

Minimally-Invasive Spine Surgery: Real Deal vs All Hype?

*Understanding the rationale, advantages,
complications and limitations*

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Disclosures

- Research support paid directly to institution
 - NuVasive, Inc.
 - AO Spine
 - SI-Bone
 - Zyga
 - SOLAS (Society of Lateral Access Surgery)
- SOLAS North America Education Chair (2017 – present).

Talk Outline

- Spine Surgery overview
- Minimally-invasive spine surgery (MISS) – overview and rationale
 1. MIS laminectomy/decompression/discectomy
 2. Lateral Lumbar Interbody Fusion (LLIF)

Spine Surgery

- Can be broken down into 2 general procedures:
 1. Decompression
 - Laminectomy, hemilaminectomy, laminotomy
 - Foraminotomy
 - Discectomy
 2. Fusion
 - Interbody fusion (ALIF, TLIF, PLIF, LLIF)
 - Posterior fusion
 - +/- osteotomies

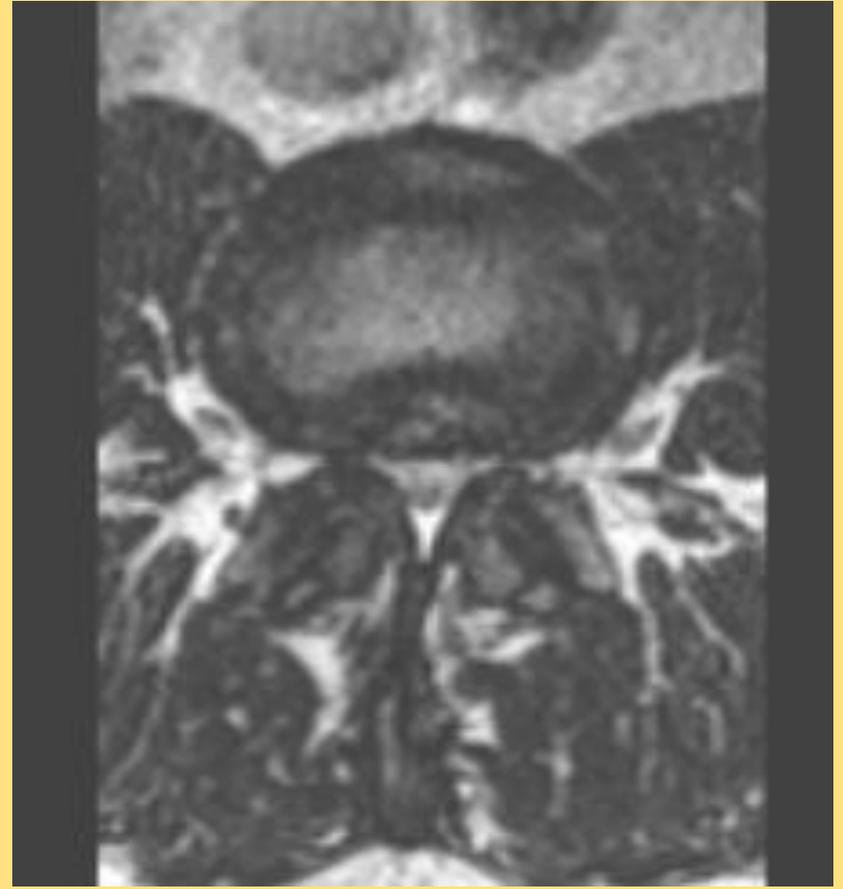
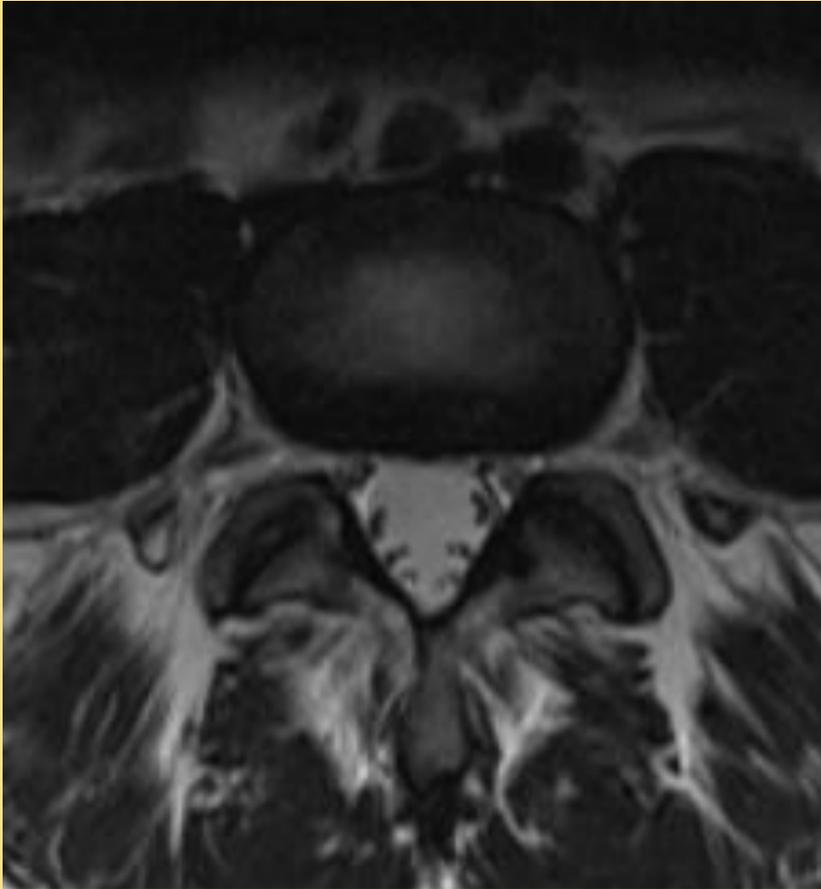
Decompression

- Indications: Spinal stenosis, disc herniation (ie: when there is nerve compression)
- Goal: To make more room for the nerves (without causing instability)

Spinal Stenosis – Sagittal imaging



Spinal Stenosis – Axial imaging



Fusion

- Goal: To make vertebrae grow together (by tricking the body into thinking it is a fracture that needs healing).
- Indications:
 - Instability (fracture, spondylolisthesis, iatrogenic)
 - Deformity (scoliosis, kyphosis)
 - Tumor

