Minimally Invasive Spinal Deformity Surgery Principles

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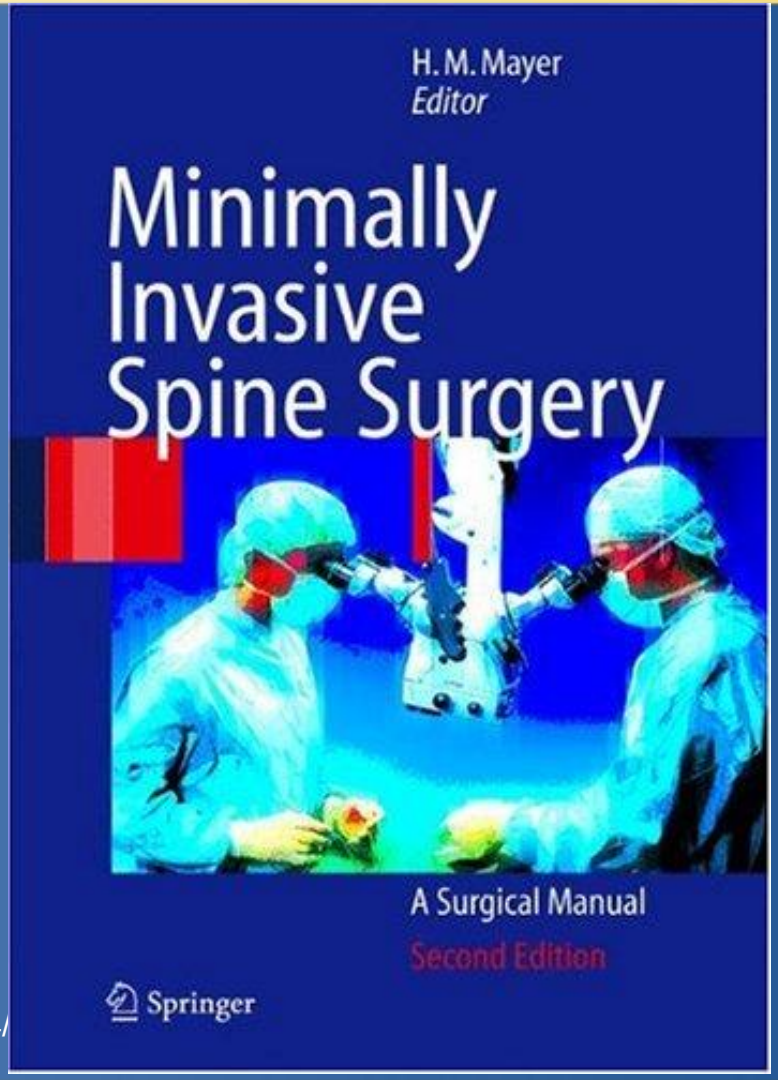
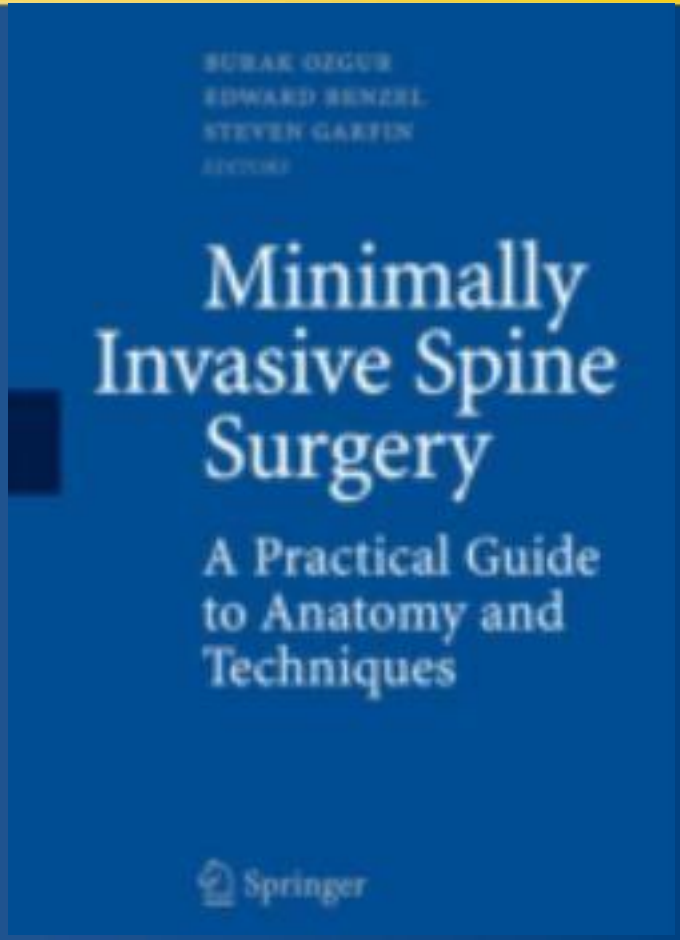
Adult Spinal Deformity Surgery

- Complications range 25% to 80%
- Overall complication rate ~40%
  - Yadla et al. - 41.2%
- Daubs et al. –
  - 37.5% overall complication
  - 20% major morbidity
  - Mean OR time of 10hrs
  - Average EBL 2L
    - 5U pRBC
  - Average LOS 13.5 days
  - Pseudoarthrosis – 12.9%
  - 33% reoperation rate
- ~25% PJK

Why Minimally Invasive Spine Surgery?





Definition

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"An MIS procedure ….. results in less collateral tissue damage, resulting in measurable decrease in morbidity and more rapid functional recovery than traditional exposures, without differentiation in the intended surgical goal."

Paul C. McAfee, MD, MBA, Frank M. Phillips, MD,
Gunnar Andersson, MD, PhD, Asokumar Buvenenadran, MD,
Choll W. Kim, MD, Carl Lauryssen, MD, Robert E. Isaacs, MD,
Jim A. Youssef, MD, Darrel S. Brodke, MD,
Andrew Cappuccino, MD, Behrooz A. Akbarnia, MD,
Gregory M. Mundis, MD, William D. Smith, MD,
Juan S. Uribe, MD, Steve Garfin, MD, R. Todd Allen, MD,
William Blake Rodgers, MD, Luiz Pimenta, MD, PhD,
and William Taylor, MD

Maximizing Benefits of MIS

Neurosurg Focus 25 (2):E19, 2008

Maximizing the potential of minimally invasive spine surgery in complex spinal disorders

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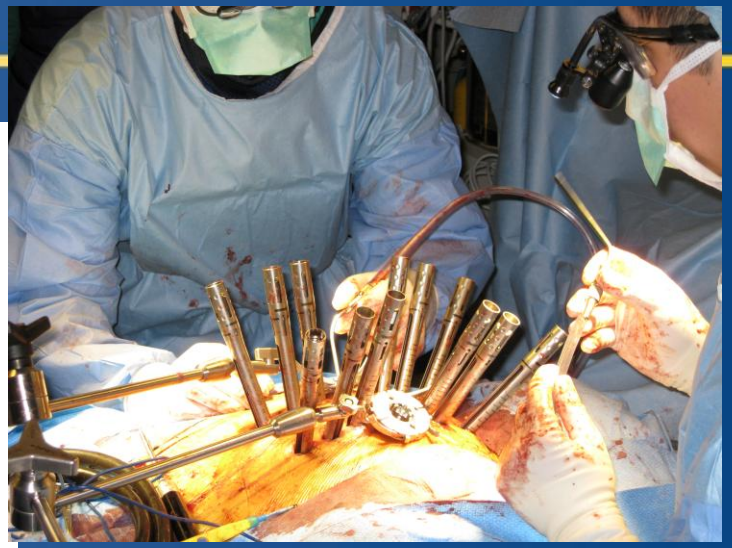
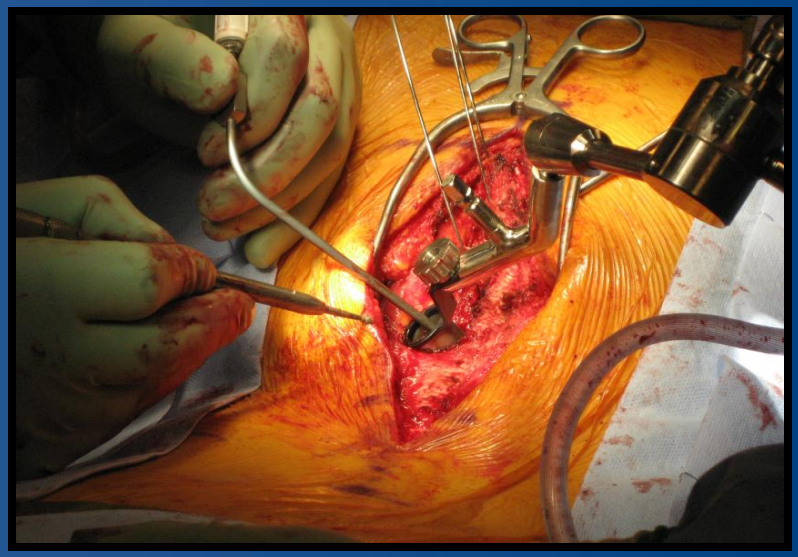
Minimally invasive surgery (MIS) in the spine was primarily developed to reduce approach-related morbidity and to improve clinical outcomes compared with those following conventional open spine surgery. Over the past several years, minimally invasive spinal procedures have gained recognition and their utilization has increased. In particular, MIS is now routinely used in the treatment of degenerative spine disorders and has been shown to be as effective as conventional open spine surgeries. Although the procedures are not yet widely recognized in the context of complex spine surgery, the true potential in minimizing approach-related morbidity is far greater in the treatment of complex spinal diseases such as spinal trauma, spinal deformities, and spinal oncology. Conventional open spine surgeries for complex spinal disorders are often associated with significant soft tissue disruption, blood loss, prolonged recovery time, and postsurgical pain. In this article the authors review numerous cases of complex spine disorders managed with MIS techniques and discuss the current and future implications of these approaches for complex spinal pathologies.
(DOI: 10.3171/FOC/2008/25/8/E19)

KEY WORDS • complex spine disorder • deformity • minimally invasive spine surgery • oncology • trauma





