What’s New in Spine?
Lateral Transpsoas Surgery

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What are the surgical goals?

- Resolve leg pain
- Restore coronal and sagittal alignment
- Minimize soft tissue disruption
- Promote fusion with large graft area
- Minimize complications
- Meet/exceed traditional results
Should we be doing Surgery?

Patients undergoing surgery fare better than those with nonsurgical treatment.
Degenerative Spondylolisthesis

• Laminectomy and fusion does better than laminectomy alone.
  – Better reproducible clinical results

• Laminectomy alone can lead to progression of the spondylolisthesis and worsening deformity


Clinical Outcome

• Decompression/fusion is the apparent right choice

• Treatment options:
  – Lami + noninstrumented fusion
  – Lami + instrumented fusion
  – mTLIF/TLIF
  – ALIF/post fusion +/- lami
  – LLIF/post fusion +/- lami
• Is fusion necessary?

• *Does clinical outcome correlate with fusion success?*
Fusion

Degenerative Lumbar Spondylolisthesis With Spinal Stenosis
A Prospective Long-Term Study Comparing Fusion and Pseudarthrosis

Martin B. Komblum, MD,* Jeffrey S. Fischgrund, MD,† Harry N. Herkowitz, MD,†
David A. Abraham, MD,‡ David L. Berkower, DO,§ and Jeff S. Ditkoff¶

• Long-term clinical outcome success favored successful arthrodesis
SPORT Data

• Early:
  – Outcomes equal across fusion methods.

• Two years:
  – Anterior/Posterior Fusion Patients area significantly better in SF-36 Back pain and Physical Function compared to posterolateral fusion with pedicle screws.
    • Back Pain = 39 vs 29; p=0.003
    • Physical Function = 32 vs. 25; p=0.04
  – A non-significant trend to worse outcomes in the posterolateral fusion group at 4 years.

Fusion Is Necessary

Solid Fusion
- Tsutsumimoto
  - Long term results JOA scores
    - Solid fusion group
      - Leg – 2.4 (p=0.018)
      - Back – 2.3 (p=0.035)
- Kornblum
  - Good to excellent results
    - 86% of patients (p=0.01)
    - 56% of patients with a pseudarthrosis (P 0.01).

Pseudoarthrosis
- Tsutsumimoto
  - Long term results JOA scores
    - Pseudoarthrosis group
      - Leg – 1.8 (p=0.018)
      - Back – 1.6 (p=0.035)
- Kornblum
  - Good to excellent results
    - 56% of patients with a pseudarthrosis (p= 0.01).


Why Lateral Surgery?

• Improve fusion rate
• Improve decompression
• Improve deformity correction
• Reduce complications
Posterolateral Fusion

- Fischgrund et al (1997)
  - 82% fusion rate
  - Prospective trial, 120 patients
  - 52% ICBG vs 54% Grafton DBM
  - Retrospective, 76 patients
  - 75% ICBG vs 67% local bone
Interbody Fusion: TLIF

• Potter et al (2006)
  – Retrospective review of 100 consecutive patients
  – 93% fusion rate
• Lee et al (2010)
  – 77% fusion rate
• Hartl et al (2010)
  – Meta-analysis of open vs MIS TLIF
    • MIS TLIF 94% (heavy BMP)
    • Open TLIF 90%

• Comparison of fusion rates for mTLIF (92%) versus open TLIF (93%)
Interbody Fusion: Lateral

  - Review of LLIF literature
  - 91 to 100% fusion rates (primarily NON BMP)
  - CT based analysis
- Rodgers et al (2010)
  - Prospective CT assessment of fusion
  - 97% fusion rate
- Pimenta et al (2012)
  - 92% fusion rate
- Zavatsky et al (2014)
  - 98% fusion rate
Summary of Fusion Data

- Posterolateral fusion: 50-85%
- TLIF/mTLIF: 78-93%
- LLIF: 91-100%

*If we believe FUSION = IMPROVED OUTCOME then interbody fusion is the wiser choice*
Improve Fusion Rate

- Placement of large cage across apophyseal rings
  - *High fusion rates*
  - *Stable interbody cages*
  - *Lower subsidence rates*
  - *Indirect decompression*
Does Spanning a Lateral Lumbar Interbody Cage Across the Vertebral Ring Apophysis Increase Loads Required for Failure and Mitigate Endplate Violation.