Spondylolisthesis

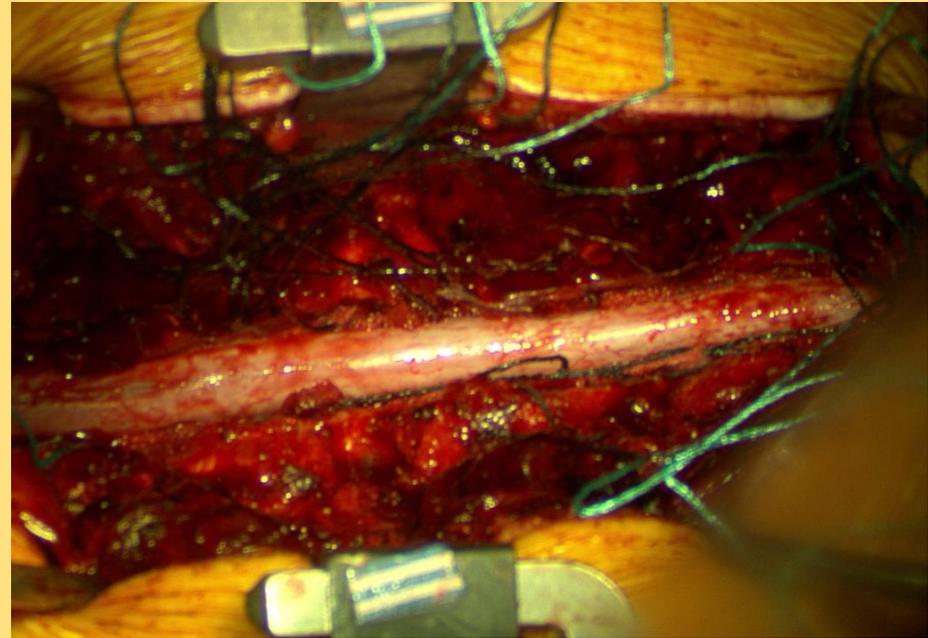


Supine vs. Standing Imaging





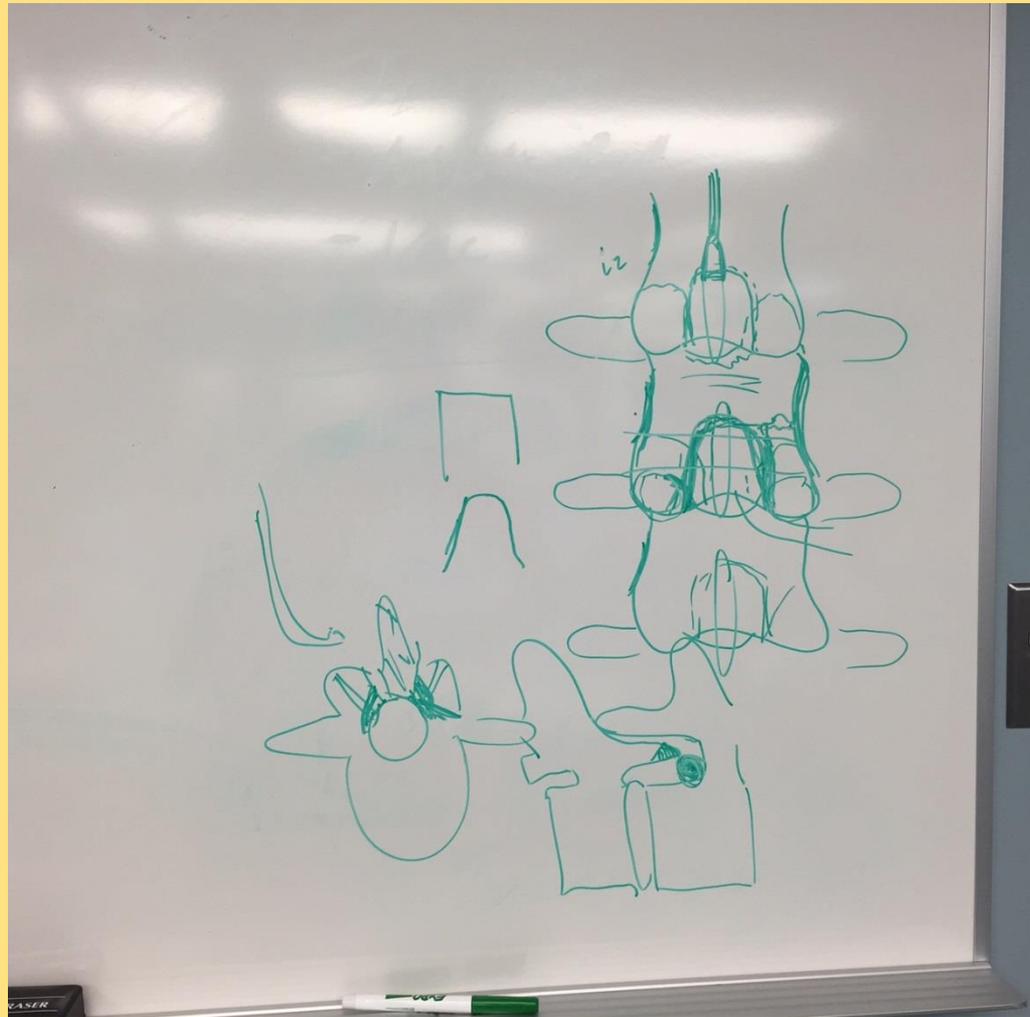
Conventional / Open Decompression



Operative Treatment - Direct Decompression

- Central decompression (laminectomy)
- Medial facetectomy
- Foraminotomy
- Diskectomy





Surgical Outcomes

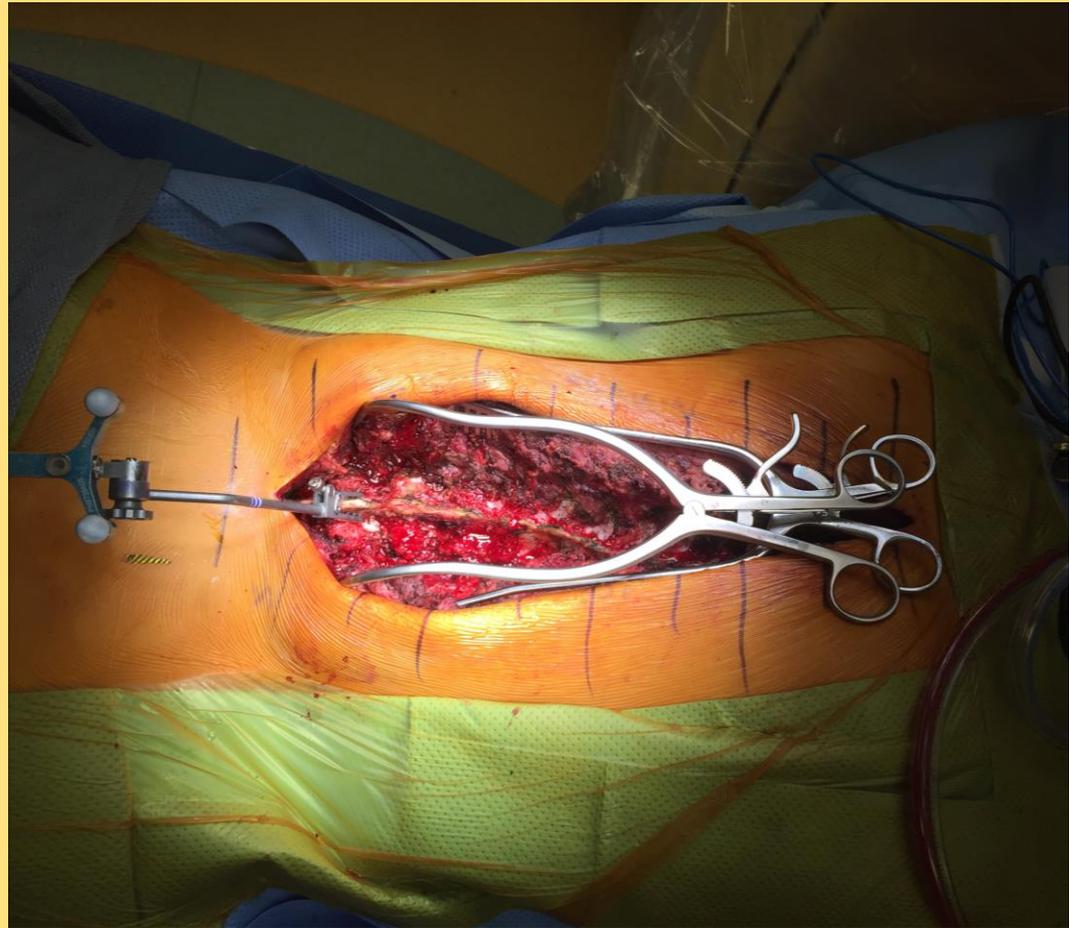
Surgical *Versus* Nonoperative Treatment for Lumbar Spinal Stenosis Four-Year Results of the Spine Patient Outcomes Research Trial

James N. Weinstein, DO, MS,*†‡ Tor D. Tosteson, ScD,*†‡ Jon D. Lurie, MD, MS,*†‡ Anna Tosteson, ScD,*†‡ Emily Blood, MS,*†‡ Harry Herkowitz, MD,§ Frank Cammisa, MD,¶ Todd Albert, MD,|| Scott D. Boden, MD,** Alan Hilibrand, MD,|| Harley Goldberg, DO,†† Sigurd Berven, MD,‡‡ and Howard An, MD§§

- Weinstein JN et al. *Spine* 2010.
 - Combined randomized and observational cohort: op vs nonop for LSS.
 - Surgery superior through 4 yrs.
 - 4-year reoperation rate: 13%
 - Most common complication: dural tear (9%)

Conventional / Open Fusion

- Anterior approach
- Posterior approach
- Combined approach







There has to be a better way ...