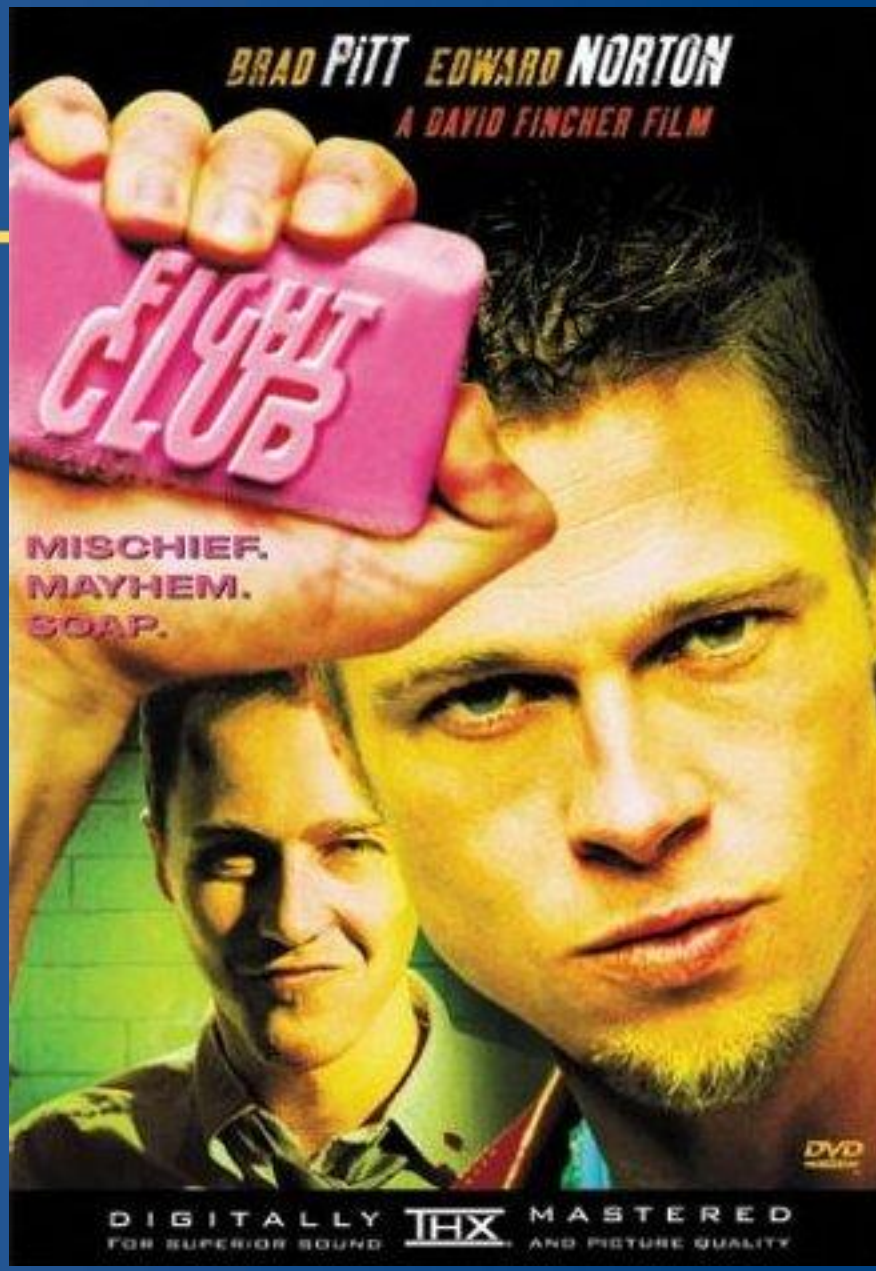
Spinal Deformity Surgery

Big cases

Long operations

Significant complications

Deformity surgeons = Club



8 Rules about MIS Deformity

First Rule

Evaluate and treat the patient's spinal deformity

8 Rules about MIS Deformity

1. Evaluate coronal, sagittal and global balance with standing films
2. Assess sacropelvic parameters
3. Evaluate modifiable and non-modifiable co-morbidities of patient
4. Consider surgery if technically feasible and expected morbidity is acceptable to surgeon and patient
5. Obtain Fusion

8 Rules about MIS Deformity

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Second Rule

Evaluate and treat the patient's spinal deformity

8 Rules about MIS Deformity

Third Rule

Be familiar with Fluoroscopy

Prone Patient Positioning

- Radiolucent table
- Make sure patient is “squared up” on the table
- Check that fluoro is adequate

Lateral Patient Positioning

8 Rules about MIS Deformity

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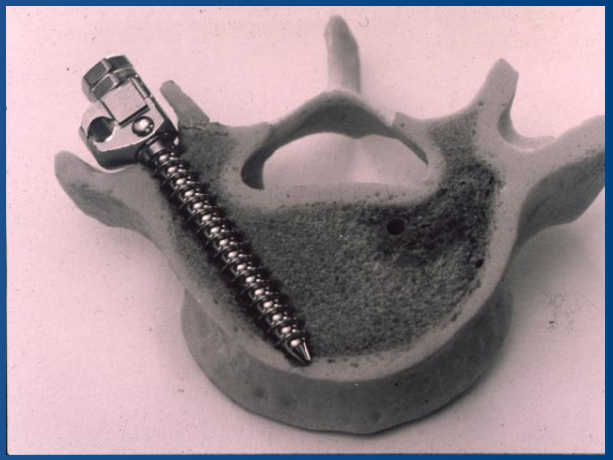
Fourth Rule

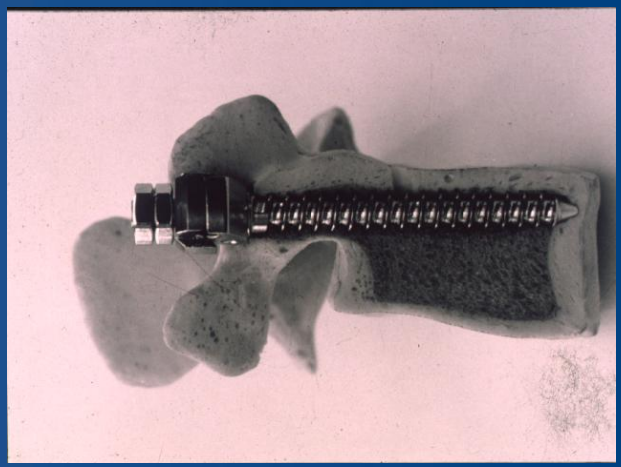
Become efficient at
- Percutaneous/fluoroscopic pedicle screw placement

Pedicle Anatomy

- Familiar visual and tactile landmarks are not available with percutaneous screws



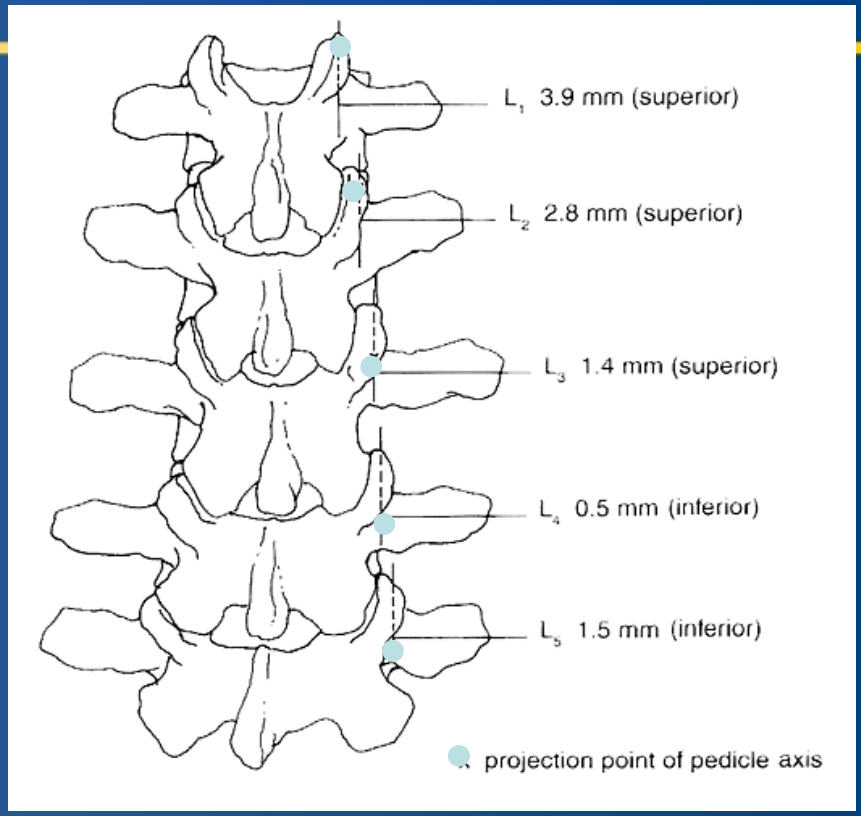
- Therefore, knowledge of pedicular anatomy is critical to successful screw placement



Pedicle Anatomy

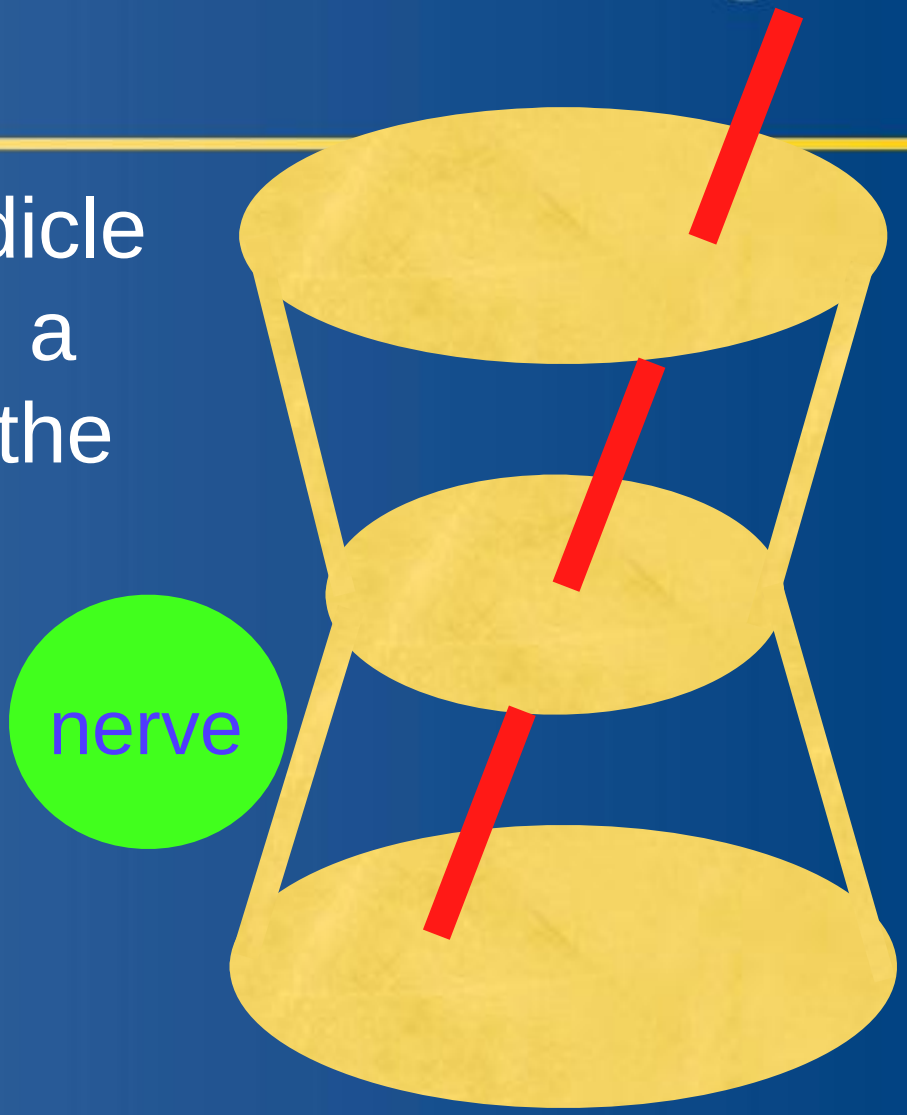
- The dorsal projection of the pedicle axis in respect to the midline of the transverse process moves superior from L5 to L1

