Influence of Lumbar Lordosis on Posterior Rod Strain in Long-Segment Pedicle Screws and Rods Instrumentation and Anterior Column Realignment: Cadaveric Study

BERNARDO DE ANDRADA PEREIRA MD; Jakub Godzik MD MSc; Jennifer Lehrman BSE MS; Anna Newcomb; Randall Hlubek MD; Juan S. Uribe MD; Jay D. Turner MD, PhD; Brian P. Kelly PhD

SPINE BIOMECHANICS LAB - BARROW NEUROLOGICAL INSTITUTE - SJHMC - PHOENIX - AZ.

Introduction:

- Restoration of lumbar lordosis (LL) is an essential element of spinal deformity correction surgery and it differs significantly between patients. (1). Posterior rod strain (RS) monitoring during biomechanical testing is an effective method to infer the stresses on spinal implants and predict failure mechanisms. (2,3). LL is most dependent on the the sacral slope (SS) and the pelvis. The lower arc of lordosis is the most important determinant of the global LL. The relationship between the sacral orientation and the shape of the LL is an important component of overall sagittal alignment. (4). We hypothesized that the geometry of the final construct may have significant impact on the resultant rod strain.

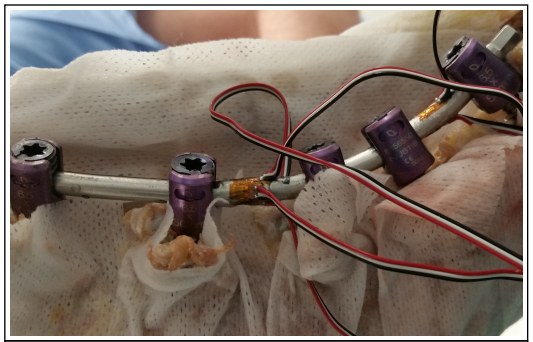
Methods

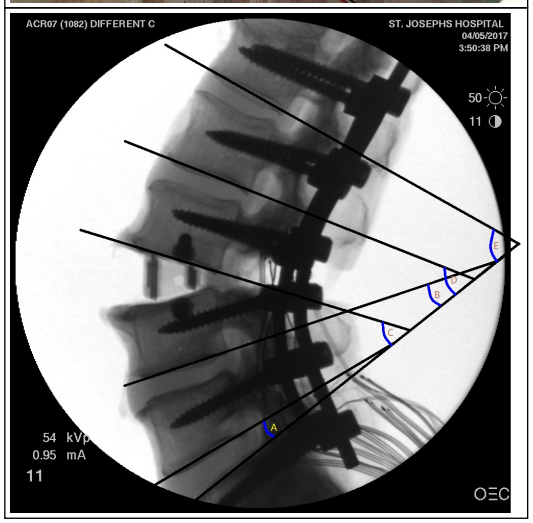
- Specimens (n=7) underwent standard nondestructive tests in 7.5 Nm flexion (FL); 7.5 Nm extension (EX) and 400 N compression (C) in a robotic apparatus. (6).
- Conditions: 1)intact; 2)pedicle screws and rods at L1-S (PSR); and 3)anterior column realignment (ACR) at L3-L4 with 30° interbody device.
- The posterior right rod was instrumented with strain gauges oriented in line with the long axis of the rod between L3-4 and L5-S1 pedicle screws.
- LL spanning different levels were measured from lateral x-rays in all different conditions using the Cobb method: A) L5-S1, B) L4-S1, C) L3-S1, D) L2-S1 and E) L1-S1.
- These angles were compared with peak recorded rod strains (RS) for each test condition. Data were analyzed using Pearson correlation analysis ($p<0.05$).

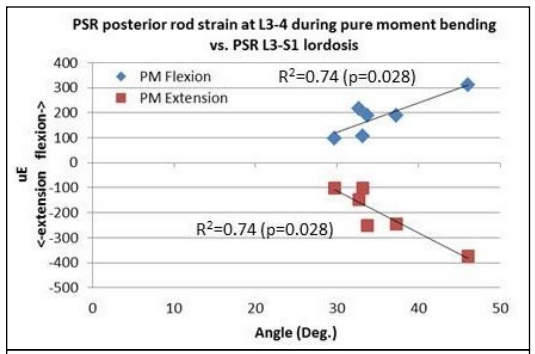
Results:

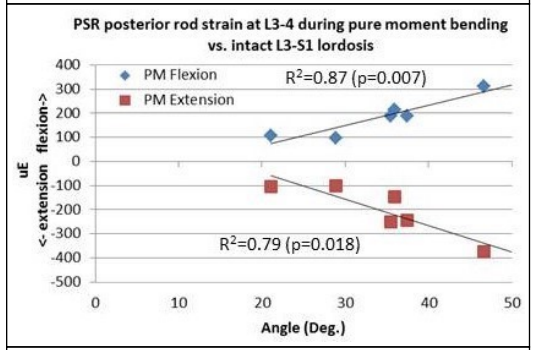
There is a strong correlation between:

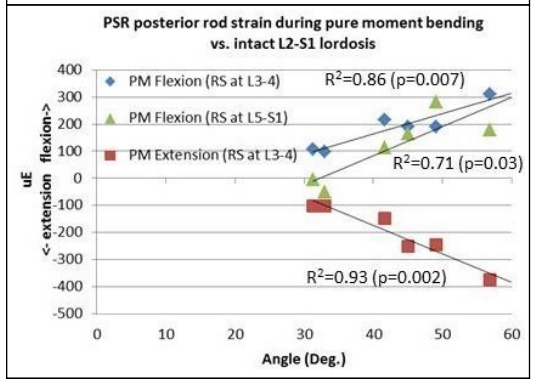
- Both intact (R2=0.74, p=0.028) and PSR (R2=0.87, p=0.007) L3-S1 angles and PSR L3-4 RS during FL.
- Intact L3-S1 angle and PSR L3-4 RS during EX (R2=0.791, p=0.018).
- Intact L3-S1 angle with ACR L5-S RS during C (R2=0.86, p=0.008).
- Intact L2-S1 angle with PSR L3-4 RS during FL (R2=0.86, p=0.007) and EX (R2=0.93, p=0.002).
- Intact L2-S1 angle with PSR L5-S RS during FL (R2=0.71, p=0.030).
- Intact L2-S1 angle with ACR L5-S RS during C (R2=0.73, p=0.030).

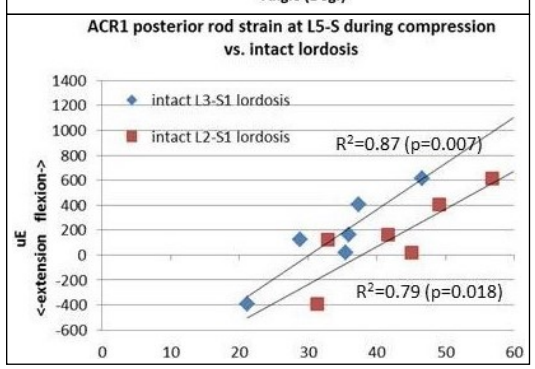












Conclusions:

LL in both the intact and PSR demonstrated strong correlations with in vitro posterior RS during various configurations. These relationships should be strongly considered when interpreting results of biomechanical testing in long segment fusion models. Further studies are necessary to assess the impact of sagittal balance on implants strain.

Learning Objectives

By the conclusion of this session, participants should be able to understand that the lumbar lordosis has influence on posterior rod strain, discuss the LL and sagittal balance features and its influence on hardware strain, identify the LL shape which has the greatest rod strain.

References:

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