Goals of MI

- To do easier / faster surgery so surgeon can get home earlier (work-life balance); or do more cases (increase income)
- To do surgery using small incisions the size of a band-aid, to improve patient and family, and use as online marketing tool
- To utilize placebo effect (since most back pain patients would get better on their own anyway).

True Goals of MIS

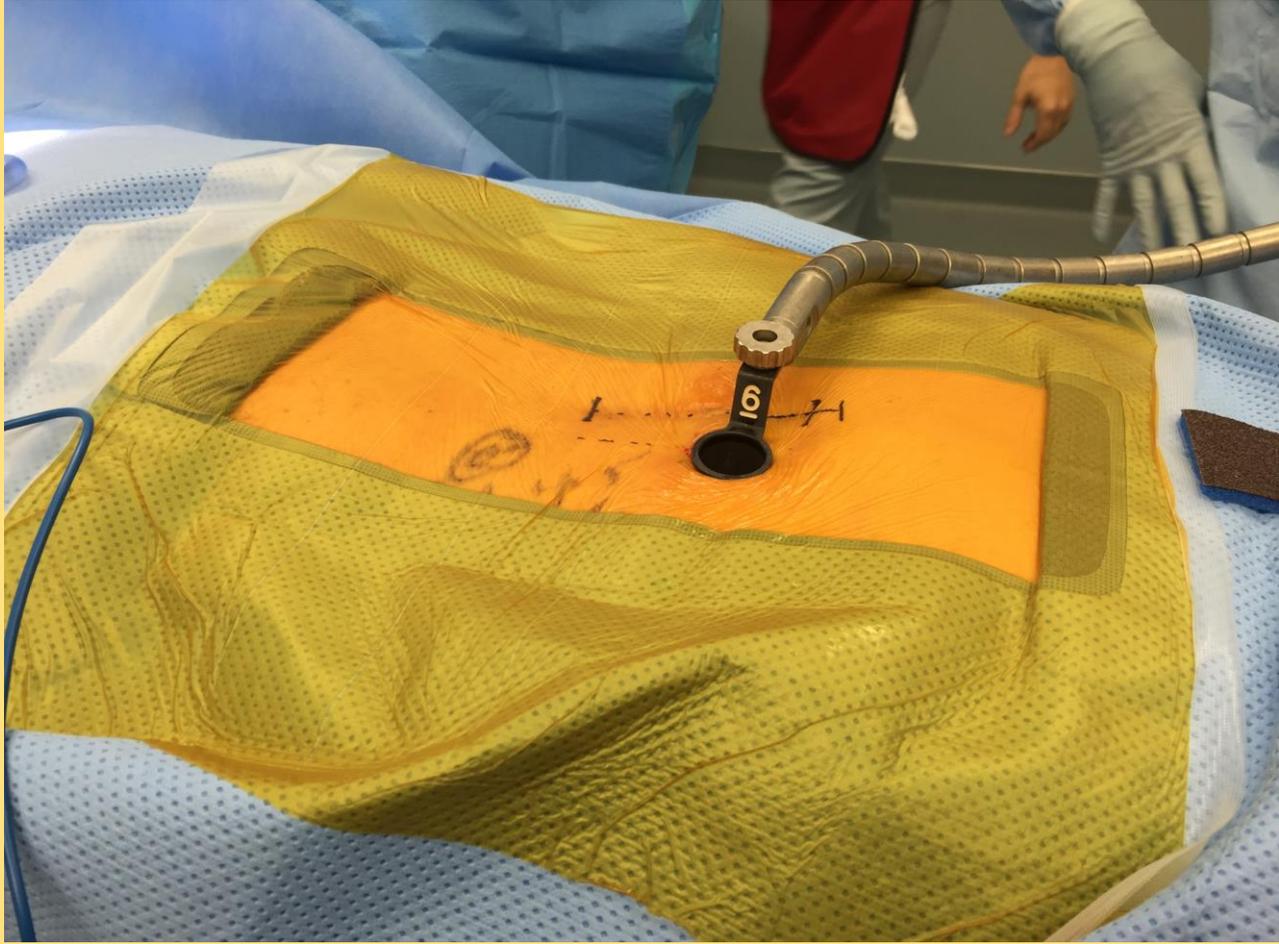
- To achieve the same goals as with open surgery, but with less tissue damage.
 - Outcomes should be at least equivalent to open surgery, and should definitely be better than non-operative treatment.
- In other words, it has much less to do with:
 - Size of incision
 - Marketing
 - Placebo
 - Reimbursement





Why MIS?

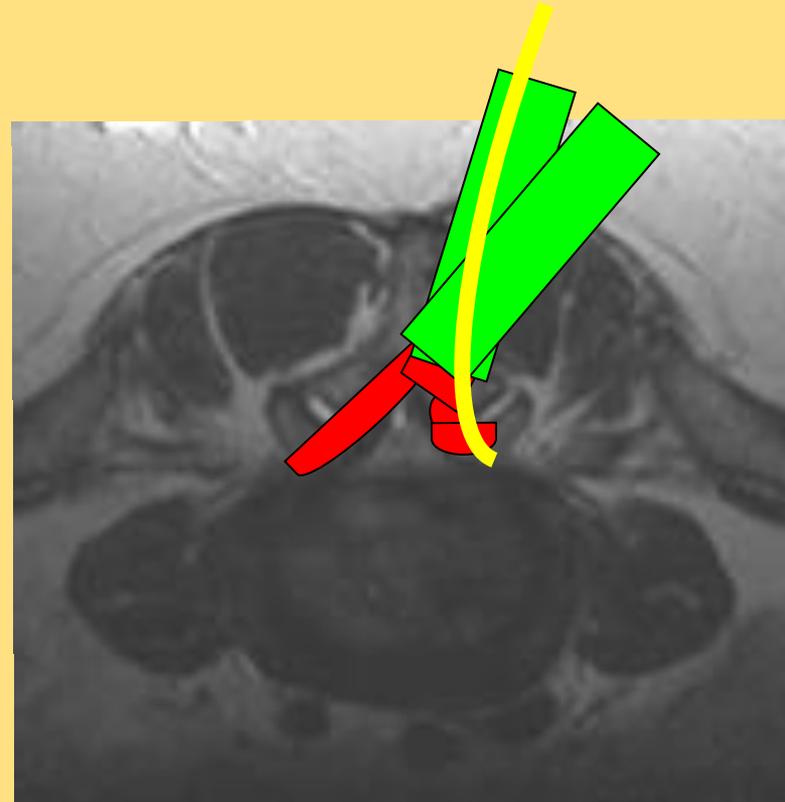
- Reduce approach-related morbidity
 - Decreased blood loss
 - Less postop pain → lower opioid consumption
 - Earlier discharge, return to work/activity
 - Lower infection rates
- Preserve paraspinal muscle and interspinous ligament integrity
 - Avoid iatrogenic instability → less need for subsequent fusion



MIS Decompression

Hemilaminectomy with
contralateral laminoplasty
through a tubular retractor

- Dock tube
- Ipsilateral hemilaminectomy,
medial facetectomy,
foraminotomy
- Contralateral laminoplasty,
medial facetectomy,
foraminotomy



Outcomes after decompressive laminectomy for lumbar spinal stenosis: comparison between minimally invasive unilateral laminectomy for bilateral decompression and open laminectomy

Clinical article

RALPH JASPER MOBBS, M.D., F.R.A.C.S.,¹⁻³ JANE LI, M.B.B.S.,^{1,2}
PRAVEENAN SIVABALAN, M.B.B.S.,^{1,2} DARRYL RALEY, M.B.B.S.,^{1,2}
AND PRASHANTH J. RAO, M.D.¹⁻³

¹Neurospine Clinic and ²Prince of Wales Hospital, Randwick, Sydney; and ³University of New South Wales, Sydney, New South Wales, Australia

- RCT 1:1
- minimally invasive unilateral laminectomy for bilateral decompression (ULBD) vs standard “open” laminectomy for lumbar stenosis
- 79 patients (2007-2009)
 - Available data: 54 patients (27 each group)
- Outcomes:
 - Oswestry Disability Index (ODI) scores
 - Visual Analog Scale (VAS) scores for leg pain
 - Patient Satisfaction Index scores
 - 12-Item Short Form Health Survey (SF-12) scores
- Mean ff-up: MIS – 37 mos; Open – 44 mos