Briski DC, Goel VK, Waddell BS, Serhan H, Kodigudla MK, Palepu V, Agarwal AK, Zavatsky JM.

- Spanning ring apophysis increased mode to failure
  - 40% for intact endplates
  - 30% for decorticated endplates

>30% endplate cage coverage = decreased subsidence

Lower subsidence rates compared to PLIF/TLIF


Outcomes

Interbody Fusion

- Ha, et al.
  - Reduction in ODI
    - 42% +/- 18%
  - Reduction in VAS
    - 6 +/- 2
- Christensen, et al.
  - 5-9 years post op
    - ODI – 28 (p=0.004)
    - SF 36 (Physical) – 39 (p=0.005)
    - SF 36 (Physical) – 57(p=0.093)

Posterolateral Fusion

- Ha, et al.
  - Reduction in ODI
    - 22% +/- 16%
  - Reduction in VAS
    - 3 +/- 2
- Christensen, et al.
  - 5-9 years post op
    - ODI – 40 (p=0.004)
    - SF 36 (Physical) – 33 (p=0.005)
    - SF 36 (Mental) – 52 (p=0.093)

Why Lateral Surgery?

- Improve fusion rate
- Improve decompression
- Improve deformity correction
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Indirect Decompression

• Central and foraminal

• Gains maintained with low subsidence

\textit{(apophyseal to apophyseal ring cage fit)}
Powerful Indirect Decompression

Large LLIF cages help drive indirect decompression

Average reported disc height gains:

**TLIF**

- 0.7mm (16%) \(^{(31)}\)

**LLIF/XLIF**

- 3.0mm (41%) \(^{(27)}\)

*Groth et. al., 2005*
• 25 patients, grade 1 degenerative spondylolisthesis, leg pain and LBP
  – Evaluate Post op MRI:
    • ↑↑ dural sac area 143%
    • ↑ AP diameter 54%
    • ↑ M-L diameter 48%
  – VAS Back Pain: 8 → 2
  – VAS Leg Pain: 7 → 2
  – ODI: 55 → 16

Elowitz et al, Min Invasive Neurosurg, 2011
Indirect Decompression

- 29 pts, pre- and post-op CTs; LBP/Leg pain
  - 10° lordotic cages +/- posterior instrumentation
  - ↑↑ Foramina → 135% of pre-op area

Disc heights:
- Ant 6.2 → 9.8mm; Post 3.7 → 6.3mm
- ↑↑ Ave height 64%
- Ant cage placement ↑↑ PCS score 13.4 vs 5 when cage placed posterior
- Outcome predictors are multifactorial....
- No correlation between FV and outcome

Why Lateral Surgery?

- Improve fusion rate
- Improve decompression
- Improve alignment and deformity correction
- Reduce complications
Interbody Fusion

- Better reduction of spondylolisthesis and deformities
  - Less local kyphosis
  - Improved biomechanics
  - Lower pseudoarthrosis rate.

- Indirect nerve decompression
  - 42% disk height increase yields:
    - 14% increase foraminal height
    - 25% increase foraminal area


Longo UG1, Loppini M1, Romeo G1, Maffulli N2, Denaro V1..
Evidence-based surgical management of spondylolisthesis: reduction or arthrodesis in situ.
Improved Alignment

• Fusion in physiologic alignment
  – Logically expect less stress on the adjacent segments
  – Lower rates of ASD

  – Intuitively we know this will not do well long term
Why do we care?

• **ASD driven (in part) by malalignment!**

• Rothenfluh et al (ESJ, 2014)
  
  – Evaluate spinopelvic parameters in patients with ASD versus controls
  
  – **10x greater risk of ASD** with PI/LL mismatch > 10 degrees
Segmental Alignment

- Laminectomy with PSF/fixation
  - No significant change in segmental parameters
  - Improve segmental alignment with interbody fusion (ALIF/LLIF)

Sembrano JN, Sharma AK, Horazdovsky RD, Santos ERG, Polly DW. Radiographic comparison of lateral fusion vs ALIF vs TLIF vs posterior fusion: Analysis of segmental sagittal contour change
Segmental Alignment

