Anterior and Lateral Lumbar Minimally Invasive Approaches: How to Choose

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Disclosures

• Consultant:
  • K2M, Inc. (<$10,000 per year)
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  • K2M, Inc. (<$10,000 per year)
  • Medtronic (<$10,000 per year)
Wash U Fellowship
Anterior Approach History

Muller Transperitoneal Approach

Iwahara Retroperitoneal Approach

Harmon Retroperitoneal Approach

1906

1944

Harmon Retroperitoneal Approach to Lumbar Spine

1995 Mayer mini-incision anterolateral

2004 Pimenta Transpsoas Lateral Lumbar Interbody Fusion

2012 Oblique Lumbar Interbody Fusion (Tubular/Mini-Open)

2012 Oblique Lumbar Interbody Fusion (Tubular/Mini-Open)
My Practice Evolution

LLIF
ALIF
OLIF
ALIF vs LLIF vs OLIF: How to Choose

- Surgeon Preference/Experience/Comfort
- Anatomy
  - Vascular
  - Neurological
  - Muscular
    - psoas
- # of levels
  - Include L5-S1
  - Above L2-3
- Deformity
  - Sagittal plane
  - Flexible/Rigid Deformity
  - Transitional L5-S1
- Patient Factors
  - Prior Retroperitoneal Exposure
  - BMI
  - Bone Density
ALIF

ADVANTAGES

- Familiar approach
- Direct visualization
- Anterior Support
  - Increased stiffness
  - Larger footprint
- Height restoration
  - Indirect Decompression
  - Direct Decompression
Anterior lumbar interbody fusion in comparison with transforaminal lumbar interbody fusion: implications for the restoration of foraminal height, local disc angle, lumbar lordosis, and sagittal balance.


**Fig. 1.** Bar graph comparing changes in foraminal height associated with ALIF and TLIF.
# ALIF

## Advantages
- No dural retraction as with PLIF/TLIF
- Revision for failed PLIF/TLIF

## Cases
- Spondylolisthesis
- Revision of TLIF/PLIF
- Rigid deformity
- Infection
- Lumbar DDD
The Morbidity of an Anterior Thoracolumbar Approach

Adult Spinal Deformity Patients With Greater Than Five-Year Follow-up

Youngbae B. Kim, MD, Lawrence G. Lenke, MD, Yongjung J. Kim, MD, Young-Woo Kim, MD, Kathy Blanke, RN, Georgia Stobbs, RN, and Keith H. Bridwell, MD

Results demonstrated an appreciably high rate of:
- postoperative pain (32.3%)
- bulging (43.5%)
- functional disturbance (24.2%)

Rely on access surgeon
ALIF CASES: 26 yo F Grade IV Isthmic Spondylolisthesis

Courtesy of M. Gupta
ALIF CASES: 44 yo M L3-4 pseudarthrosis/cage migration/ectopic bone
ALIF CASES: 44 yo M L3-4 pseudarthrosis/cage migration/ectopic bone
ALIF CASES: 27 yo F post-discectomy lumbar DDD and pain
ALIF: When Do I Use It

- L3-4 through L5-S1 involved
- Lumbar Anatomy not good for LLIF
  - High iliac crest
  - “mickey-mouse” psoas
- Need to restore LL
  - L4-5, L5-S1
- High BMI
  - Vascular surgeon dependent
ALIF: When Do I Avoid It

- Avoid TAA
- History of retroperitoneal surgery, radiation
LLIF

Advantages

• Minimal Access Surgery
• No Need for access surgeon
• Extensile approach of Thoracic-Lumbar spine
  • L5-S1 not accessible
• Biomechanical Advantages of Anterior Cage as in ALIF
  • Rigid construct
  • Large footprint
• Height Restoration
  • Indirect Decompression
Radiological and clinical outcomes following extreme lateral interbody fusion.

Alimi M, Hofstetter CP, Cong GT, Tsiouris AJ, James AR, Paulo D, Elowitz E, Härtl R.