Ebraheim, Spine 1996



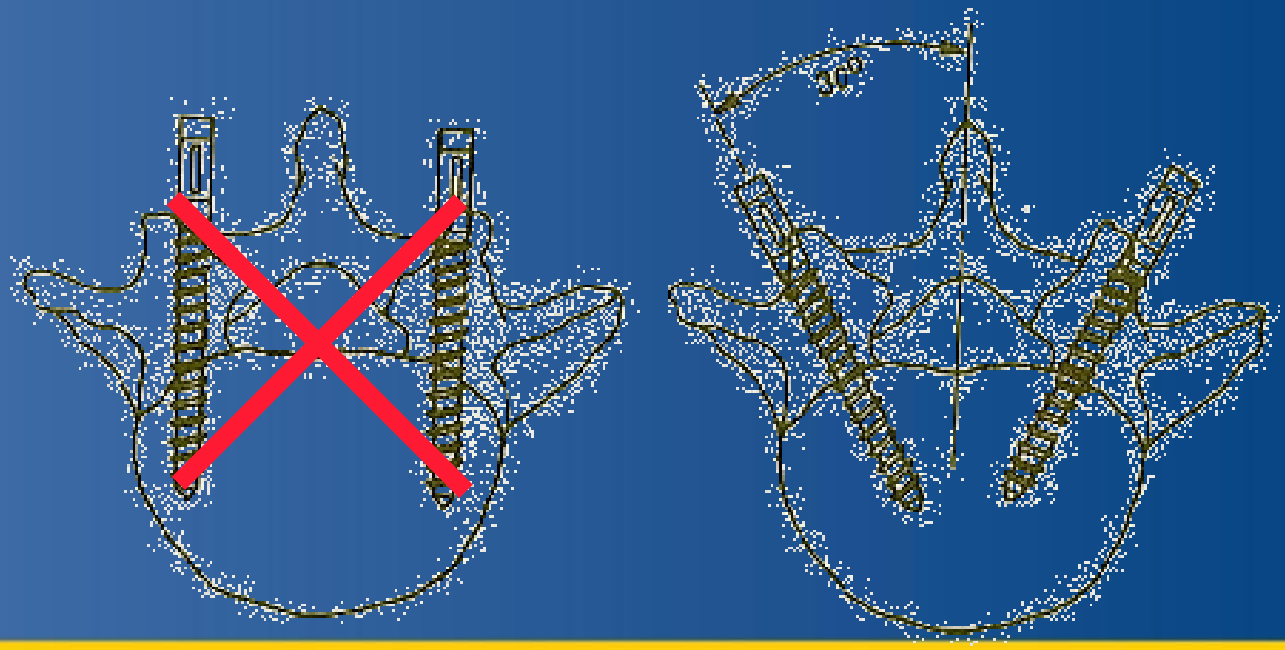
Shape of the Pedicle

- Shape of the pedicle is cylindrical with a tapered width in the middle



Screw Trajectory

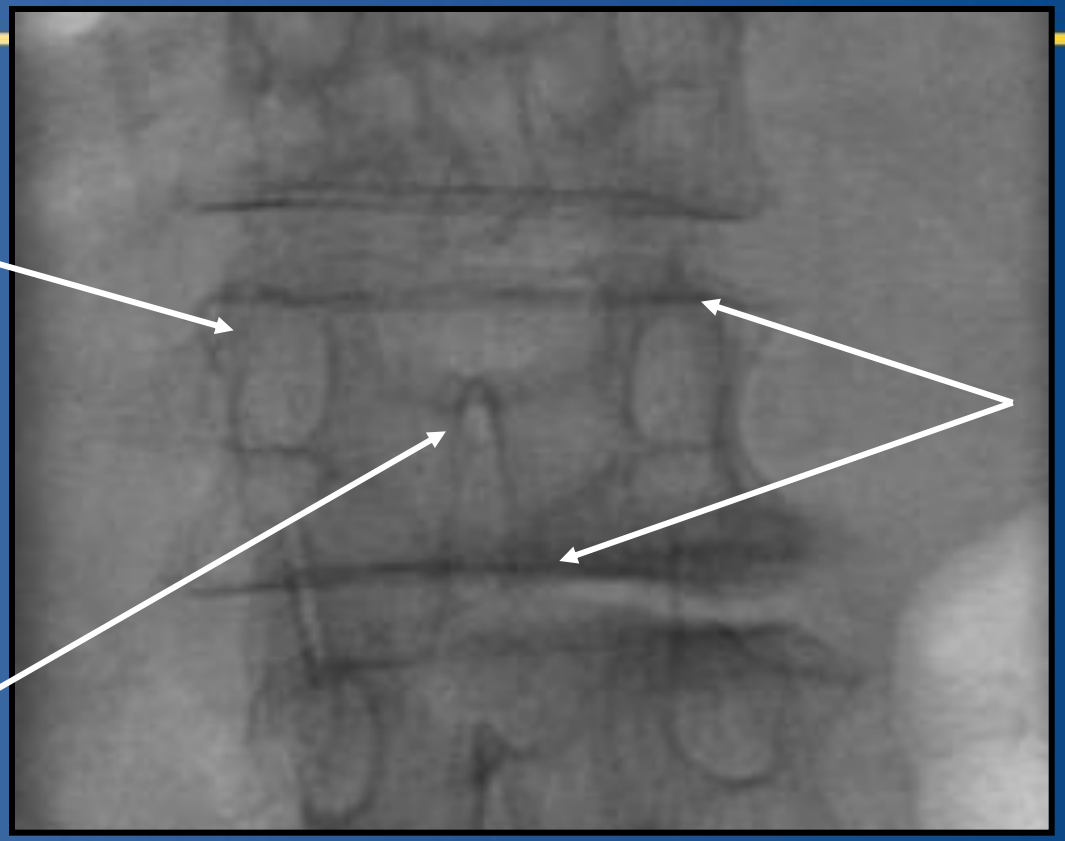
- Avoid straight ahead placement
- Convergent placement is desired
  - Avoid facet joint
  - Improve fixation strength



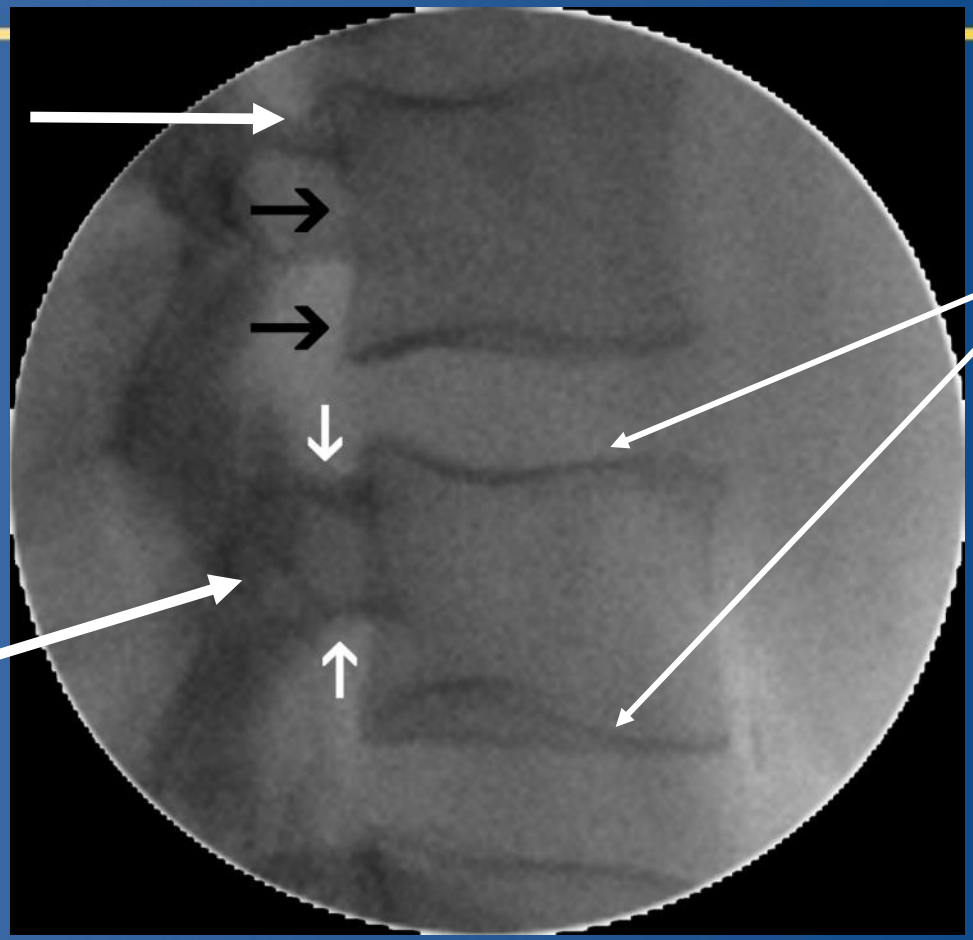
Adequate Pedicle Targeting

- Place AP & lateral films on view box to help with orientation
- Place targeted vertebrae in the middle of image
- Vertebral endplates parallel
  - Avoid parallax inaccuracy
- Line up spinous process
  - Be aware of patients with scoliotic curves and compensate

AP View


Pedicles in upper half of vertebral body
Endplates parallel
Spinous Process Equidistant

Lateral View



Screw Orientation & Starting Point

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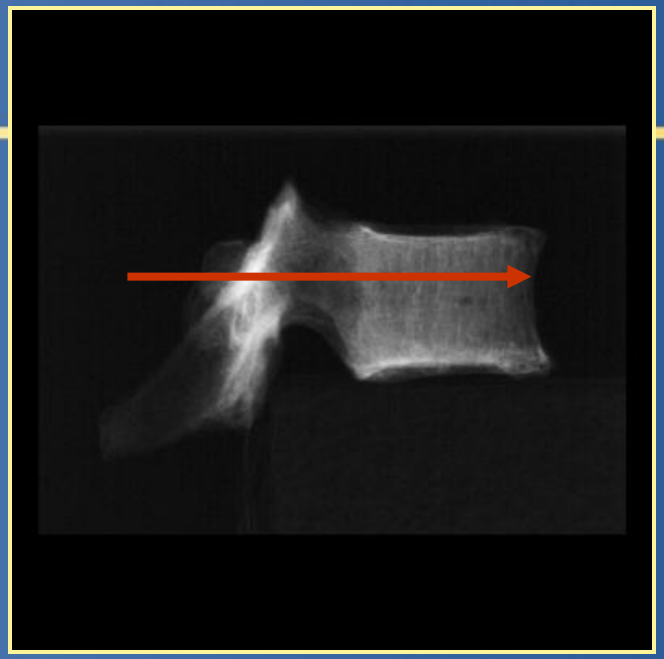

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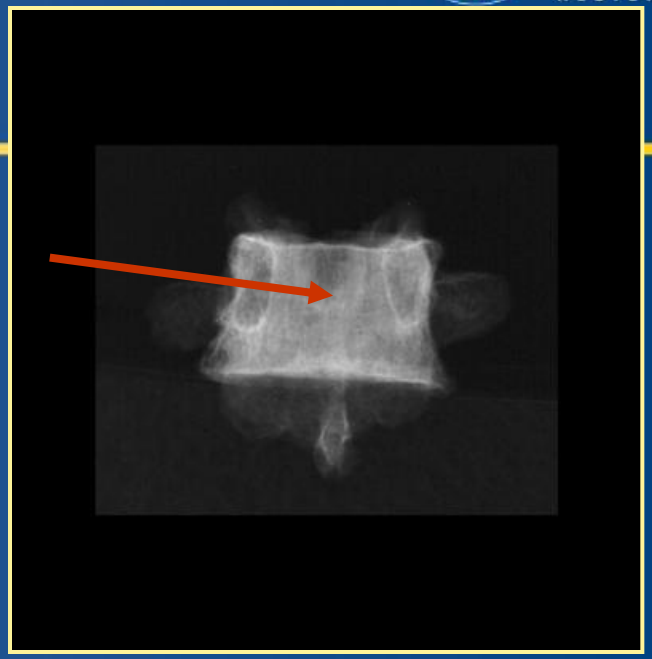

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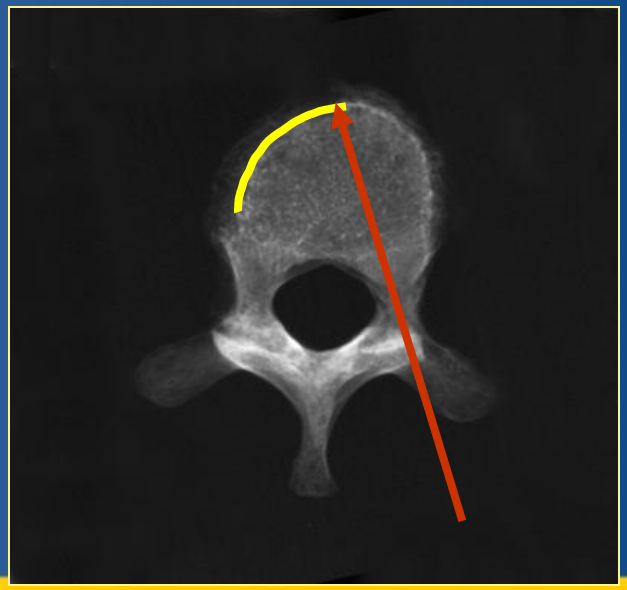
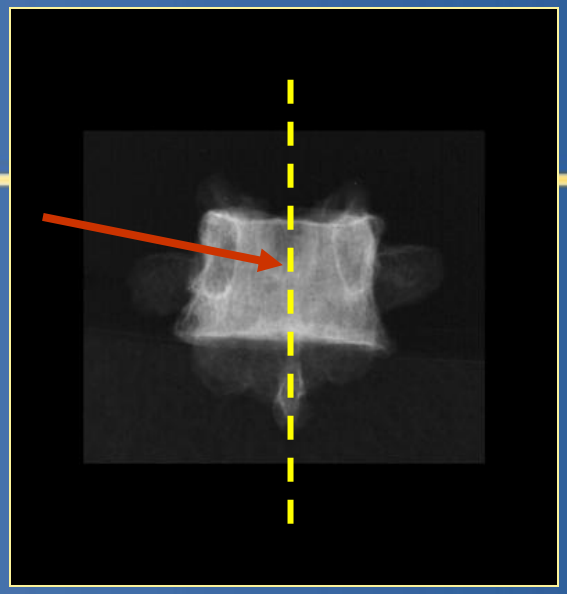