Outcomes after decompressive laminectomy for lumbar spinal stenosis: comparison between minimally invasive unilateral laminectomy for bilateral decompression and open laminectomy

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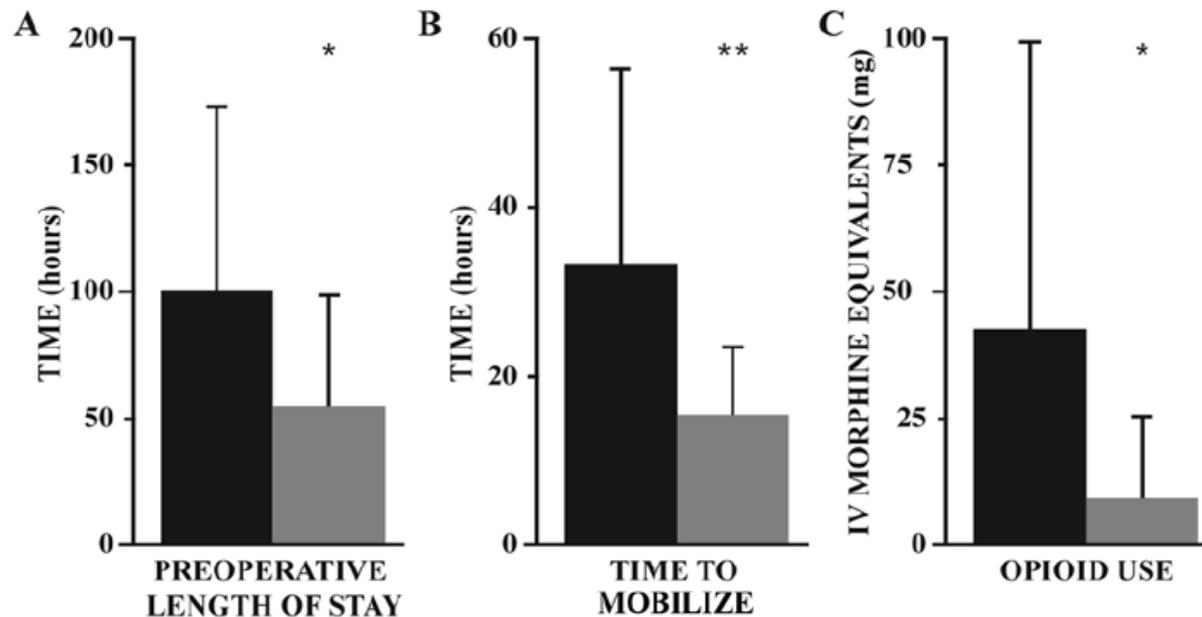


FIG. 5. Measures of postoperative recovery for the open laminectomy (black) and ULBD (gray) procedures. Postoperative length of stay (A), time to mobilization (B), and opioid use (C) differed significantly between groups. * $p < 0.01$. ** $p < 0.001$.

Outcomes after decompressive laminectomy for lumbar spinal stenosis: comparison between minimally invasive unilateral laminectomy for bilateral decompression and open laminectomy

J Neurosurg Spine 21:179–186, 2014
©AANS, 2014

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- Conclusions
 - MIS as effective as Open in improving function (ODI), with benefit of greater decrease in:
 - pain (VAS)
 - recovery time
 - time to mobilization
 - opioid use.

Minimally Invasive *Versus* Open Laminectomy for Lumbar Stenosis

SPINE Volume 41, Number 2, pp E91–E100
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A Systematic Review and Meta-Analysis

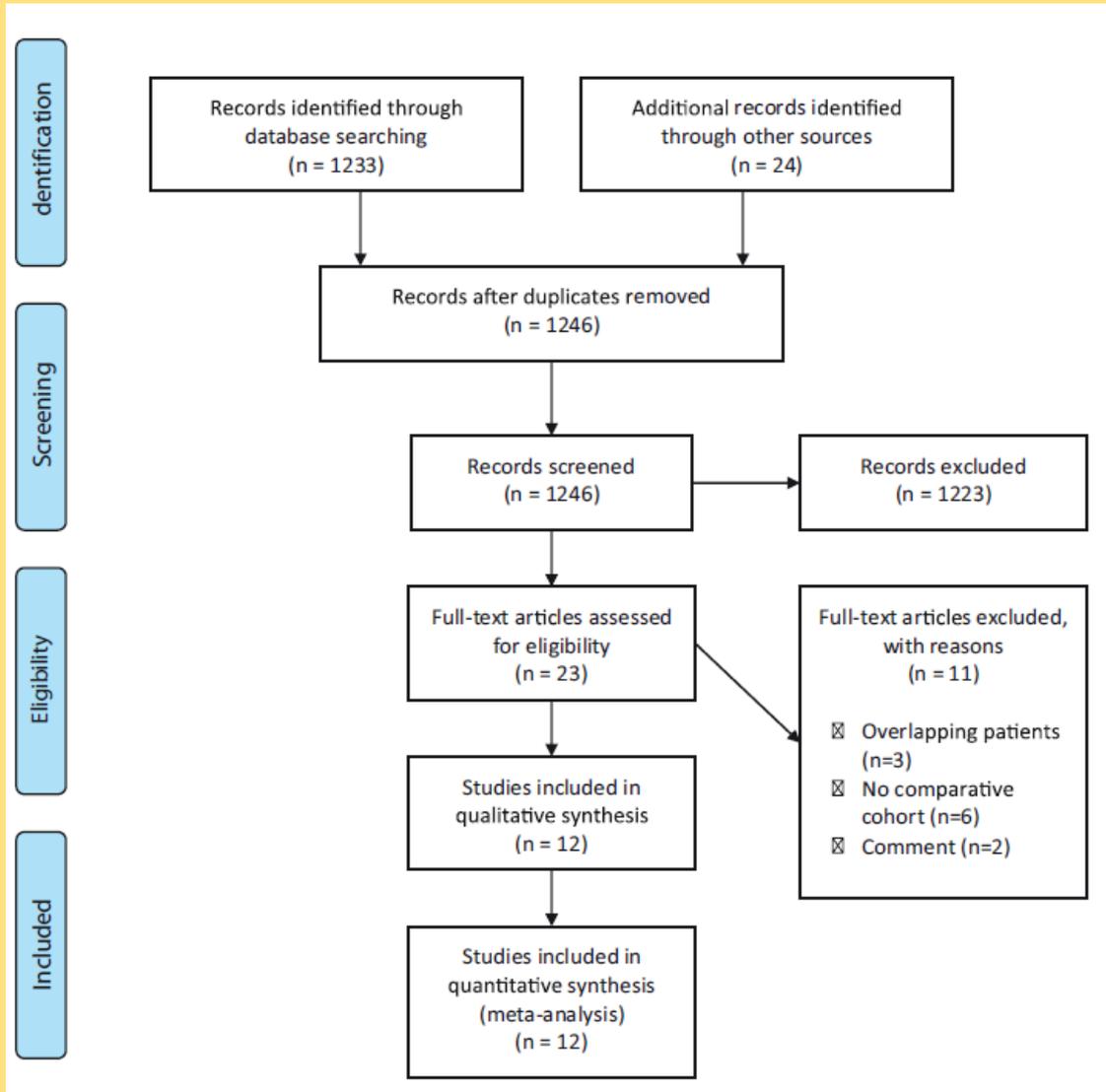
Kevin Phan, BSc (adv)^{*†‡} and Ralph J. Mobbs, BSc, MBBS, FRACS^{*†‡}

Systematic review and meta-analysis

MIS vs Open laminectomy

12 studies (2002 – 2014)

- 5 RCT's
- 7 Observational



Minimally Invasive *Versus* Open Laminectomy for Lumbar Stenosis

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A Systematic Review and Meta-Analysis

Kevin Phan, BSc (adv)^{*†‡} and Ralph J. Mobbs, BSc, MBBS, FRACS^{*†‡}

- Satisfaction higher in MIS (84% vs. 75.4%; P = 0.03)
- VAS Back pain lower in MIS (P<0.00001).
- MIS operative time 11 mins longer than Open (P = 0.001).
- EBL lower in MIS (P<0.00001).
- Hospital stay 2.1 days shorter in MIS (P<0.0001).
- Dural injuries and CSF leaks comparable, but reoperation rates lower in MIS (1.6% vs. 5.8%; P = 0.02).

