Biomechanics of the Lumbar Spine
Biomechanics of the Spine
“6 degrees of freedom”

The disc/annulus/ALL/PLL complex is the major restraint to motion.
Biomechanics of the Spine
The Disc

• The interaction of the anterior and posterior lumbar spinal columns is critical for normal physiologic function, load transmission, and kinematics
• Lumbar range of motion varies between vertebral levels and individuals
• As the vertebral body rotates anteriorly, the anterior annulus is compressed
• As rotation occurs, the weight of the upper body and trunk lead to shear strain forces at the disc and slight translation
Biomechanics of the Spine

The Neutral Zone

• Tensile, compressive, shear & torsional loads are applied on the Spine

• The Neutral Zone: A region of little or no resistance to motion on either side of the neutral position for a motion segment

• The neutral zone is a region of intervertebral motion around the neutral posture, where little resistance is offered by the passive spinal column

• It is a clinically important measure of spinal stability function.
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**IAR**

- **Instantaneous Axis of sagittal Rotation (IAR)** located in posterior third of disc
- The disc and facets work together to constrain spinal kinematics
- Facets contribute 30% axial rotation control
- Disc / Annulus contributes 50% torsional stability

\[ M = \text{bending moment}; \ F = \text{Force}; \ D = \text{Distance from IAR} \]
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IAR

Comparison: Neutralizing the Instantaneous Axis of Rotation

**Leverage Arm**

- PS Leverage Arm
- Trans-facet fixation: 0.5 - 1
- GO-LIF fixation: 0 – 0.5
- Axial-LIF fixation: 0 – 0.5
- Anterior plate fixation: 1

Source: Neurosurge Focus 2003 American Association of Neurological Surgeons
Biomechanics of the Spine
GO-LIF

- Feasibility test shows that GO-LIF construct is equal / stronger than conventional pedicle-screw-based constructs

- The GO-LIF instrumentation is localized near the IAR thus minimizing shear forces that act on the construct

Pedicle stress distribution for level S1-L5.

GO-LIF stress distribution for level S1-L5.
• Bio-Mechanical tests shows that GO-LIF construct is as strong as conventional pedicle-screw-based constructs

• GO-LIF stiffness are comparable to conventional pedicle-screw-based constructs

• When comparing 6.25 Amethyst to a standard 6.2 Pedicle screw, the GO-LIF is over 10% stronger
GO-LIF test results are above the average values of Lumbar spine implants

**Static Test:**
GO-LIF™ = **530N** > Pedicle screws = **450N**

**Fatigue Test:**
GO-LIF™ = **305N** > Pedicle screws = **270N**
GO-LIF Biomechanics Study  
Method

• 2 groups of motion segments from L1-L5, with matched spinal levels and BMD, were tested with GO-LIF protocol (Group 1, n = 5) or instrumentation with pedicle screws (PS) (Group 2, n=5).

• The prepared motion segments were then tested under +/-5Nm flexion-extension (FE) and lateral bending (LB).

• Three-dimensional kinematics of each vertebral body during flexibility testing was captured.

• Flexibility tests:
  • intact specimen
  • instrumentation states alone,
  • respective instrumentation states with anterior interbody graft,
  • Failure
GO-LIF Biomechanics Study

Method

Specimen Preparation

Specimen with Graft

Specimen without Graft
GO-LIF Biomechanics Study

Results

GO-LIF

Results; flex ext

Ped Screws
GO-LIF Biomechanics Study

Results

Results; Lat Bending

GO-LIF

Ped Screws
GO-LIF Biomechanics Study

Conclusions
GO-LIF Biomechanics Study

Conclusions

Failure Test

![Graph showing failure load comparison between PS and OLIF in flexion and extension.](image)
GO-LIF Biomechanics Study
Conclusions

- GO-LIF stiffness (ROM and NZ) are comparable to pedicle screws and rod fixation

- GO-LIF failure loads are comparable to pedicle screws and rod fixation

- GO-LIF failure occurred ventrally through the anterior cortical rim without concomitant pedicle fracture

- Interbody Graft did not significantly add stability