TABLE 3: Radiological outcome for 90 patients who underwent ELIF*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Preop</th>
<th>Postop</th>
<th>p Value</th>
<th>Last FU</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean coronal Cobb angle in degrees</td>
<td>23.8 ± 13.0</td>
<td>10.3 ± 8.55</td>
<td>&lt;0.0001 †</td>
<td>10.6 ± 8.85</td>
<td>&lt;0.0001 †</td>
</tr>
<tr>
<td>mean lumbar sagittal lordosis in degrees</td>
<td>39.7 ± 16.97</td>
<td>45.7 ± 12.73</td>
<td>&lt;0.0001 †</td>
<td>43.7 ± 14.73</td>
<td>0.014 †</td>
</tr>
<tr>
<td>mean foraminal height in mm</td>
<td>15.4 ± 3.99</td>
<td>18.5 ± 4.1</td>
<td>&lt;0.0001 †</td>
<td>17.5 ± 3.7</td>
<td>&lt;0.0001 †</td>
</tr>
<tr>
<td>mean disc height in mm</td>
<td>4.1 ± 2.48</td>
<td>7.5 ± 2.17</td>
<td>&lt;0.0001 †</td>
<td>6.8 ± 1.84</td>
<td>&lt;0.0001 †</td>
</tr>
</tbody>
</table>

* FU = follow-up.
† A p < 0.05 was considered statistically significant.
LLIF

Advantages

• No dural retraction as with PLIF/TLIF

Cases

• Lumbar Adjacent Segment Disease
• Post-laminectomy deformity
• Spondylolisthesis
• Infection
• Deformity
  • Sagittal Plane Restoration
  • Avoiding PSO w/ ACR
Disadvantages

- Less Direct Visualization
- No access to L5-S1 level
- L4-L5 variable accessibility
  - Table Break
- L4-L5 Nerve location variable
  - Femoral Nerve
- Psoas Muscle Dilation
  - Thigh Pain
  - Hip Flexion weakness
  - Genitofemoral nerve
    - Groin/thigh pain/dyesthesias
- Neurological Injury
- Vascular Injury
- Peritoneal Injury
- Need to pay attention to shape and size of psoas muscle
• Jack-Knife for 60 minutes resulted in transient neuropraxia
• 25 degrees of Jack-Knife starts the insult to the lumbar plexus
• Compression can occur against the L5 transverse process at L4-5
• Degree of stretch and compression coupled with time, dictates the amount of neural insult

Moro Zones

- Psoas vein
- L4-L5 disc space
- Anterior Zone
  - Zone 1
  - Zone 2
  - Zone 3
  - Zone 4
- Posterior Zone
- Lumbar plexus
- Left L4-L5 neuroforamen
Femoral Nerve

Zone 3 (27.8%)

Zone 4 (38.9%)

Zone P (27.8%)
Neurogram with Retractor
LLIF: 63 yo M L34 ASD with radiculopathy

Preop ODI 44
VAS back 7/10
Vas leg 9/10
LLIF: 63 yo M L34 ASD with radiculopathy

1 year ODI 6
LLIF: 67 yo F prior L4-S1 PSI/F w/ L2/L3 radiculopathy
LLIF: When Do I Avoid

- L5-S1 involved
- Large psoas
- Transitional Anatomy
- L4-5 with high iliac crest
  - Table break
- Facet OA
- Maintained disc heights with SS
  - Don’t trust indirect decompression
OLIF

- My rational for transitioning to OLIF from ALIF and LLIF
Rationale

- Iliac Crest Avoidance
- Muscle Sparing (Corridor)
- Femoral Nerve Avoidance
- All Disc Levels in One Position
- Ergonomics
- No Neuromonitoring
Spondy – L4/L5 (High Crest)
Rationale

- Iliac Crest Avoidance
- Muscle Sparing (Corridor)
- Femoral Nerve Avoidance
- All Disc Levels in One Position
- Ergonomics
- No Neuromonitoring

OLIF Corridor – NO MUSCLE
Non-Muscular Corridor
Psoas View During Retractor Removal

Cephalad

Posterior

Caudal
Rationale

- Iliac Crest Avoidance
- Muscle Sparing (Corridor)
- Femoral Nerve Avoidance
- All Disc Levels in One Position
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K-wire Piercing the Femoral Nerve at the Mid-Coronal Line of L4-5 Disc
Cadaveric: Femoral Nerve Distribution

Distribution by Zone

Zones (Moro)

L4

L5

Corridor

Zone 1

Zone 2

Zone 3

Zone 4
Femoral Nerve

- Average Diameter - 13.1 mm
- Obturator - anterior to the femoral nerve
- L5 Transverse Process - dorsal border
Neurogram and Gross Anatomy