Minimally Invasive *Versus* Open Laminectomy for Lumbar Stenosis

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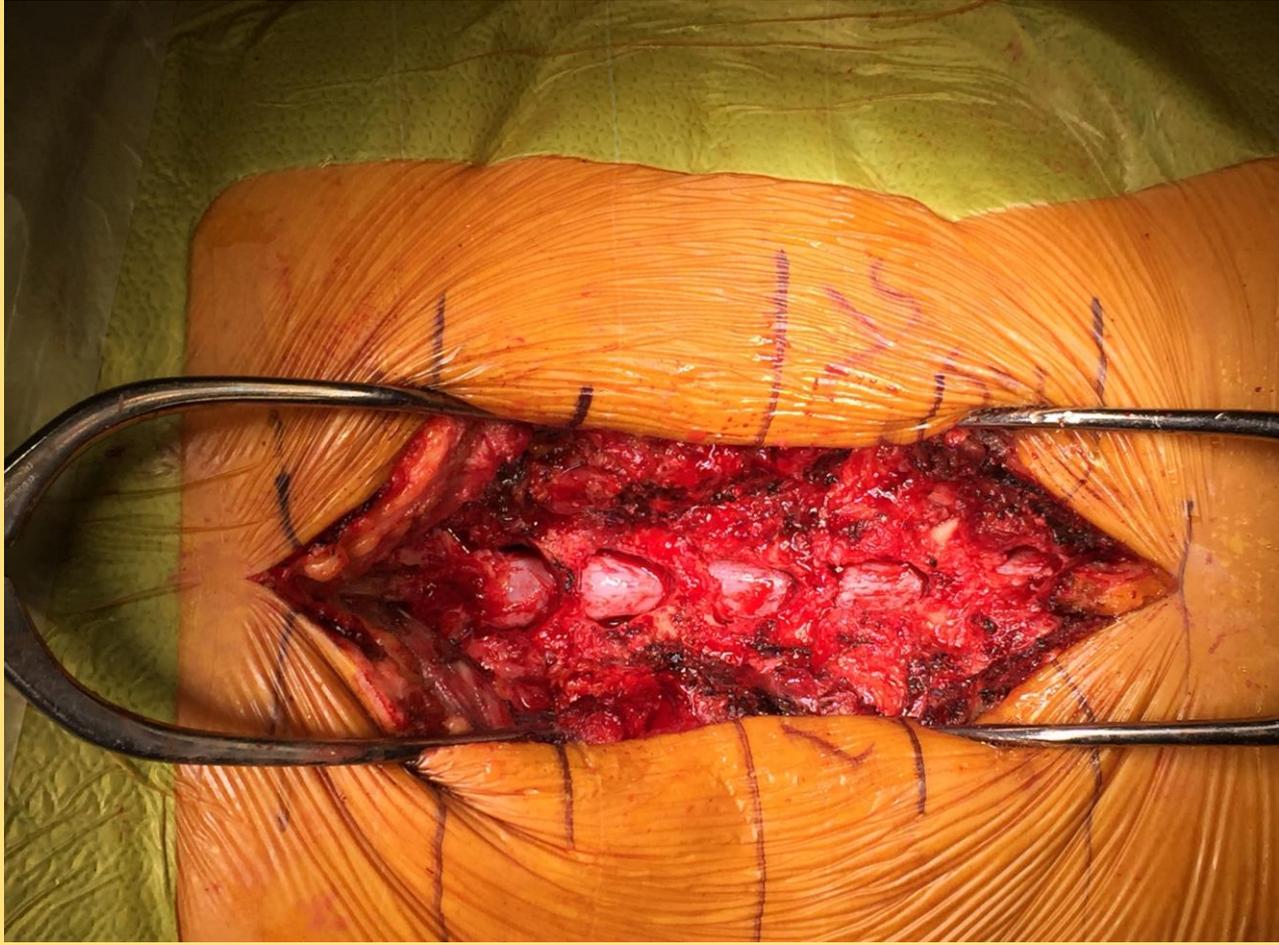
A Systematic Review and Meta-Analysis

Kevin Phan, BSc (adv)^{*†‡} and Ralph J. Mobbs, BSc, MBBS, FRACS^{*†‡}

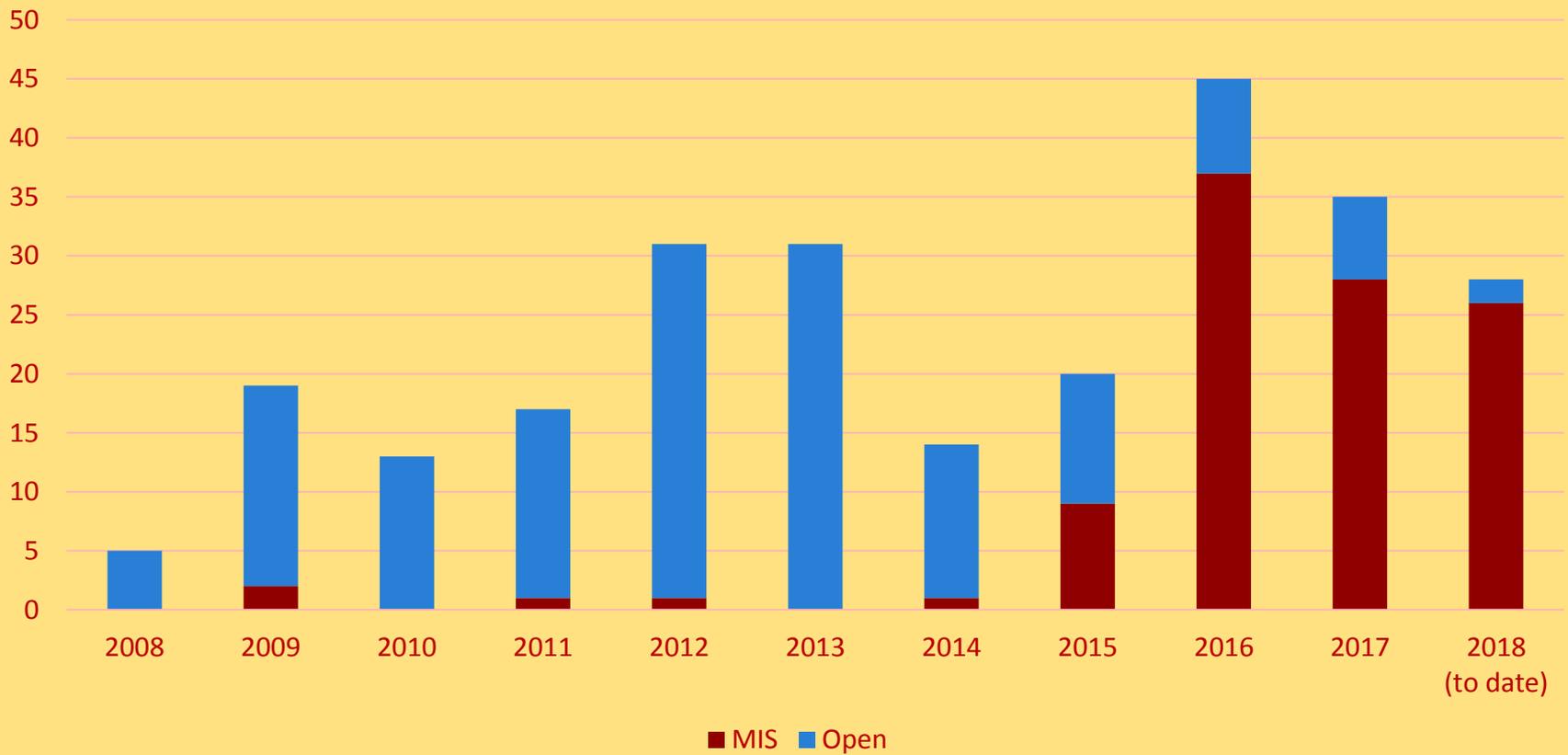
- **Conclusions**
 - Moderate quality evidence supporting superior satisfaction rates, reduced hospitalization and blood loss, but longer procedures in MIS vs Open.

