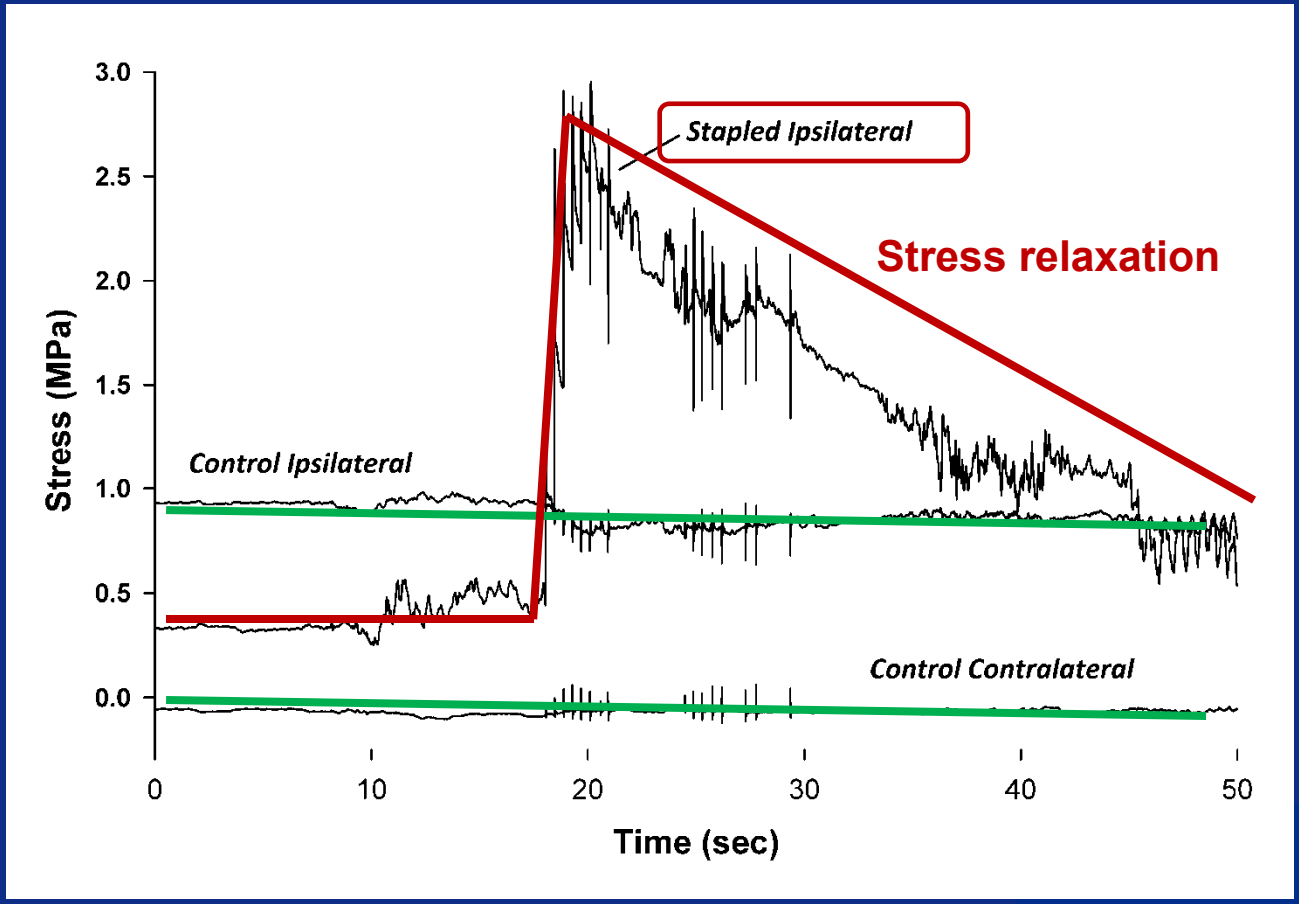
Methods: Post-operative

- Biweekly
  - Position of instrumentation
    - Radiography
  - Baseline stresses
    - Anesthetized, ventilated
      - Prone
- Daily
  - Stresses 3x / week
    - Run duration - 100 s
    - Sampling frequency - 670 Hz
  - PO week 1 analyzed
  - Activities categorized