Targeting



Aim for midline on AP view

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Aim to be 80% across

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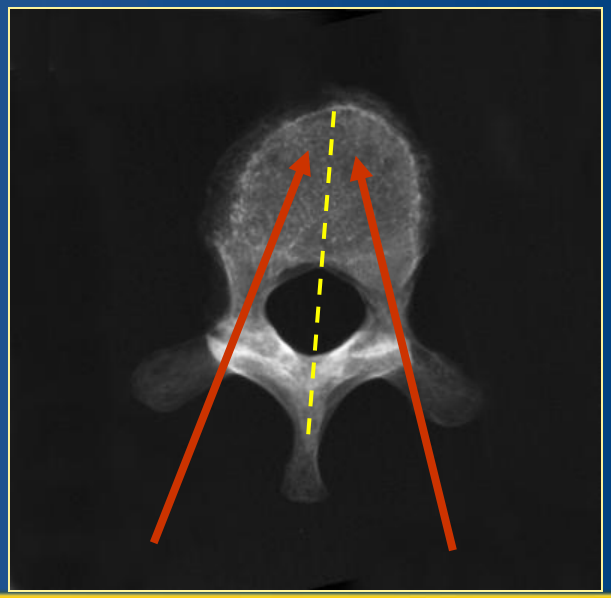
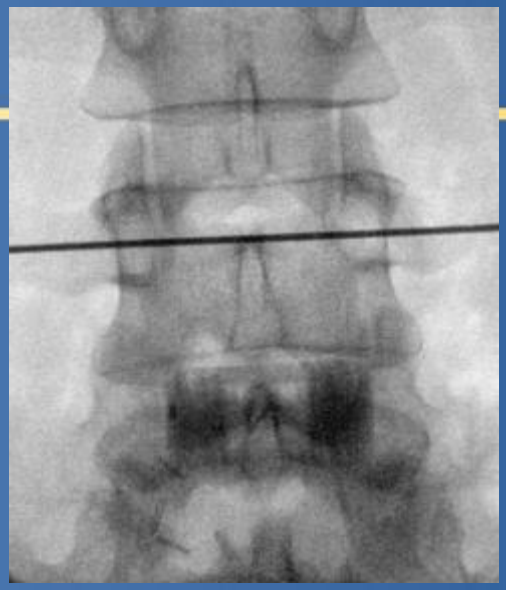
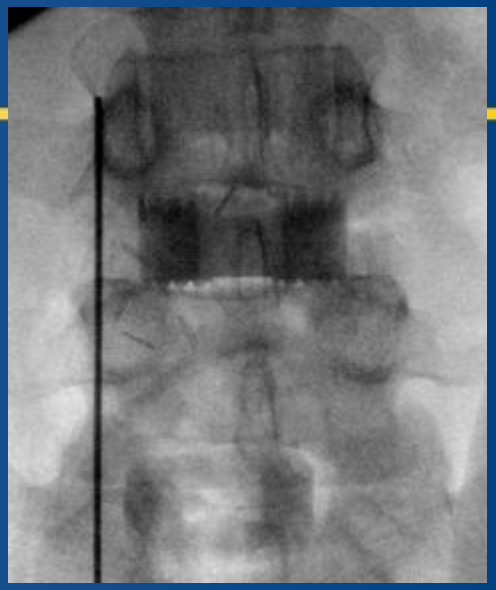
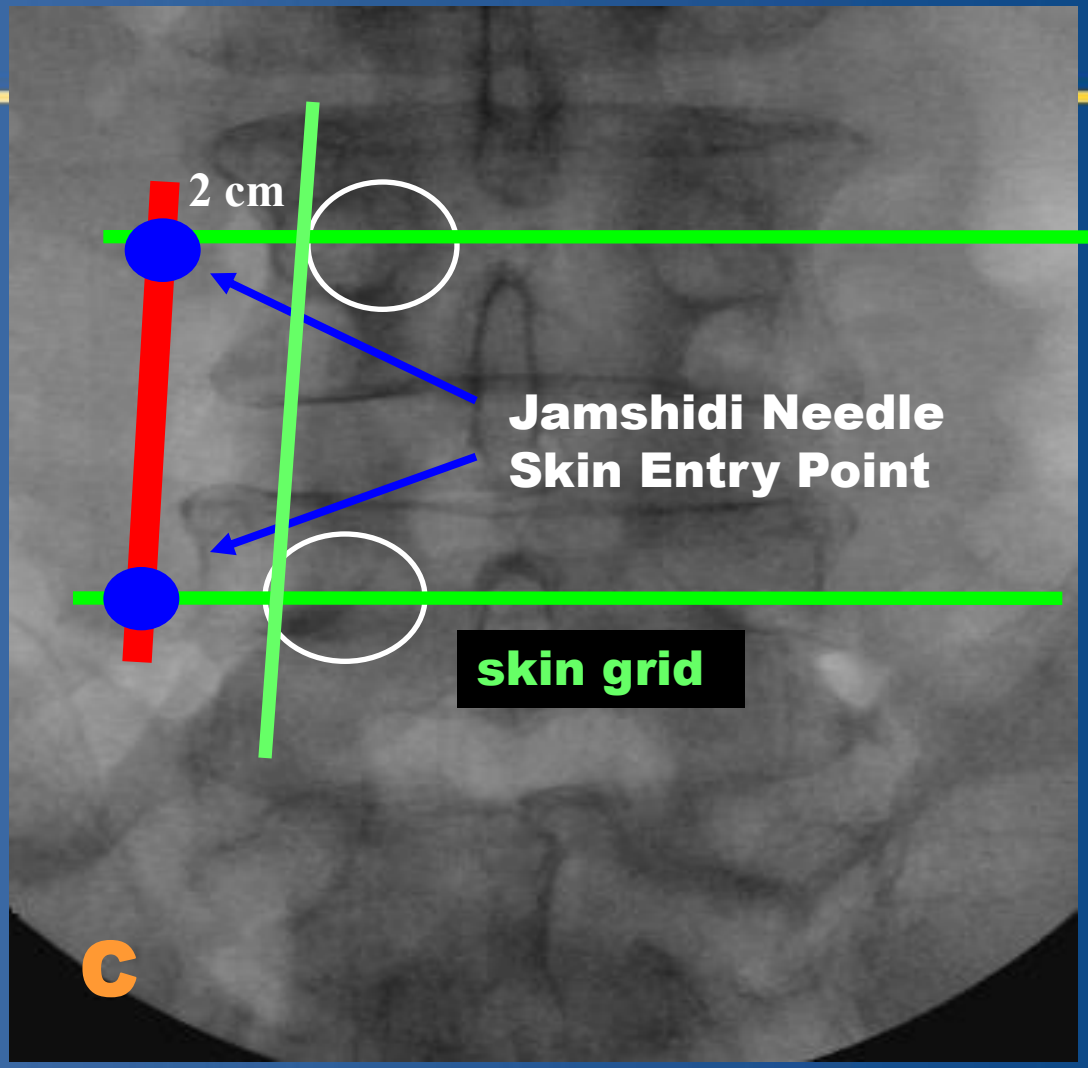


Targeting The Pedicles





Targeting



Fluoro / Skin Marking

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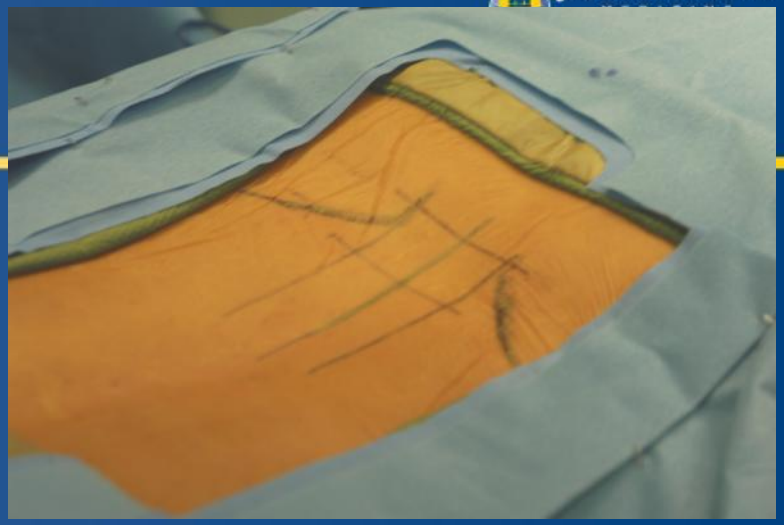
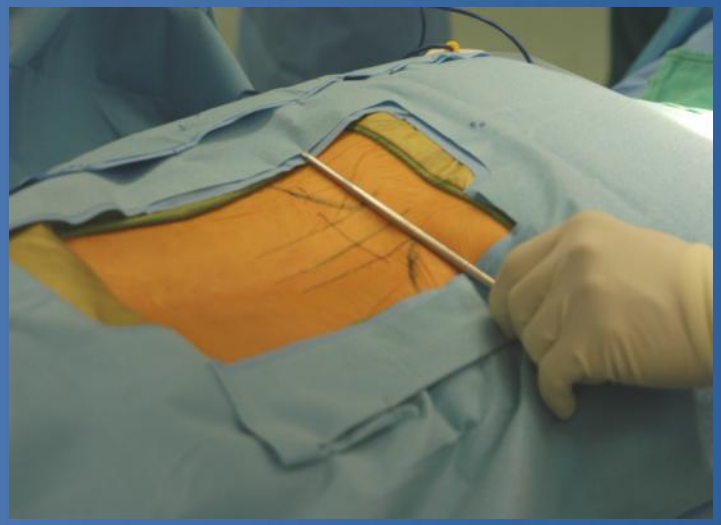
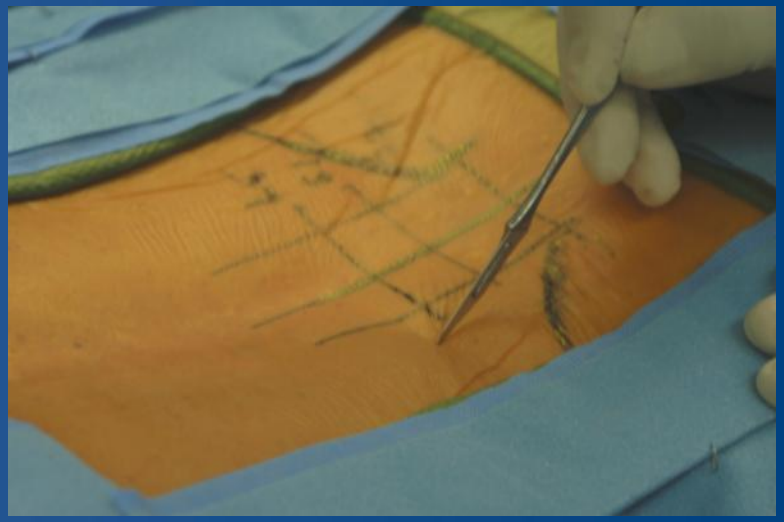
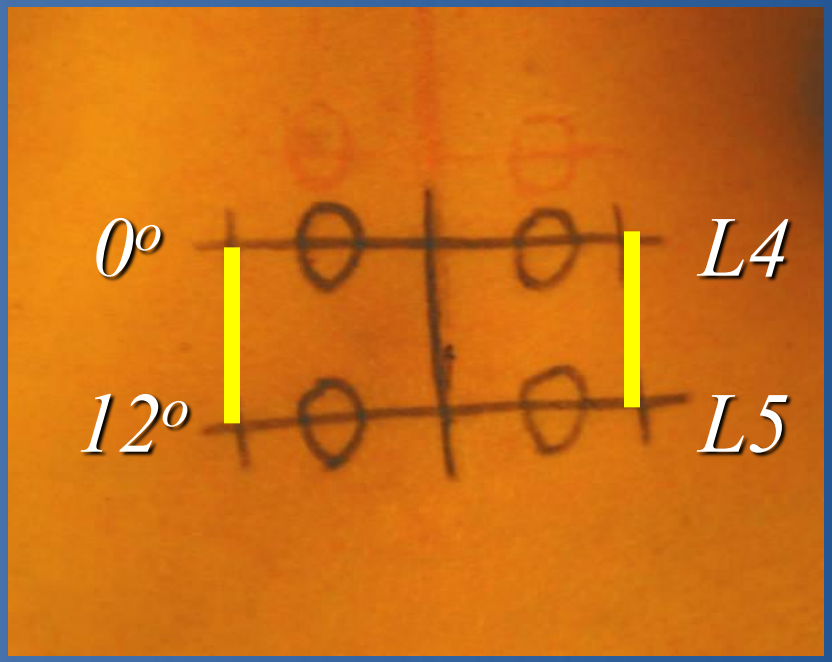
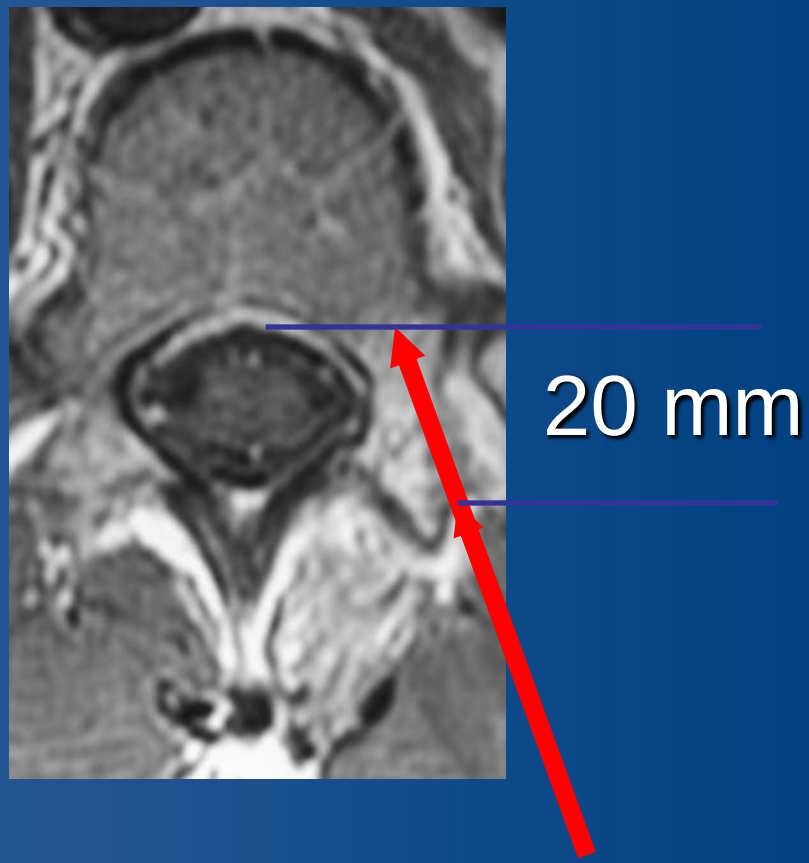