Why Not MIS?

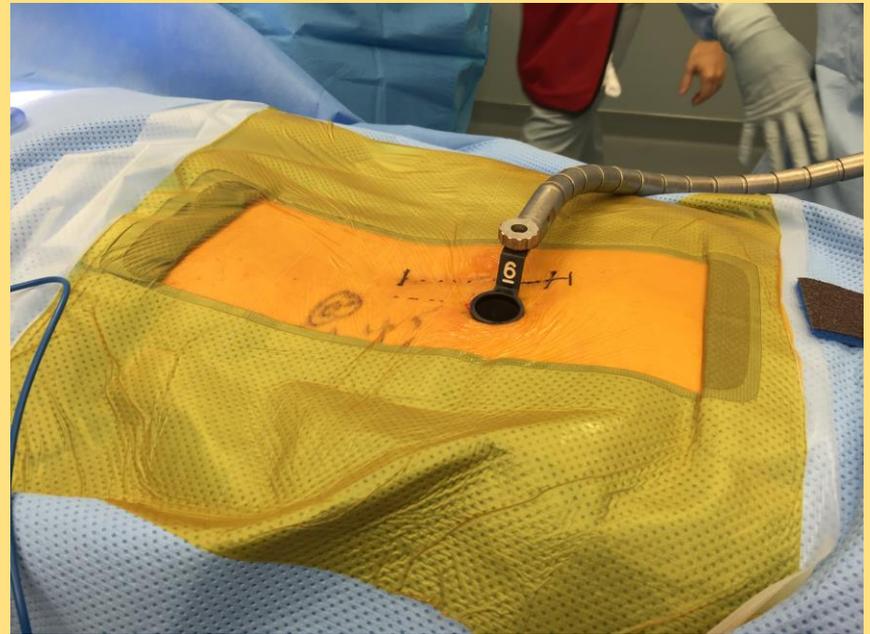
- If the same results as with open surgery cannot be achieved.
 - Inadequate decompression
 - Higher complication rates (dural tears, nerve injuries)
 - Higher pseudarthrosis rates
 - Poorer outcomes
 - Inadequate alignment correction



JNS UofM Decompression Surgeries

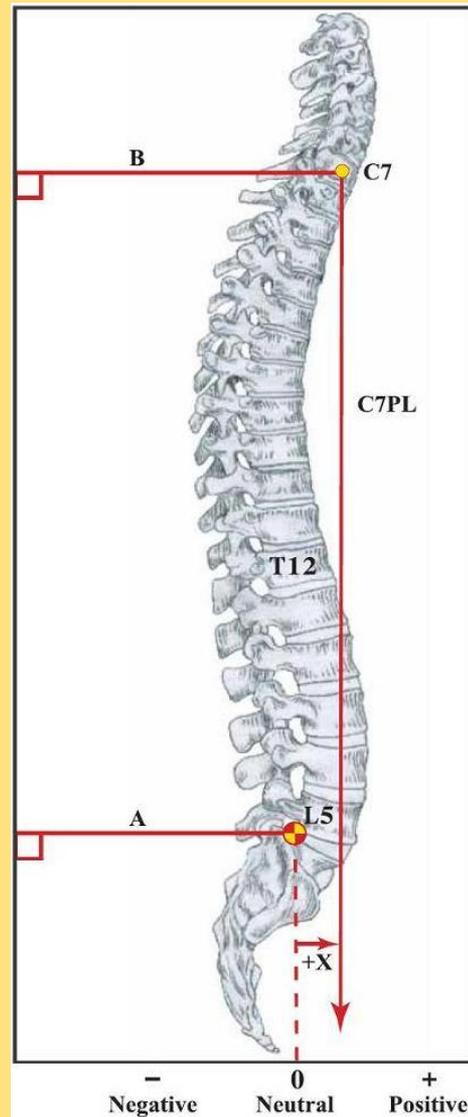
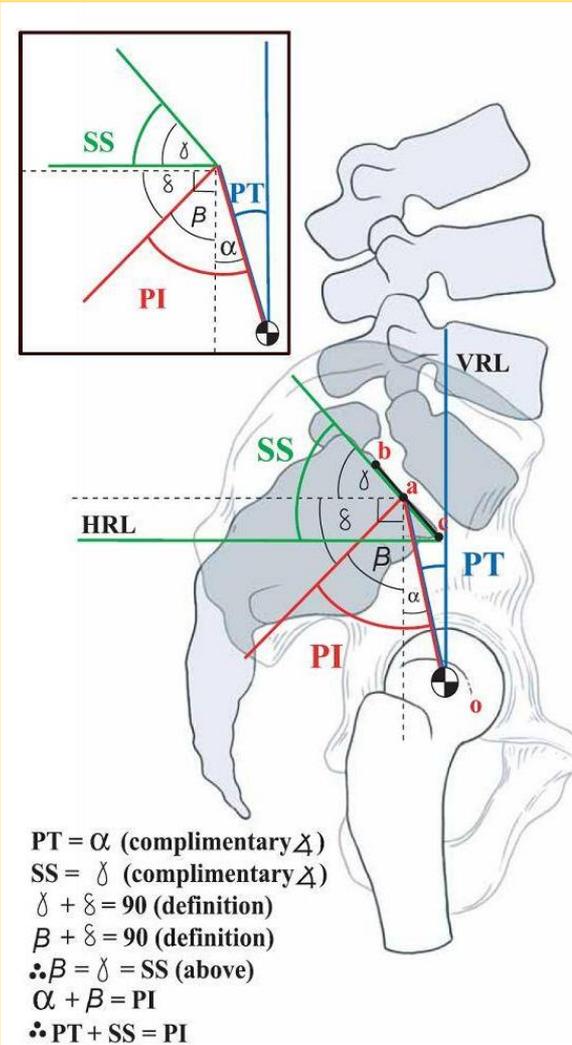


So, which would you choose?



MIS Fusion – The lateral approach

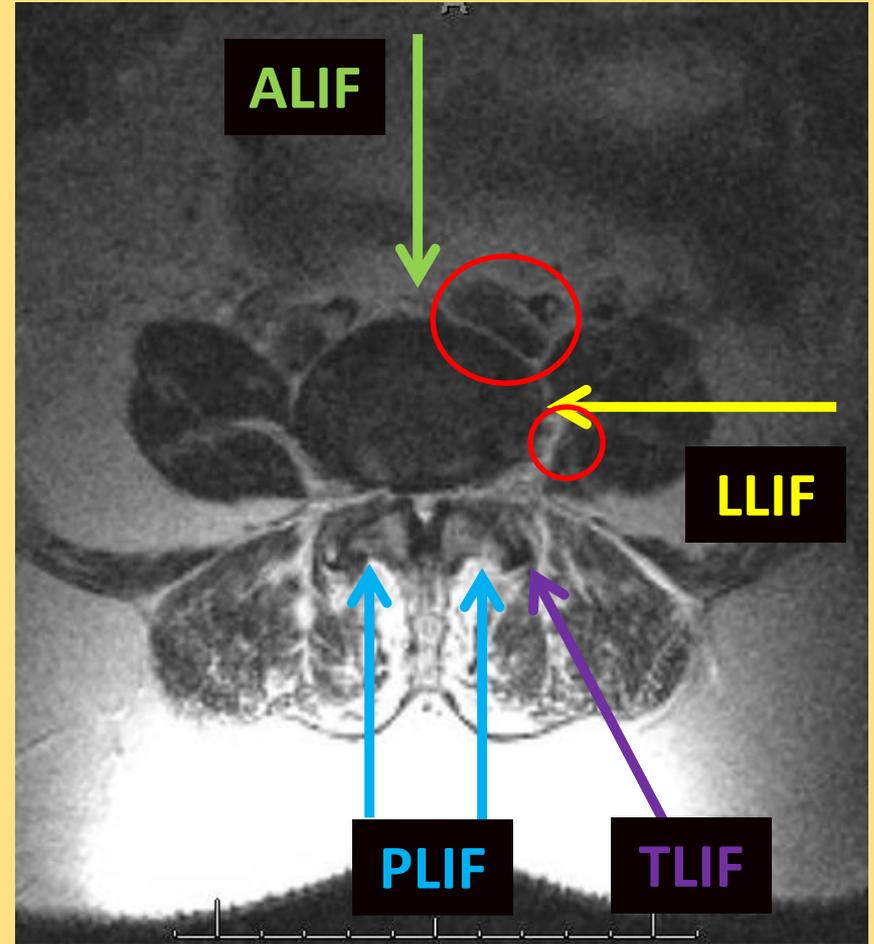




LL - Lumbar lordosis
PI - Pelvic incidence
PT - Pelvic tilt
SS - Sacral slope
SVA – Sagittal vertical axis

From "Radiographic Measurement Manual", Spine Deformity Study Group, Medtronic, 2004.