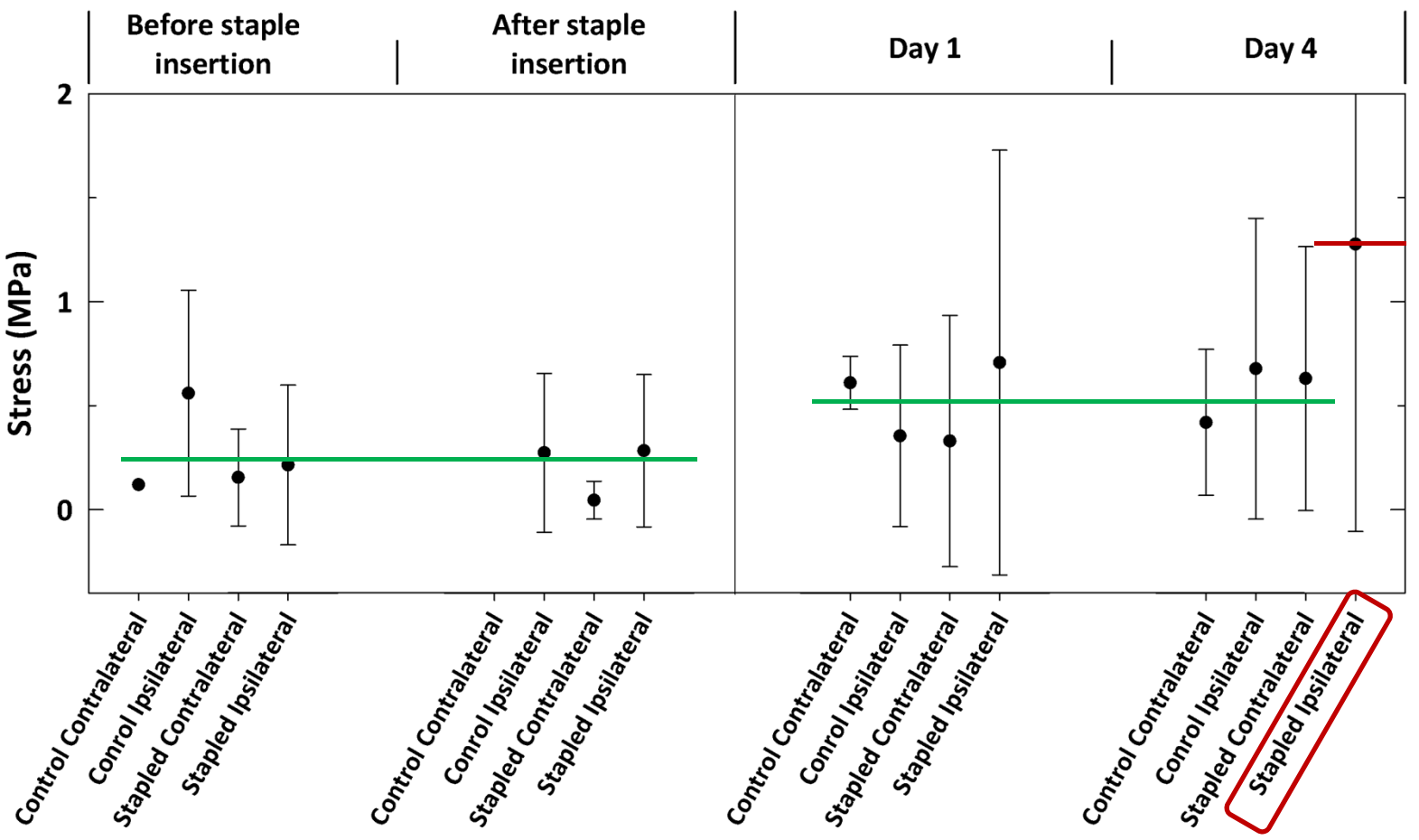
Results: Intra-operative

Stresses during staple insertion



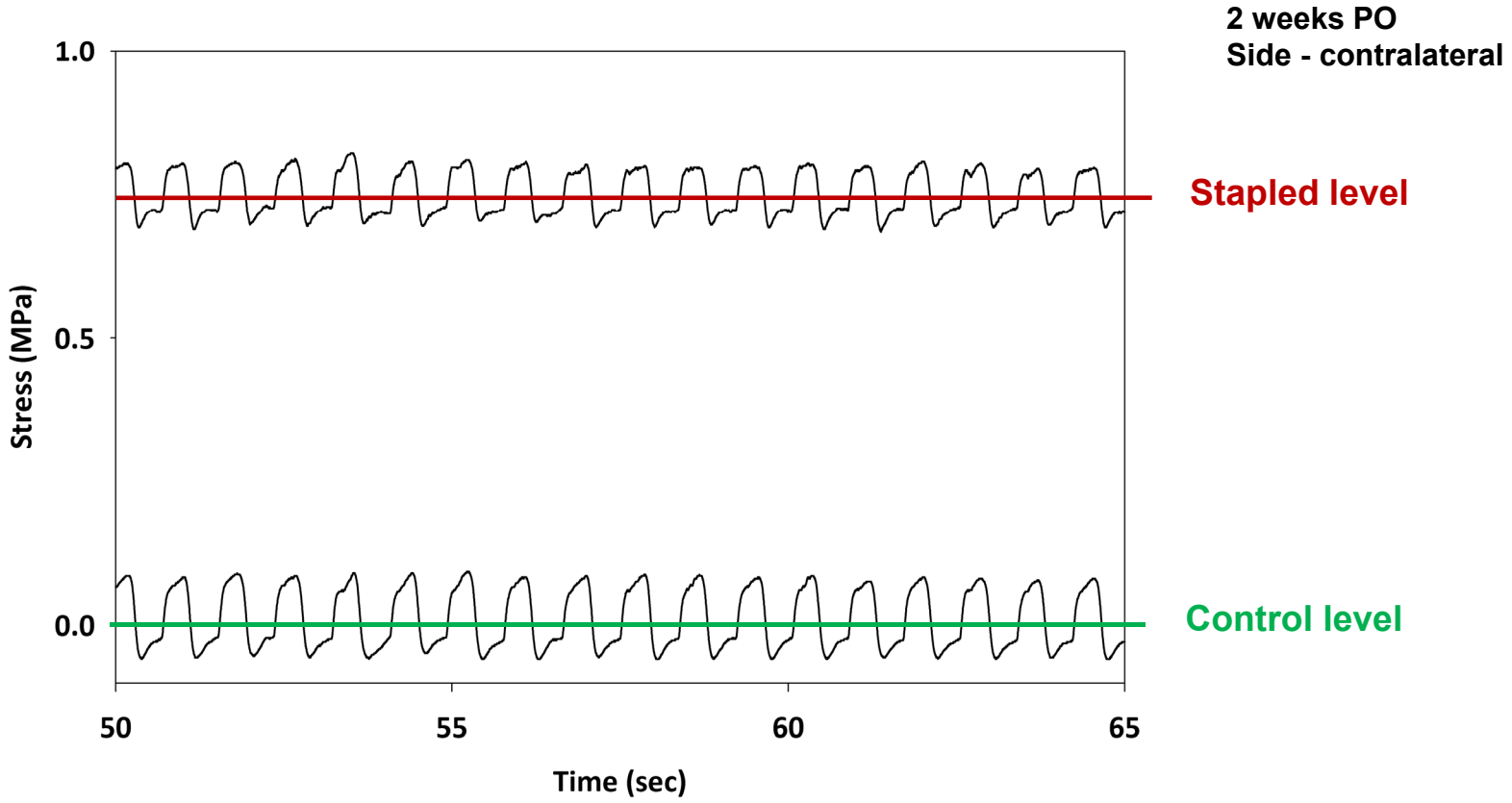
Intra-op to Post-op