Through The Pedicle





Insert Guide Wires Through Jamshidi Needles

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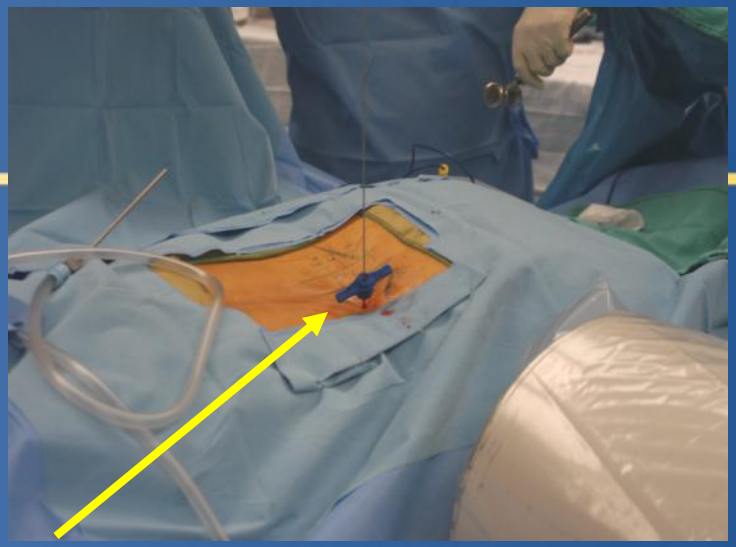

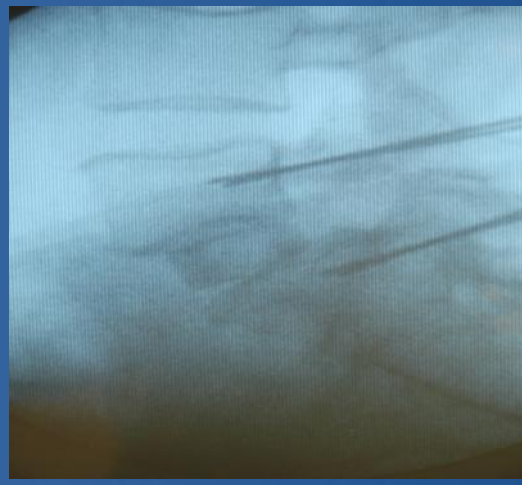

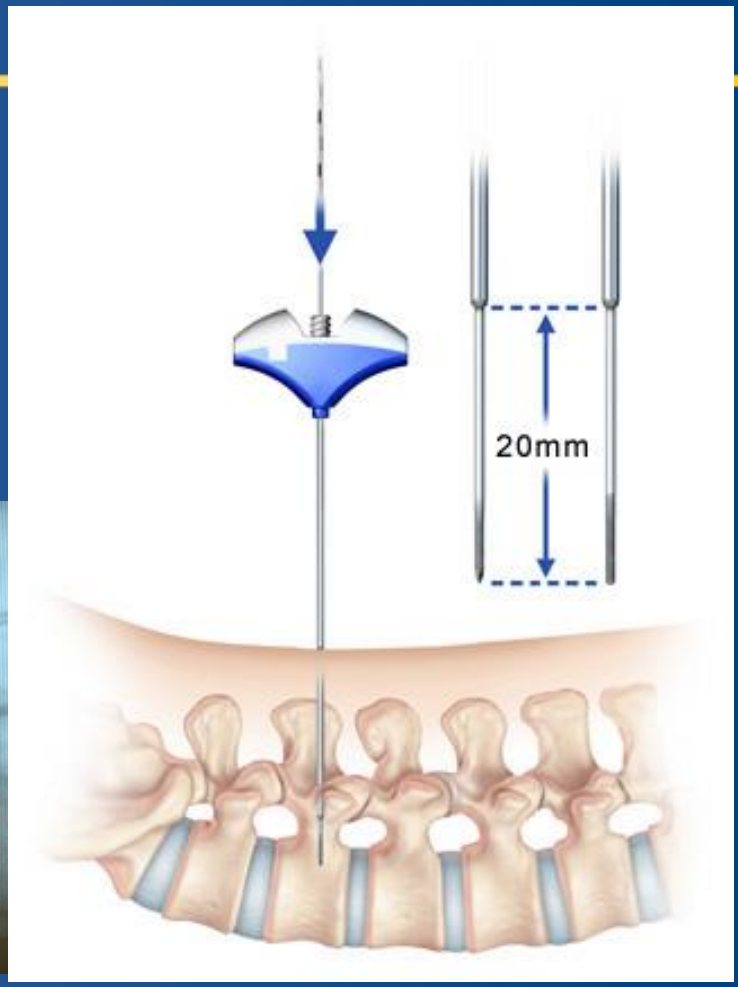

Insert Screws Over Guide Wires

8 Rules about MIS Deformity

Fifth Rule

Become efficient at Tubular access

Traditional Surgical Approaches

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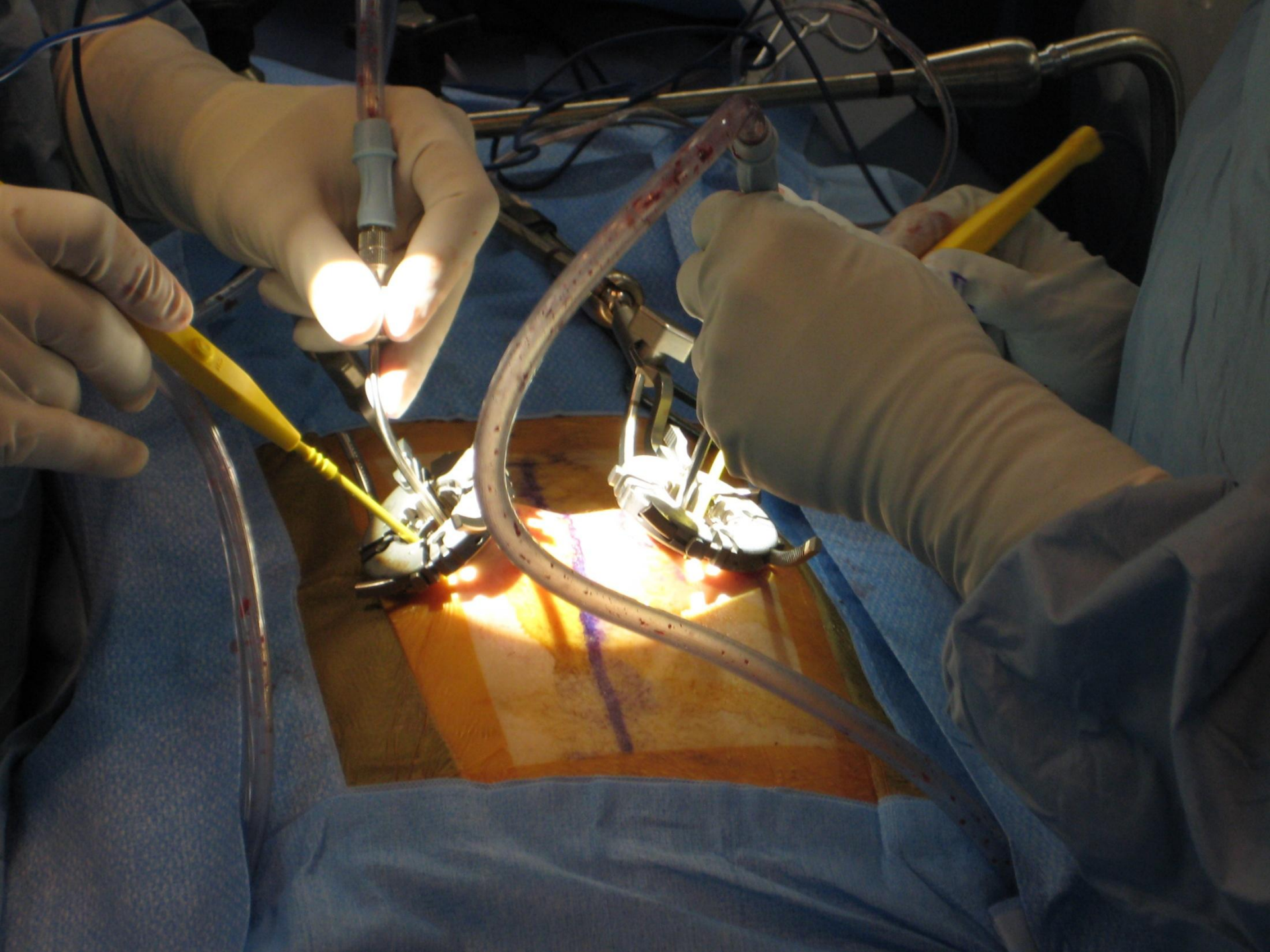
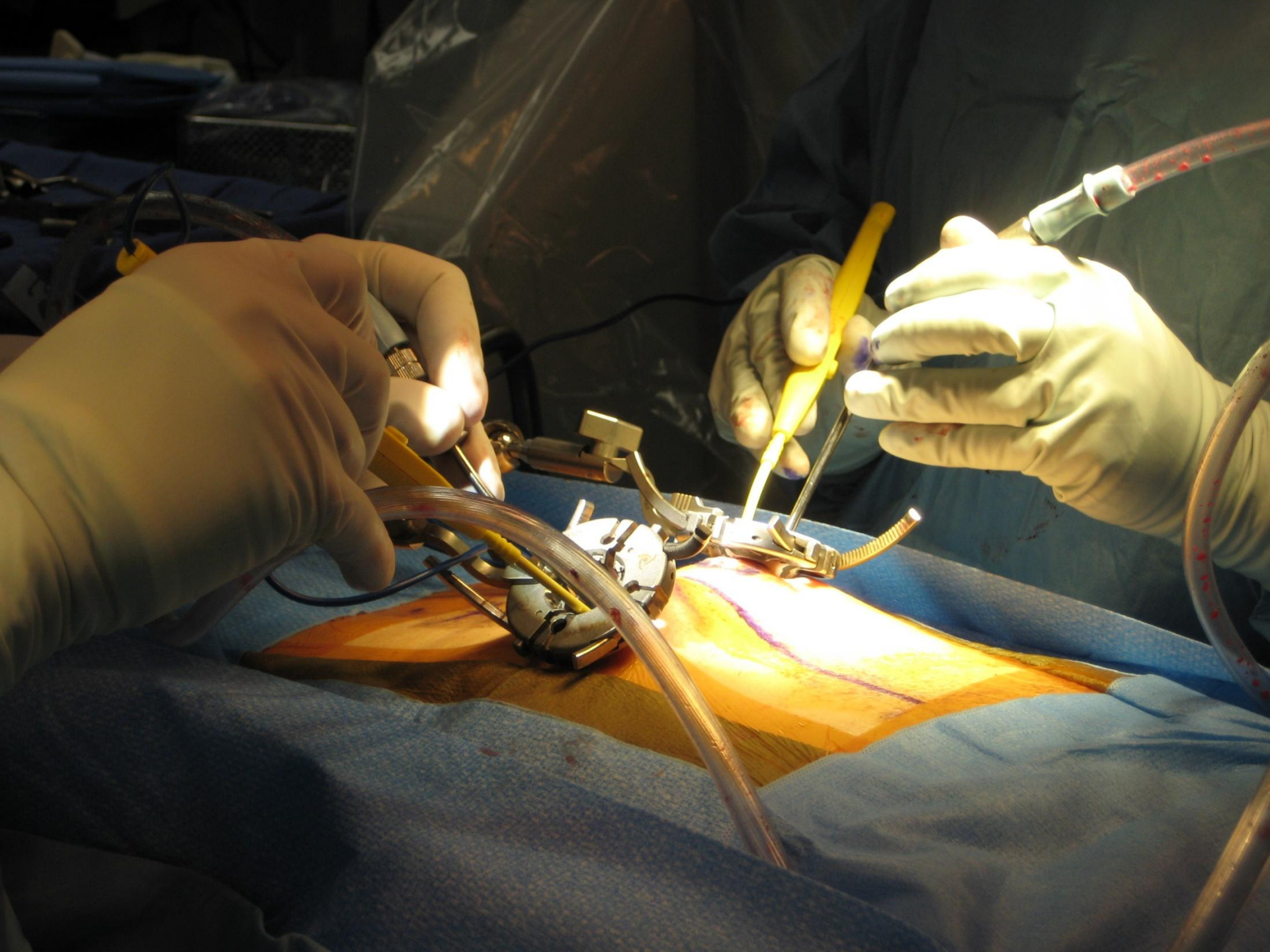
Posterior Lumbar Interbody Fusion (PLIF)