LLIF aka XLIF / DLIF / Transpsoas



LLIF aka XLIF / DLIF / Transpsoas



The Spine Journal 6 (2006) 435-443

THE
SPINE
JOURNAL

Technical Report

Extreme Lateral Interbody Fusion (XLIF): a novel surgical technique for anterior lumbar interbody fusion

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William R. Taylor, MD^b

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^bDivision of Neurosurgery, University of California, San Diego Medical Center, 200 West Arbor Drive #8893, San Diego, CA 92103-8893, USA

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Received 11 March 2005; accepted 25 August 2005





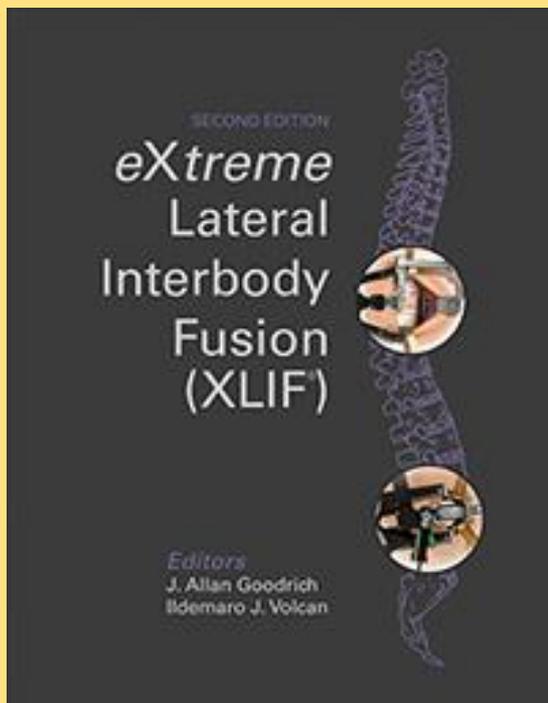
MIS Lateral Approach Advantages

- Less injury to abdominal wall musculature.
- Less need for retraction/mobilization of bowels and great vessels.
 - May not need approach surgeon
- In obese, much easier than open approach
- Placement of large footprint cage:
 - Greater restoration of disc height / lordosis; less subsidence

SOLAS

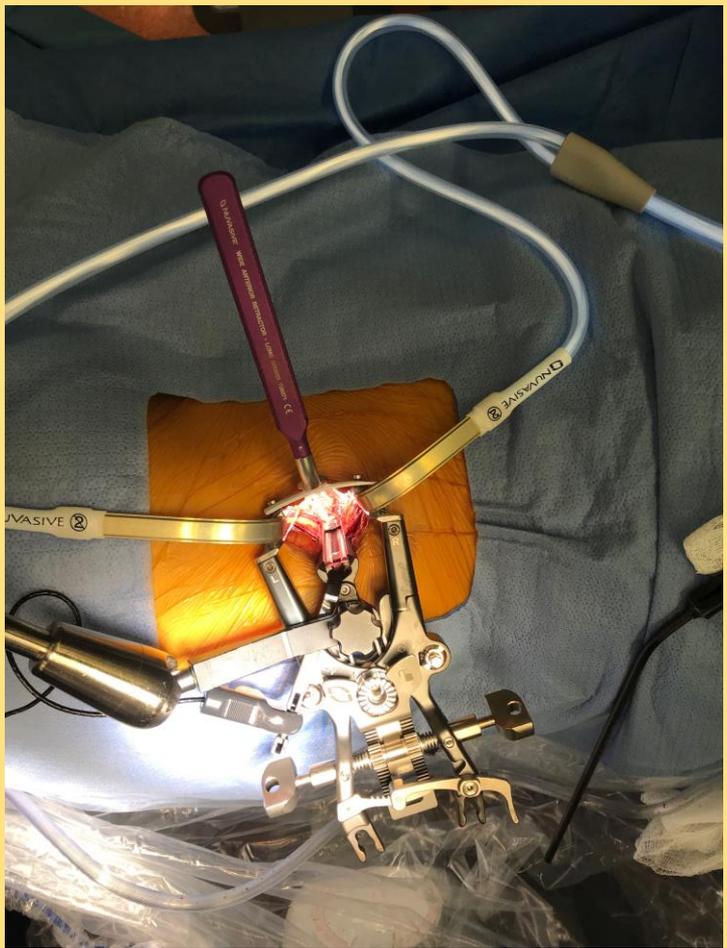
- SOLAS – Society of Lateral Access Surgery (2006)
 - Member since 2009
 - Have attended all annual research meetings except 1st in 2008 (8/9)
 - Member BOD 2012-2015
 - Appointed North Am Education Chair (09/2017-present)

XLIF Book

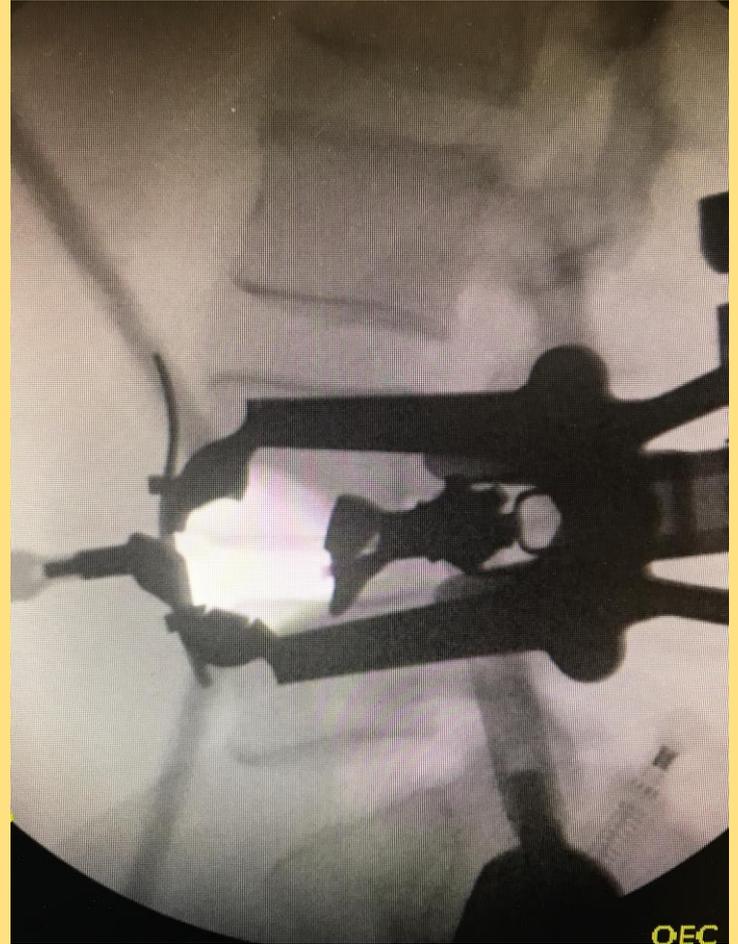


- 1st ed 2008
- 2nd ed 2013
 - Co-wrote chapter
 - Wupperman RM and **Sembrano JN** (2013). XLIF with Pedicle Screw Fixation. In: Goodrich JA and Volcan IJ (Eds), *eXtreme Lateral Interbody Fusion (XLIF)* (2nd ed, pp. 233-249). St. Louis, MO, USA: Quality Medical Publishing.