Anesthetized & lying **Awake & Standing**



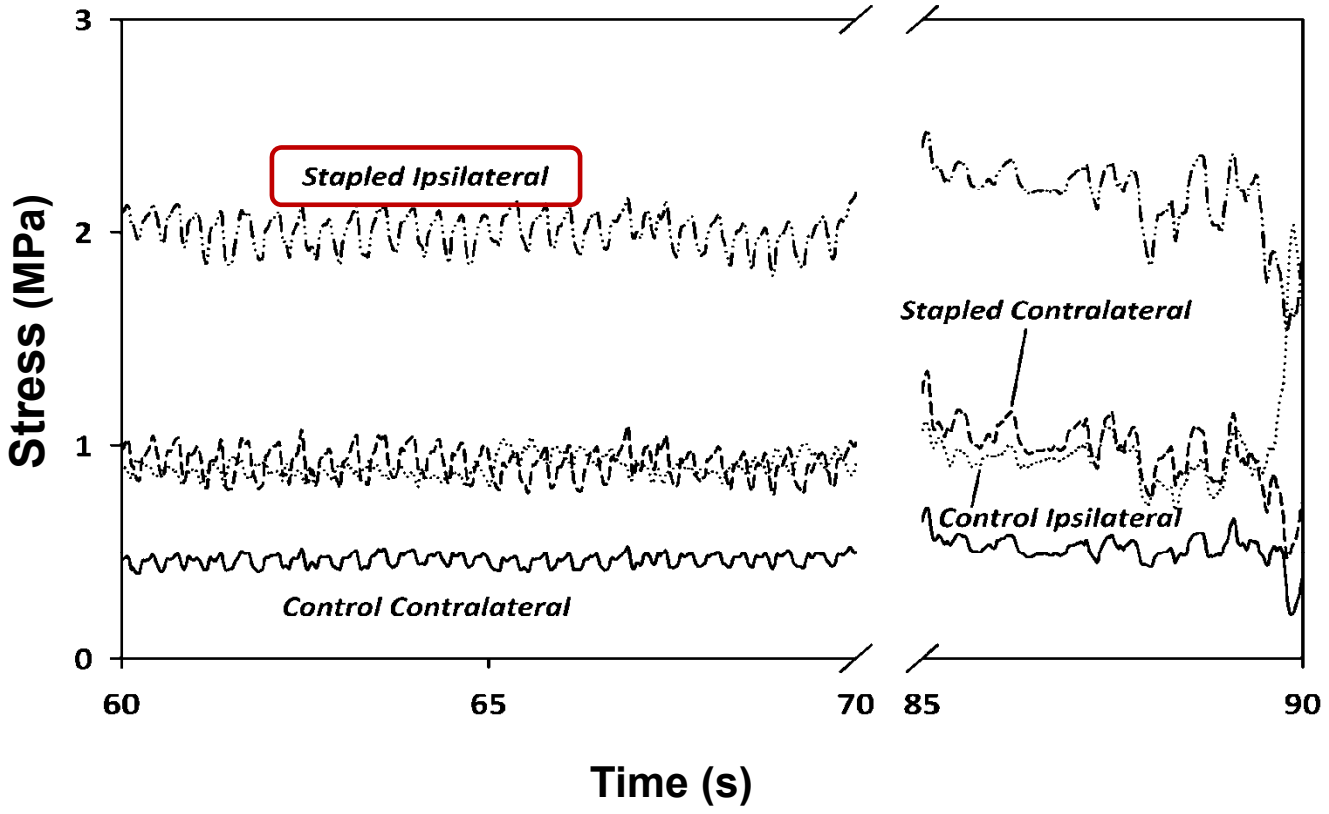
Biweekly

Baseline: Anesthetized, prone



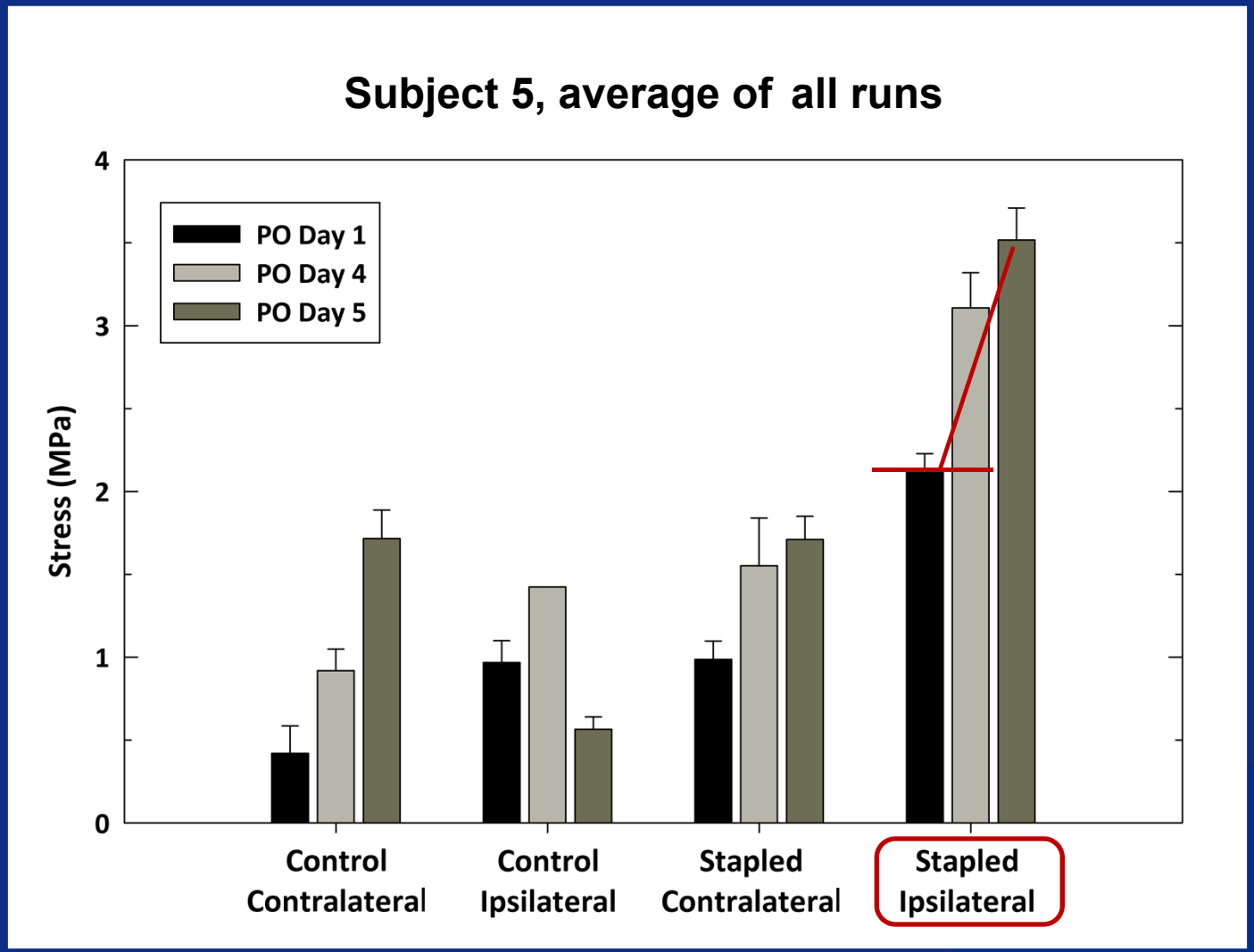