- Approached through the center of the lower back
- PLIF: requires disruption to back muscles, bones, and ligaments on both sides of the spine

Traditional Posterior Lumbar Interbody Fusion (PLIF) exposure with bilateral resection of back muscles, bone, and posterior spinal ligaments.


LUXTEC



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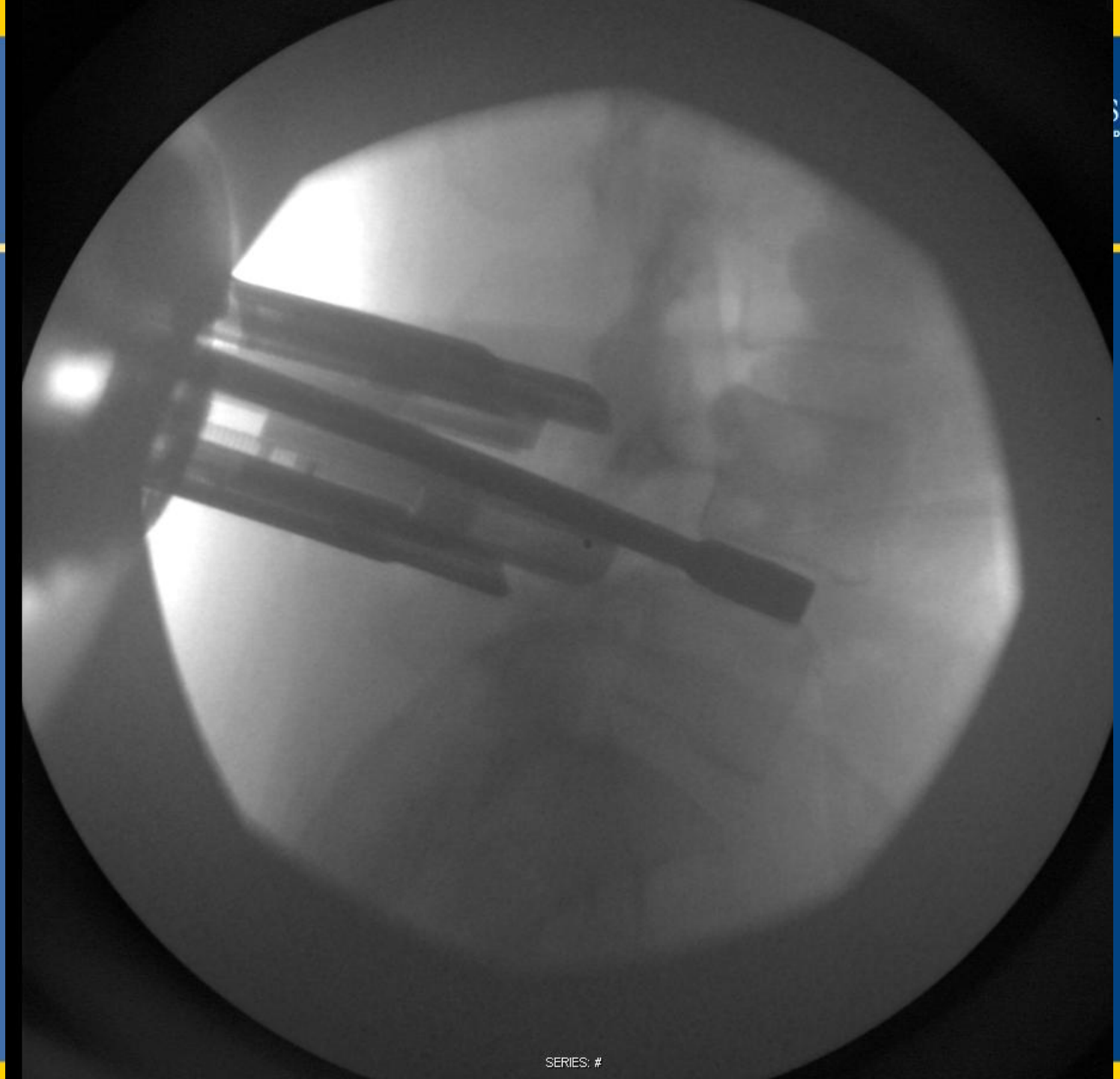
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8 Rules about MIS Deformity

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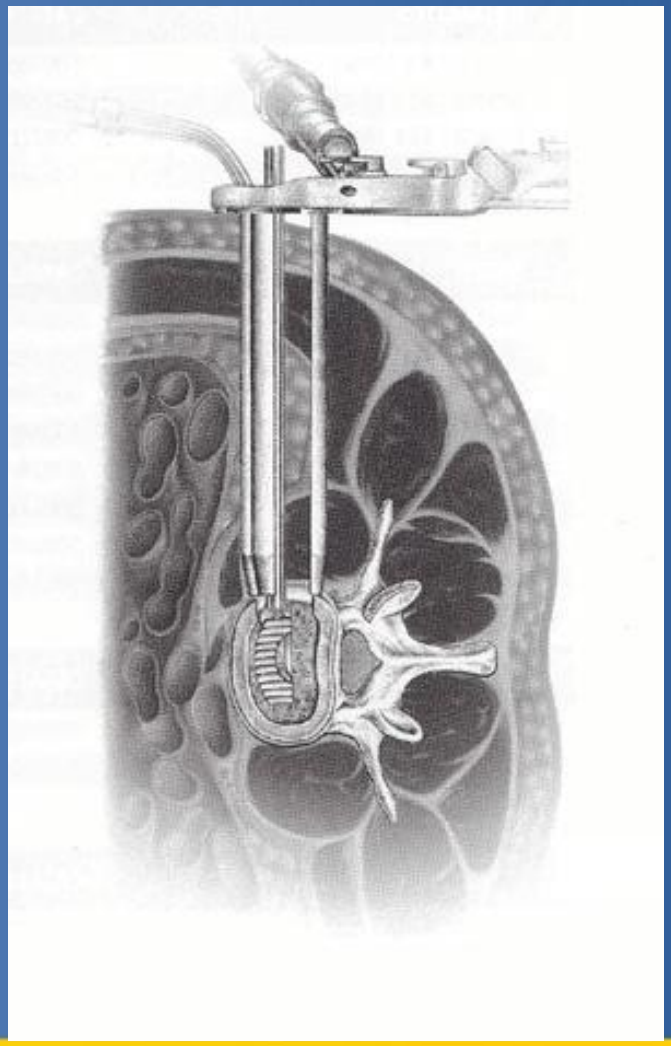
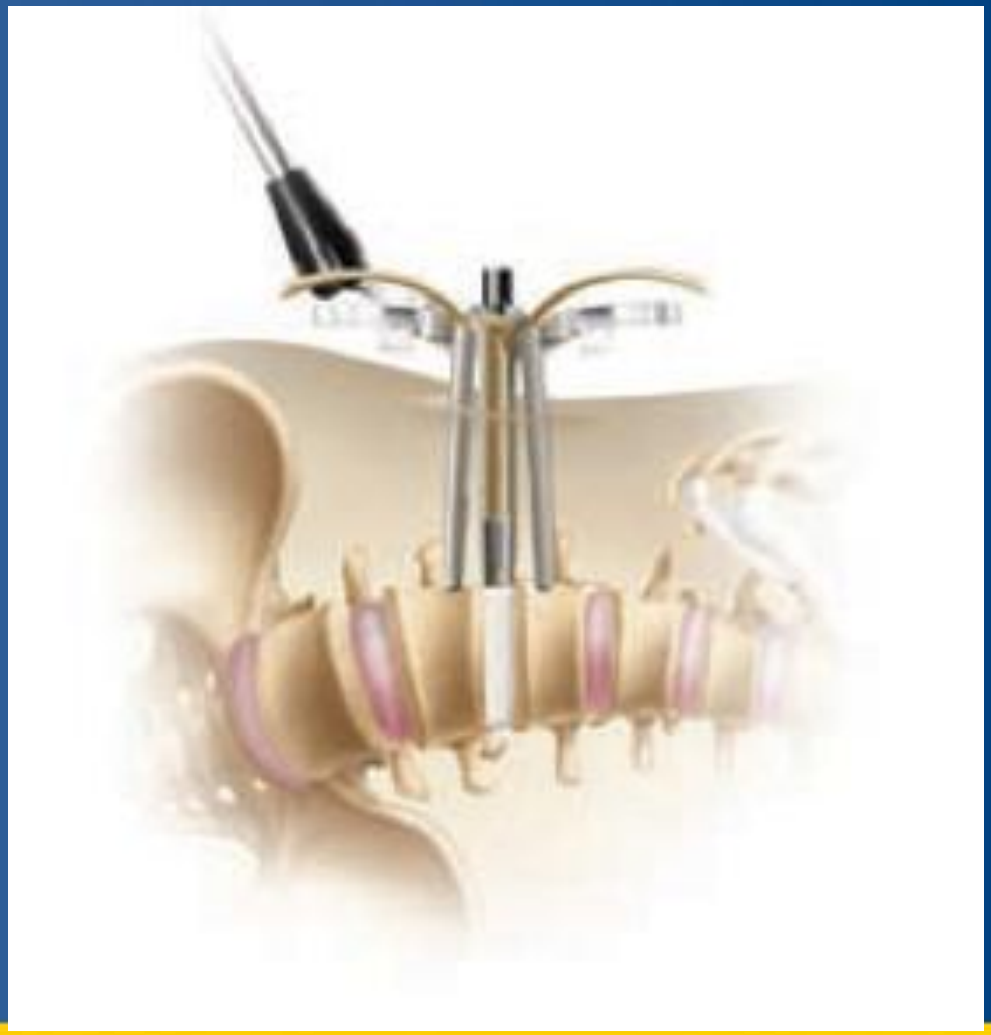
Sixth Rule