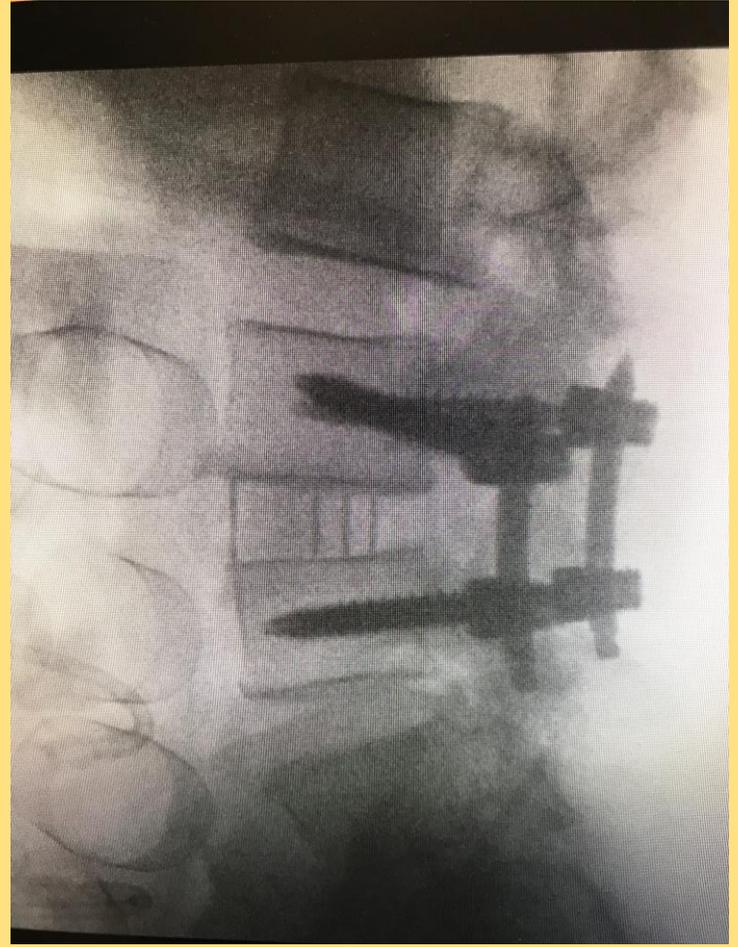
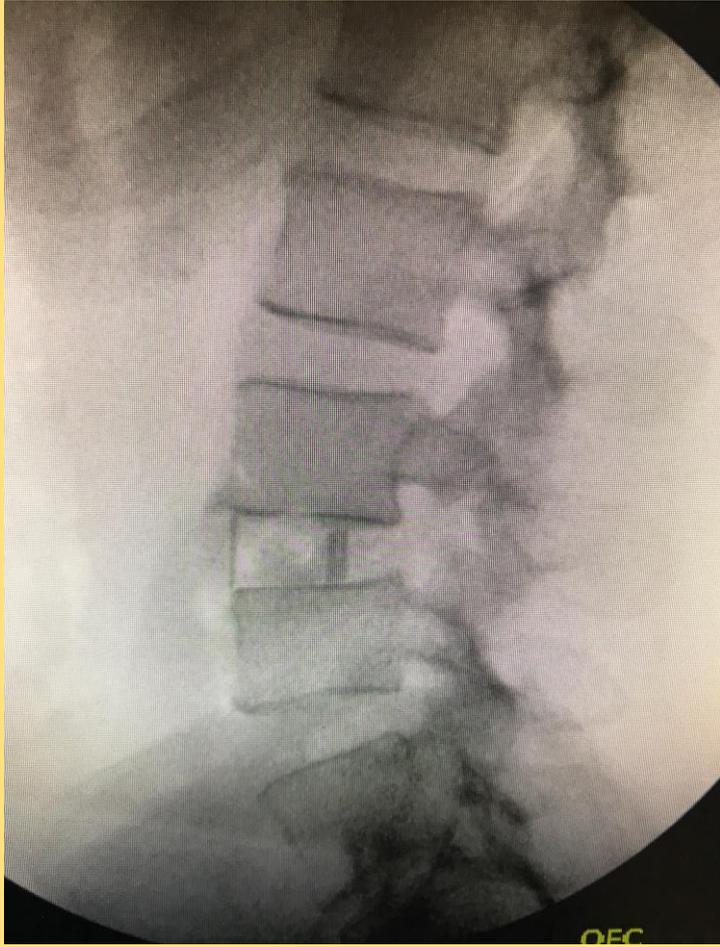








OEC



OFC

*Is LLIF able to restore segmental /
regional lordosis???*

Changes in coronal and sagittal plane alignment following minimally invasive direct lateral interbody fusion for the treatment of degenerative lumbar disease in adults:
a radiographic study

J Neurosurg Spine 15:92-96, 2011

Clinical article

FRANK L. ACOSTA JR., M.D.,¹ JOHN LIU, M.D.,² NICHOLAS SLIMACK, M.D.,²
DAVID MOLLER, M.D.,³ RICHARD FESSLER, M.D., PH.D.,² AND TYLER KOSKI, M.D.²

- 36 patients
- Segmental lordosis improved 2.9° (5.3 to 8.2) (p < 0.001).
- Lumbar lordosis improved 4.1° (42.1 to 46.2) (p > 0.05)
- SVA from 41.5mm to 42.4mm (p = 0.7)



Do lordotic cages provide better segmental lordosis vs. non-lordotic cages in Lateral Lumbar Interbody Fusion (LLIF)?

Jonathan N. Sembrano MD^{1,2}, Ryan D. Horazdovsky MD¹, Amit K. Sharma MD¹, Sharon C. Yson MD¹, Edward Rainier G. Santos MD¹, David W. Polly Jr. MD^{1,3}

J Spinal Disord Tech 2014, Jun 4 [Epub ahead of print]

- 40 patients, 61 levels; 2 surgeons
 - Non-lordotic cage group (NL), n=30
 - Lordotic cage group (L), n=31
- Segmental lordosis change
 - L group = 2.8° (p=0.01)
 - NL group = 0.6° (p=0.71)
- Conclusion: Lordotic cages provided significant increase in operative level segmental lordosis compared to non-lordotic cages although overall lumbar lordosis remained unchanged.

Radiographic Comparison of Lateral Lumbar Interbody Fusion Versus Traditional Fusion Approaches: Analysis of Sagittal Contour Change

Int J Spine Surg 2015 May 19:9:16.

*Jonathan N. Sembrano, MD, Sharon C. Yson, MD, Ryan D. Horazdovsky, MD, Edward Rainier G. Santos, MD, David W. Polly Jr., MD
Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, MN*

- 147 patients, 212 levels
 - ALIF vs TLIF vs LLIF vs PSF
- Segmental lordosis
 - ALIF (3.8°) > LLIF (3.2°) > TLIF (1.9°) > PSF (0.7°)
- Lumbar lordosis
 - ALIF (4.2°) > LLIF (2.5°) > TLIF (2.1°) > PSF (-0.5°)
- Conclusion:
 - LLIF similar to other interbody fusion approaches, superior to no interbody. ALIF provides greatest amount of segmental and regional lumbar lordosis correction.

Two-Year Comparative Outcomes of MIS Lateral and MIS Transforaminal Interbody Fusion in the Treatment of Degenerative Spondylolisthesis

Part II: Radiographic Findings

SPINE Volume 41, Number 8S, pp S133–S144
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Robert E. Isaacs, MD,* Jonathan N. Sembrano, MD,^{†,‡} Antoine G. Tohmeh, MD[§], and SOLAS Degenerative Study Group

- Multicenter prospective trial LLIF (XLIF) vs MIS TLIF for degenerative spondylolisthesis
- 55 patients (29 LLIF, 26 MIS TLIF)
- Segmental lordosis:
 - XLIF: 9.2° → 9.6°
 - TLIF: 8.3° → 9.9°
- Lumbar lordosis:
 - XLIF: 58.4° → 58.6°
 - TLIF: 56.9° → 59.5°
- Conclusion: Both MIS procedures are reasonable treatment options for degenerative spondylolisthesis with stenosis.

JNS LLIF Cases (VA and UofM)