Iliolumbar Vein
Neurogram with Retractor

L4-5 Disc
L4 Root
Femoral Nerve
L5 TP

L4-5 Disc
L4 Root
Femoral Nerve
L5 TP
Visualization of Major Nerve During OLIF

Cephalad

Posterior

Caudal
Rationale

- Iliac Crest Avoidance
- Muscle Sparing (Corridor)
- Femoral Nerve Avoidance
- All Disc Levels in One Position
- Ergonomics
- No Neuromonitoring
ALIF & LLIF Have Limitations

- **ALIF**
  - Access to above L3/L4?
  - Mobilization of Great Vessels (SHP)
  - Extensive Retroperitoneal Dissection

- **ALL LEVELS IN ONE POSITION**
  - Access to L4/L5 – Iliac Crest
  - Neurological Risk – Femoral Nerve
  - Muscular Pain – Psoas
  - No Access – L5/S1

**OLIF**
Rationale

- Iliac Crest Avoidance
- Muscle Sparing (Corridor)
- Femoral Nerve Avoidance
- All Disc Levels in One Position
- Ergonomics
- No Neuromonitoring

C-Arm Fixed
Reduced Flexion
Shoulder Adducted
Wrist Neutral
Neutral Flexed Spine

OLIF
Surgeon in Positive Sagittal Balance x 30 Year Career?

C-Arm Moves

Head/Neck

Shoulders

Bent Spine

Hands

LLIF

Surgeon in Neutral Sagittal Balance x 30 Year Career?

C-Arm Fixed

Head/Neck

Shoulders

Erect Spine

Hands

OLIF
Ergonomics / Working View

- Fluoroscopy remains stationary
- Surgeon and Fluoro work at same time
Surgeon & Fluoro See Disc Space Simultaneously

LLIF

OLIF
Rationale

‣ Iliac Crest Avoidance
‣ Muscle Sparing (Corridor)
‣ Femoral Nerve Avoidance
‣ All Disc Levels in One Position
‣ Ergonomics
‣ No Neuromonitoring
The Corridor Eliminates Neuromonitoring

Major Vessels

<table>
<thead>
<tr>
<th>Space</th>
<th>Unretracted</th>
<th>Retracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2/L3</td>
<td>18.0mm</td>
<td>24.9mm</td>
</tr>
<tr>
<td>L3/L4</td>
<td>18.8mm</td>
<td>26.3mm</td>
</tr>
<tr>
<td>L4/L5</td>
<td>14.4mm</td>
<td>23.6mm</td>
</tr>
<tr>
<td>L5/S1</td>
<td>15.2mm</td>
<td>24.8mm</td>
</tr>
</tbody>
</table>
OLIF Limitations

- Aberrant vascular anatomy
Look at MRI

- Aberrant ascending lumbar vein
OLIF Benefits

• Patient
  – Direct Visualization through ante-psoas approach
    • Less femoral nerve injury at L4/5 level
  – No table bend necessary – stretch of psoas/lumbar plexus

• Procedural
  – L2-S1 access through 1-2 incisions
  – Direct visualization
  – Sagittal plane correction through ALL release, lordotic cages at L4-5, L5-S1
  – Indirect and Direct Decompression of stenosis
• Ante-Psoas Avoids Neurological Structures Within the Psoas
• Vascular Injury Equivalent to L5/S1 ALIF
• Temporary Sympathetic Nerve Injury
• Historical Retroperitoneal Corridor
• Avoids Psoas – Less Complaints
• Avoids Neural Elements – Optional Neuromonitoring
• Consistent Access to L4/L5 – Avoids Crest
• OLIF25™ and OLIF51™: Access to L2-S1 Discs in One Patient Position
Benefits of OLIF Procedures

- Ability to Access Multiple Levels From One Patient Position (Sacrum and Above)
  - Consistent Access to L4/L5 (vs LLIF)
  - Access to Upper Levels (vs ALIF)
  - Familiar Access to L5/S1 (like ALIF)
- Ability to Directly Visualize Anterior Longitudinal Ligament and Release as Needed for Sagittal Correction
- Anterior Plate Fixation is Biomechanically Advantageous
- Anterior to Psoas
  - Decrease Muscular & Neurological Risk
  - Minimal Mobilization of Great Vessels
  - Direct Visualization of Space