• TLIF (open and/or MIS)
  – Lee et al (Neurosurg, 2008)
    • 2 degrees increase lordosis
    • Bilateral TLIF can restore up to 7-8 degrees
  – Wong et al (Neurosurg, 2014)
    • 5.6 degrees improvement

Alignment

• Significant improvements in segmental and global coronal and sagittal alignment
  – Anterior cage positioning ~ 7.4 deg/level (Kepler et al, 2012)
  – Increased correction with lateral interbody with osteotomies (Lee et al, 2014)

• Akbarnia et al (IMAST, 2010)
  – Significant increase in SRS-22, VAS, ODI at 2-yr
  – Average Cobb 47 → 17 degrees
  – Coronal L4 tilt 23 → 10 degrees
  – 45% coronal correction, 70% with posterior instrumentation

• Phillips et al (Spine, 2013)
  – Significant improvements: ODI, SF-36, VAS
  – 85% satisfaction score
  – LL improvement 28 → 34 degrees
  – Cobb correction 21 → 15 degrees

• Multiple hyperlordotic (>15 deg) options now available

• Greater focus on posterior fixation compression
Coronal and Sagittal Balance

• Significant improvement in coronal alignment

• Hyperlordotic transpsoas placed cages may improve segmental lordosis
  – Overall sagittal vertical alignment improved from 12cm to 6cm
  – Significant improved regional lordosis with open decompression + osteotomies (Attanello et al 2013)

• Correlation with slip angle
  – Restoration of slip angle associated with improvement in pain outcomes scores

Why Lateral Surgery?

- Improve fusion rate
- Improve decompression
- Improve alignment and deformity correction
- Reduce complications
Complication Rates

Posterolateral/Open

  - Open posterolateral fusions in elderly (>65 y/o)
  - 80% complication rate

- Dekutoski et al (2010)
  - >500,000 open fusions for degenerative spondylolisthesis
  - 14%

MIS TLIF

  - 7-25% rate (meta analysis)

  - MIS 7.5%, Open 12.6%

PLIF

- Okuda et al
  - 25% (> age 60)

- Benz et al
  - 41% (> age 70)
Complications in Lateral Interbody Fusion

- Isaacs et al (Spine, 2010)
  - 107 patients prospective, Level II
  - 12% rate of major complications
    - 9% MIS
    - 21% posterior open
    - 2.8% reoperation rate

- Rodgers et al (Spine, 2011)
  - Reviewed 600 cases (741 levels)
    - 69% include L4-5
    - 99% posterior instrumentation
  - Overall complication rate 6.2%
    - 1.5% surgery related
    - 2.8% medical events
    - No wound infections, deaths, or intraop visceral injury
MIS in Octogenerians

• Comparison of 20 open PLIFs vs 40 LLIFs
  
  (Rodgers et al, Spine (2010))

  – 92.5% MIS patients d/c home
  – ALL PLIF patients d/c to SNF

• Complication rate: 60% PLIF vs 7.5% LLIF

• Postop mortality related to: infection, complications, EBL

  – All significantly greater in PLIF
Neurologic Injury

- Mild transient psoas weakness – 20-25%
- LE weakness > than a few months – 6.5%
- Persistent weakness uncommon → 1 of 107
  (↑↑ to 4/5 manual muscle strength at 6 mo)
- Lumbar plexus injury rare: 0.3% per level
  - Risk increases in proportion to # levels performed

***Recommend neuromonitoring in all cases***
Cost

• Initial cost
  – Interbody fusion is costlier $47k vs 42k

• Long term (4-9 years)
  – Cost saving of circumferential fusion (TLIF or PLIF) compared with posterolateral fusion
    • Incremental Cost Utility Ratio $49k/QALY
      – Due to lower revision rates


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Summary

• Lateral transpsoas interbody fusion affords an alternative to traditional open fusion techniques
  – Improved fusion rates
  – Indirect decompression

• Improved coronal and sagittal alignment maintenance and correction

• Decreases morbidity in patients at high risk from traditional open surgeries
  – Reduced EBL and mortality risk
  – Adhere to meticulous surgical technique to minimize procedural risks

• Continued expansion of technique indications

• Additional high quality studies needed for further evaluation
Thank You!