Become efficient at Lateral access

Extreme or Direct Lateral Interbody Fusion (XLIF/DLIF)






METRIC
INCHES
Devon
OR Products & Safety Solutions
Measurement device is not calibrated. Use for approx. mea

8 Rules about MIS Deformity

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Seventh Rule

Practice these techniques with "smaller/comfortable" degenerative cases

MIS Procedure

- Category encompasses various gradations of surgical exposures:
  - "mini-open"
  - "tubular"
  - "percutaneous"
  - "combined approaches/hybrid"

- Minimize surgically induced tissue damage

8 Rules about MIS Deformity

Eighth Rule

Employ MIS techniques with complex deformity if goals can be technically met

Indications and Patient Selection

- Can I achieve the surgical goals of open deformity surgery with available MIS techniques?

- Factors to consider
  - Levels of surgery?
  - Flexibility of the curves?
  - How much sagittal balance correction is needed?
  - Duration of surgery
  - Ability to achieve long term fusion

MIS alone versus Hybrid

- MIS as primary treatment
  - Good overall sagittal balance
  - Flexible curve
  - Less than 5 levels of treatment
  - Avoiding extension into ilium is possible

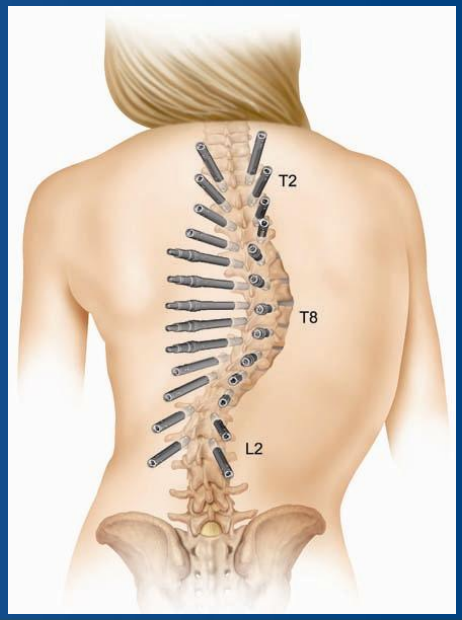
- MIS as adjunct treatment
  - Percutaneous posterior fixation
  - Posterior osteotomies to provide additional releases for optimizing anterior correction
  - Topping off with percutaneous fixation in open cases
  - Interbody fill-up for fusion

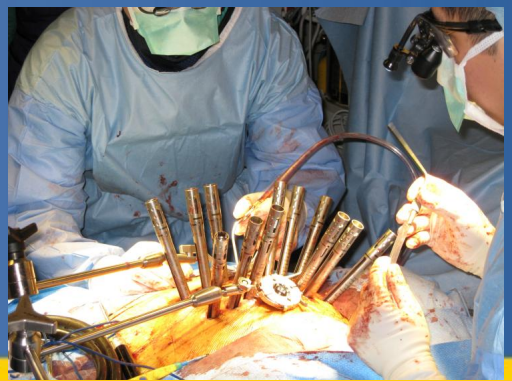
Posterolateral Technique

Percutaneous Instrumentation

- Allows for sagittal and coronal translation as well as derotation

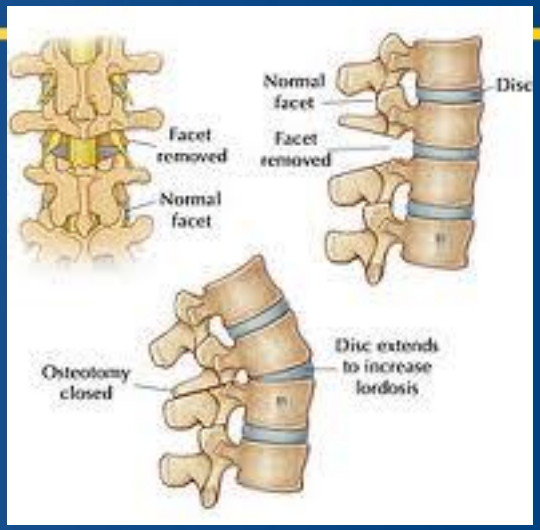
- Current limitations
  - Inability to cantilever
  - In ability for in-situ rod bending
  - Difficulty to manage multiple curves in single construct (kyphosis to lordosis or opposing coronal curves)

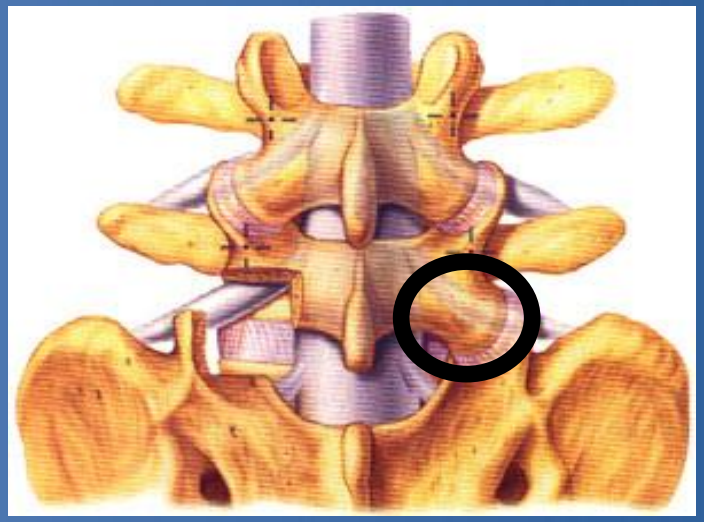


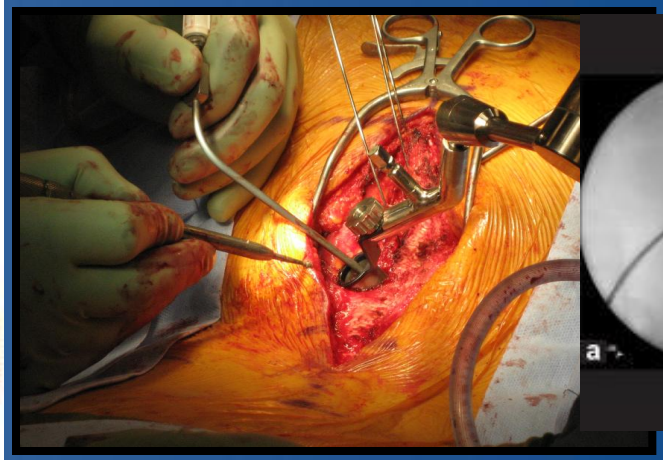


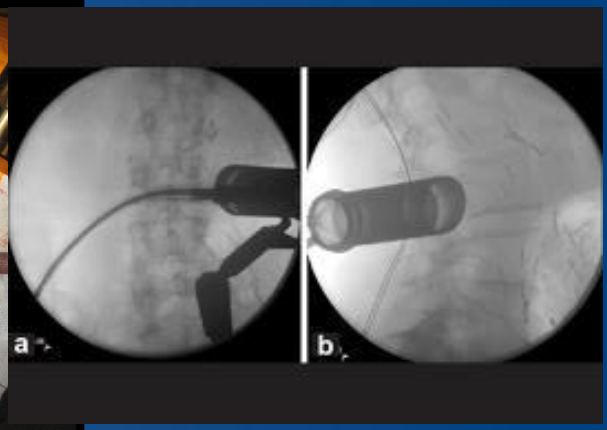
Posterolateral Technique

- Tubular options
  - MIS-TLIF
    - Unilateral cage placement
  - Posterolateral osteotomies
    - Ponte/Smith-Petersen Osteotomies



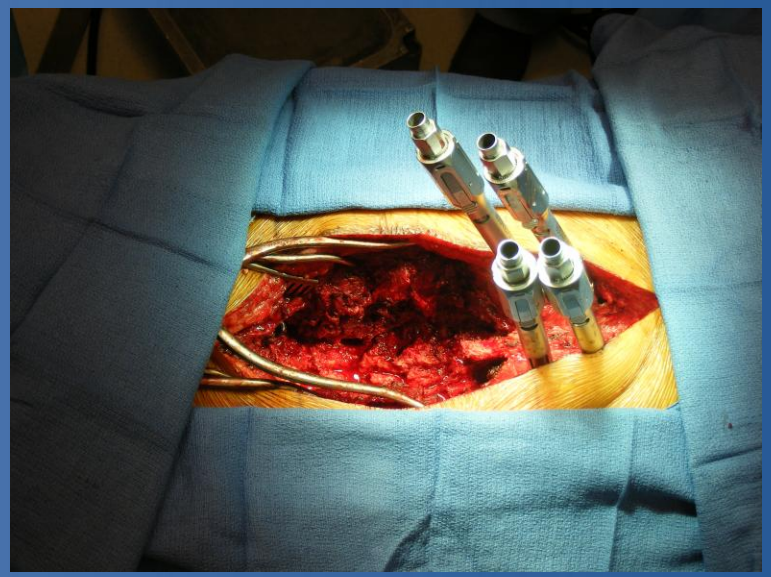






Percutaneous Application for Deformity

- Percutaneous vertebral augmentation
- Percutaneous instrumentation



All MIS posterior correction: Tubular SPO T11-L2, percutaneous instrumentation T10-L3