Physiologic dynamic stresses

Standing Walking



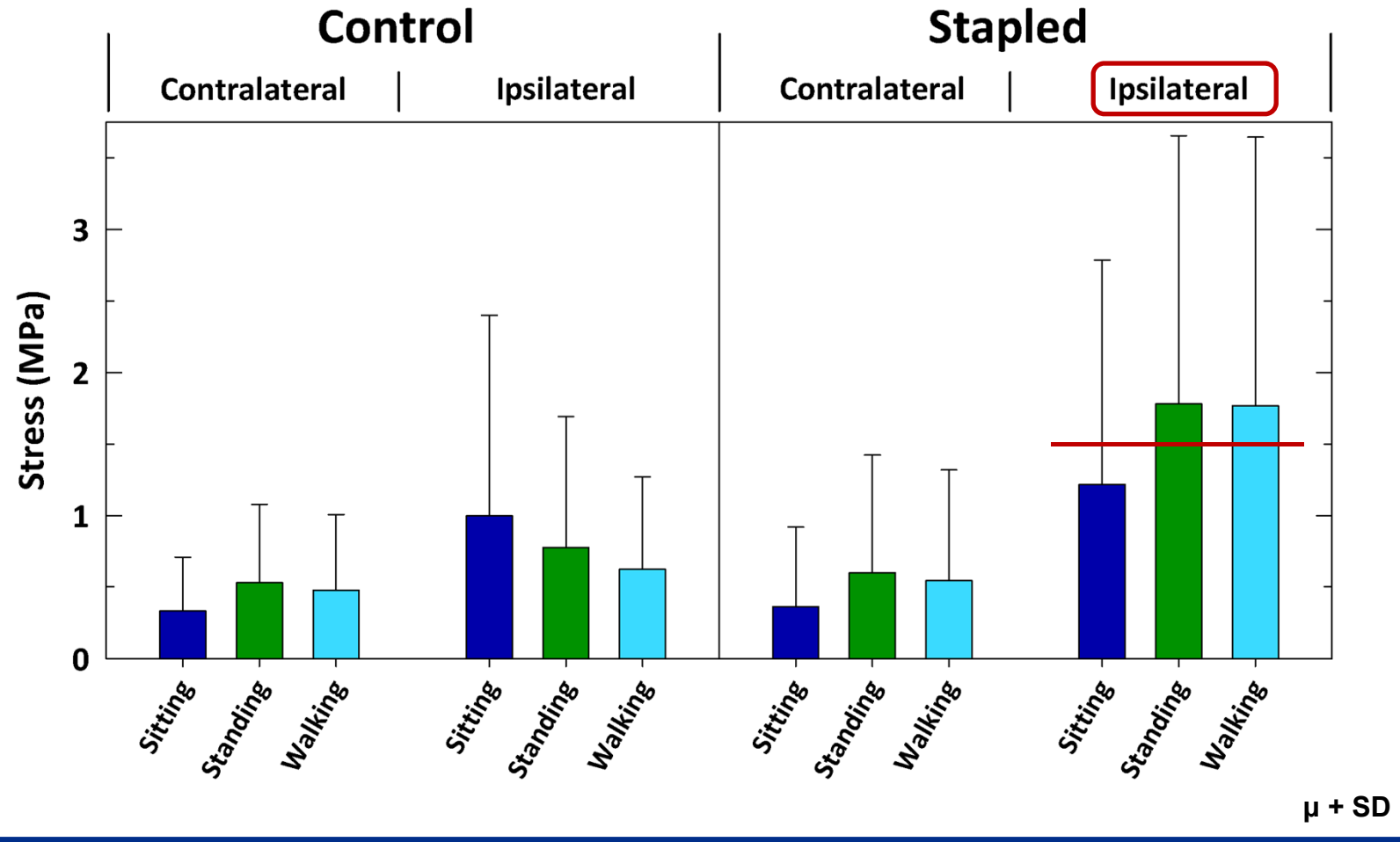
PO Day 1
Subject 5

Stress by sensor location & PO day



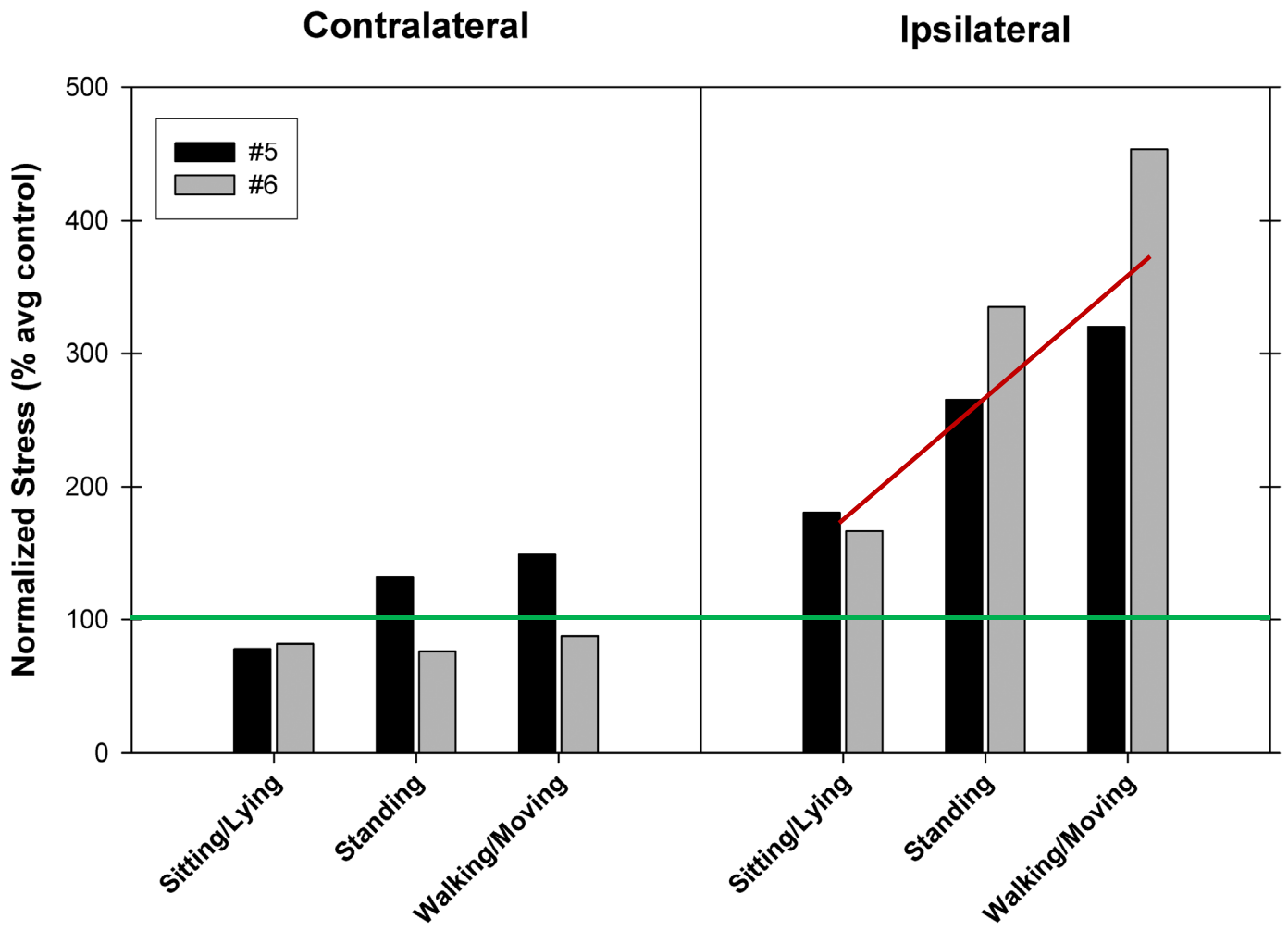
Stress by location & activity

All available subjects averaged
PO Day 4



Mean stress at stapled level

Normalized by control level



Conclusions

- Dynamic disc compression at all locations
  - Intervertebral motion
- Highest mean stresses nearest implant
- This type of model system may be used to help define extent to which different methods of growth modification change static and dynamic compressive stresses transmitted to discs and vertebral growth plates

Thank you

Cincinnati Children's®