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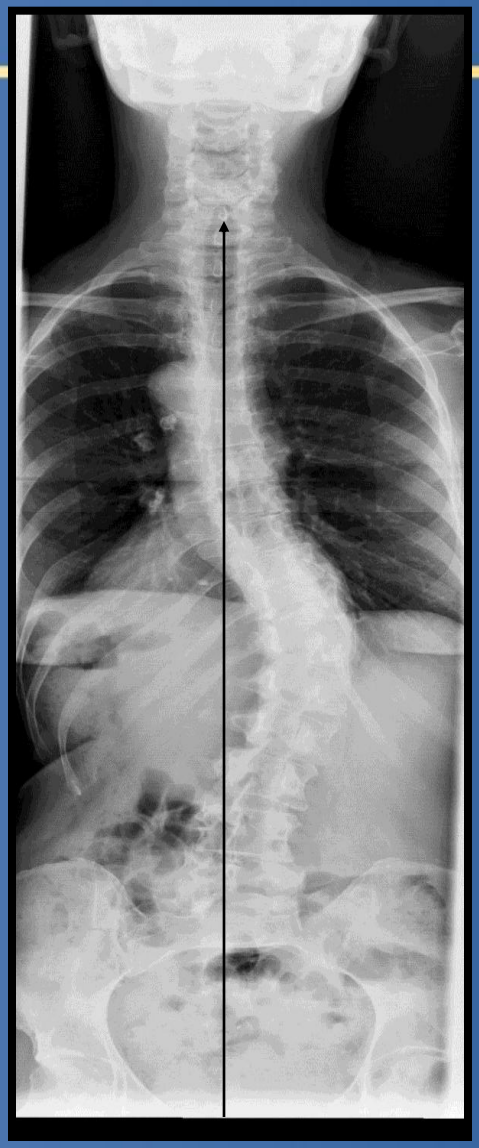
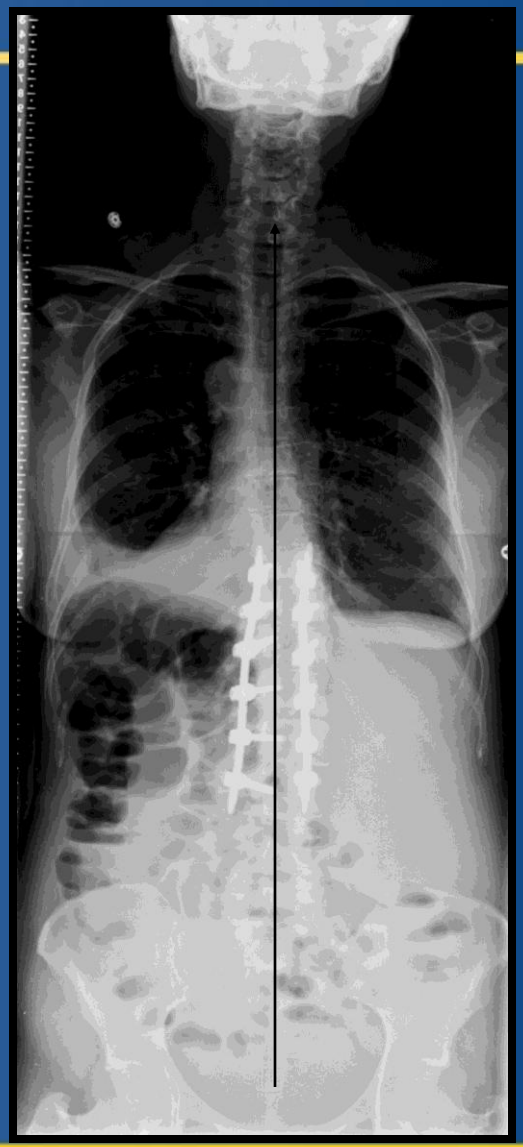
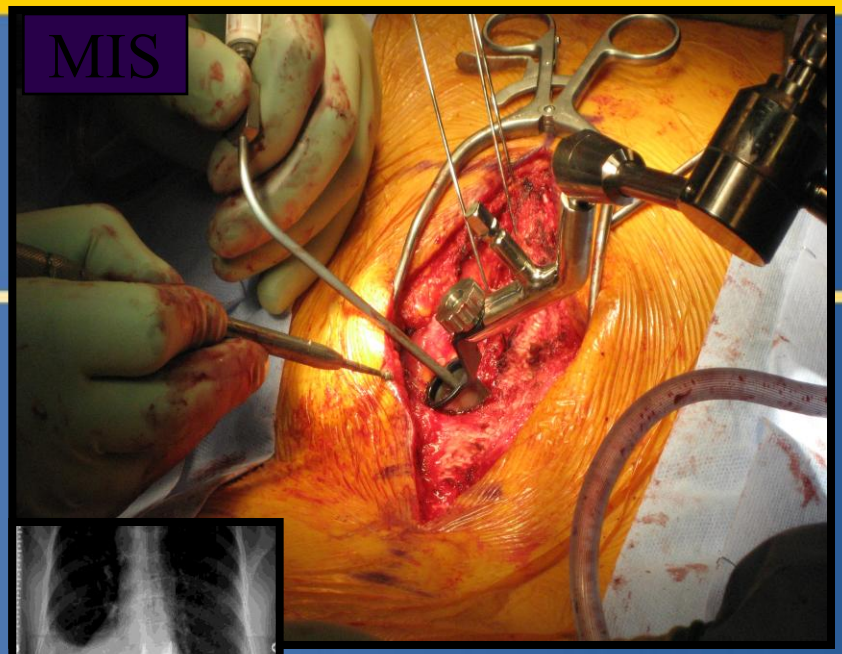
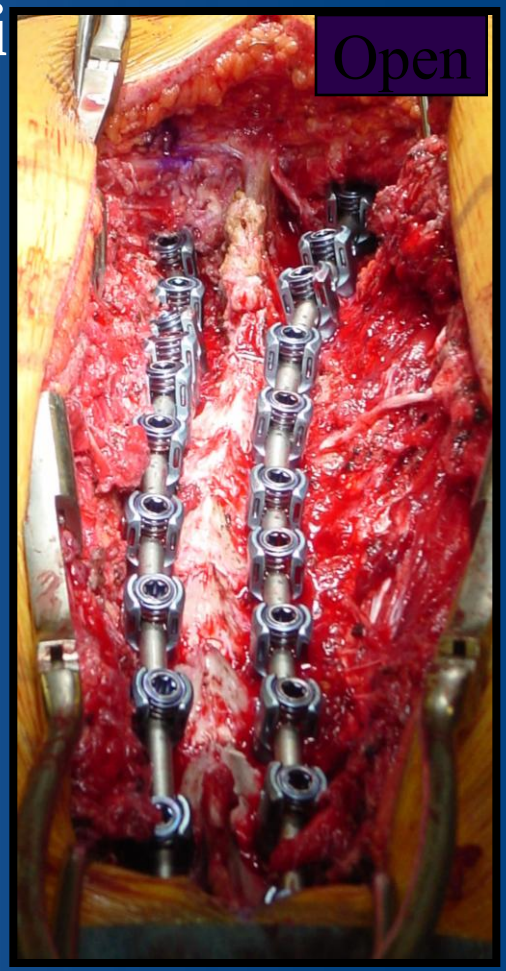





Soft Tissue Injury Comparison
Open vs. MIS Deformity Correction Techniques: No





MIS Three Column Osteotomies

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Minimally Invasive Posterior Osteotomies

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OBJECTIVE: Surgery for thoracolumbar deformity can lead to significant muscle injury, excessive blood loss, and severe postoperative pain. The aim of the following studies was to determine the feasibility of minimally invasive posterior thoracic corpectomy and thoracolumbar osteotomy techniques for deformity in human cadavers and select clinical cases.

METHODS: Human cadaveric specimens were procured for thoracic corpectomy and Smith-Petersen and pedicle subtraction osteotomy using a minimally invasive approach. Post-procedural computed tomography was used to assess the degree of decompression following corpectomy and the extent of bone resection after osteotomy. Pre and post-osteotomy closure Cobb angles were measured to evaluate the degree of correction achieved.

RESULTS: The minimally invasive lateral extracavitary approach for thoracic corpectomy provided adequate exposure and allowed excellent spinal canal decompression while minimizing tissue disruption. Nearly complete osteotomies of both types could be achieved through a tubular retractor with a modest change in Cobb angle.

CONCLUSION: These techniques may play a role in deformity surgery for select cases with further technological advancements.

KEY WORDS: Corpectomy, Minimally invasive spinal surgery, Osteotomy, Posterior approach

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Clinical Results on MIS for Spinal Deformity

- Anand et al.; Mid-term to long-term clinical and functional outcomes of minimally invasive correction and fusion for adults with scoliosis; Neurosurg Focus 28 (3):E6, 2010
  - 28 consecutive patients MIS anterior/posterior fusion
  - Average 4.8 levels
  - Average age 67.7 y/o
  - Mean follow-up of 22 months
  - EBL 241ml for anterior procedure
  - EBL 231 for posterior procedure
  - OR time 470 minutes combined
  - Mean coronal correction of 15 deg (22.3 to 7.5)
  - Improved clinical outcome (VAS, TIS, ODI, SF36)
  - 23 patients had complications (82%)
    - 17 with thigh dyesthesia (61%)
    - 4 major complications (14%)
  - Reported: ”sagittal balance correction achieved via this technique was excellent.” However, supporting data lacking

- Wang MC, Mummaneni PV; Minimally invasive surgery for thoracolumbar spinal deformity: initial clinical experience with clinical and radiographic outcomes; Neurosurg Focus 28 (3):E9, 2010
  - 23 patients MIS anterior/posterior fusion from 2 centers
  - Average age 64.4 (range 42 to 84)
  - Average 3.7 levels fused
  - Mean EBL 477ml
  - Mean OR time 401 minutes
  - Improved VAS leg and back (2.78 and 3.96)
  - Mean coronal correction 20 deg (31.4 to 11.5)
  - Mean lumbar lordosis correction 8 deg (37.4 to 45.5)
  - Complications – 43.5%
    - 7 patients (30.4%) with ipsilateral sensory motor deficits
      - 2 required inpatient rehabilitation
      - 1 required assistive device for ambulation
    - 1 pneumothorax
    - 1 sacral screw pull-out
    - 1 CSF leak

MIS for Spinal Deformity

- Various MIS techniques are available for treatment of spinal deformity
- Peri-operative blood loss is decreased compared to data from open surgery
- Data suggested excellent coronal correction
- Sagittal correction data lacking
- Lower complication rate?
- Need for Long-term follow-up data >2-5 years

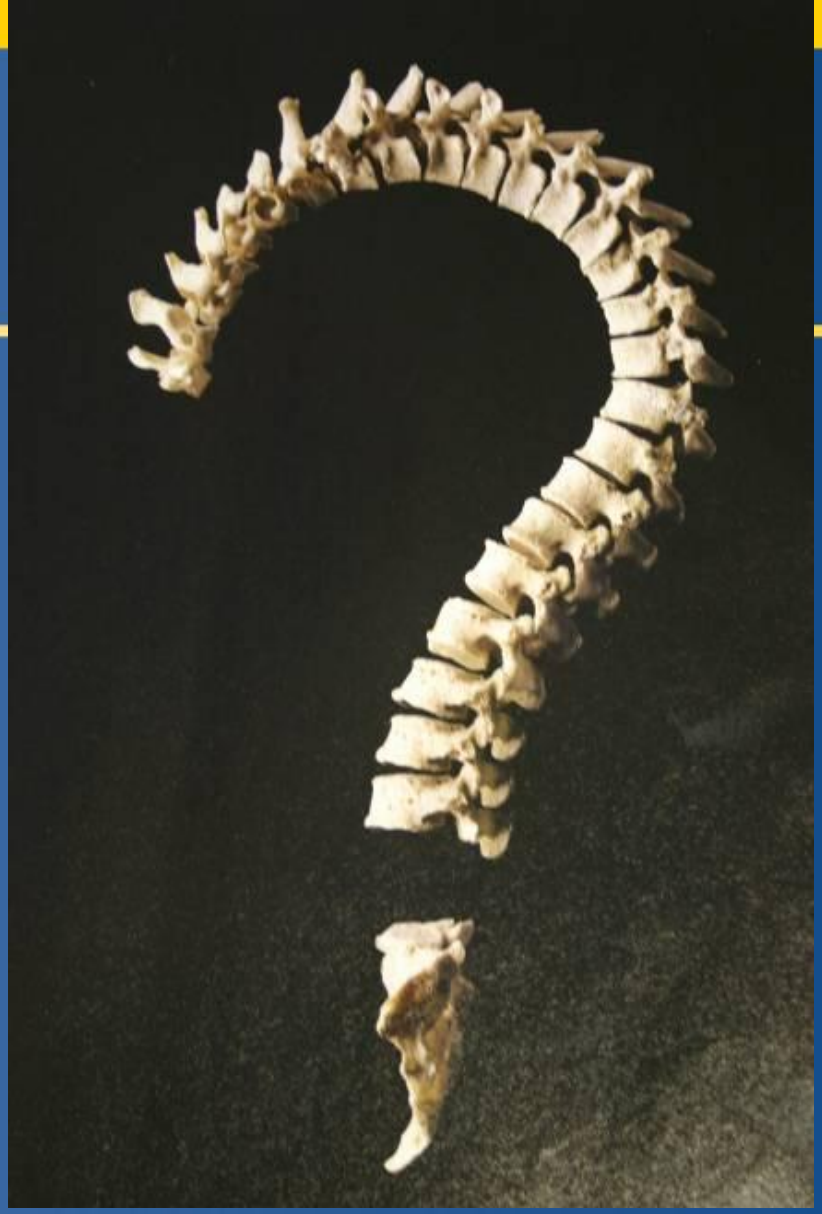
Selecting the ideal patients

Need to address clinical symptoms and radiographic parameters of sagittal and coronal balance (SVA $\leq$4cm, PT <25deg, LL>PI = +9deg)

Patients with curve apex at L2-4

Patients with flexible deformity

Patients without significant sagittal imbalance



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