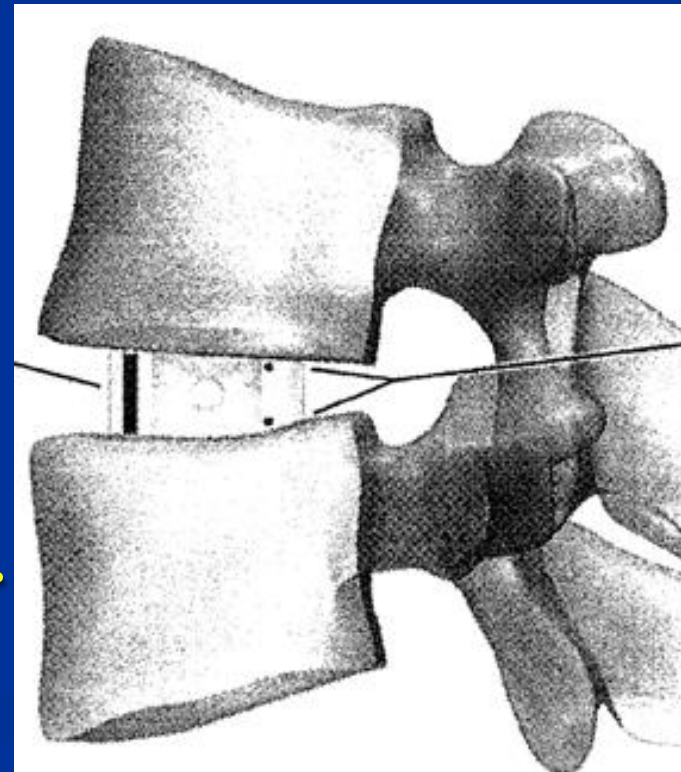


# Patient selection, radiographic considerations and indications lateral surgery: including tests & treatment

22 Feb 2019

Chambliss Harrod, M.D.

Deer Valley Meeting

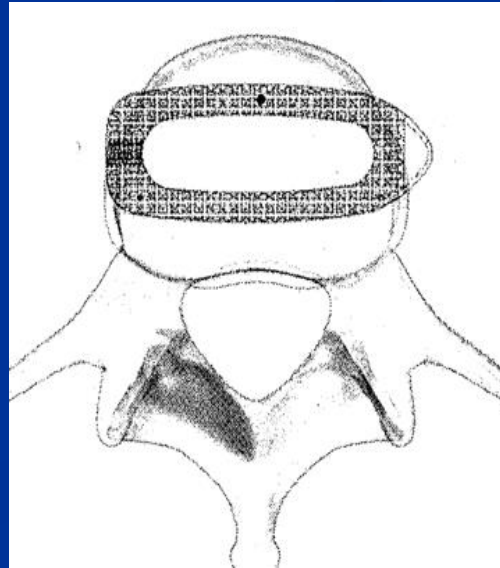


# Acknowledgements

- Innovasis - Consultant.
- Integrity - Consultant
- K2M – Consultant, Research Aid
- Stryker – Consultant, Research Aid
- Depuy – Consultant, Research Aid

# This *trans-psoas* procedure suffers many proprietary names

- DLIF (Direct Lateral Interbody Fusion – Medtronic)
- XLIF (eXtreme Lateral Interbody Fusion – NuVasive)
- LLIF (Lateral Lumbar Interbody Fusion - Globus)

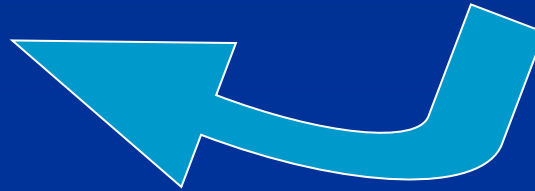


# Rationale for the lateral approach

## ■ Alternative anterior procedures

- ALIF
  - Open lateral retroperitoneal
- 

Lateral is less invasive?



## ■ Alternative posterior procedures

- TLIF
- PLIF

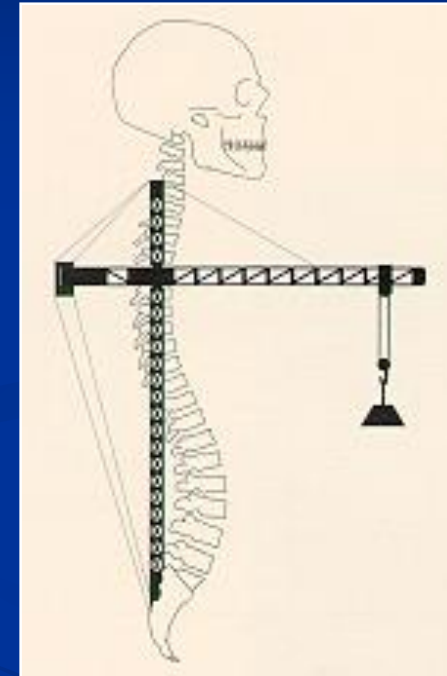
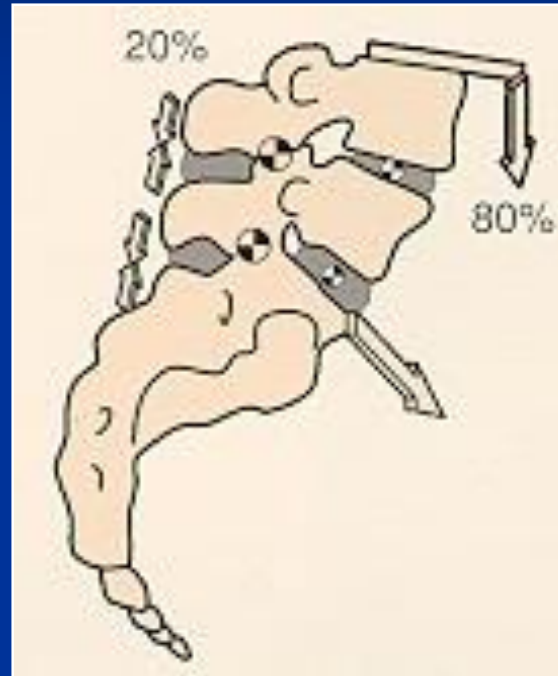
Lateral is better reconstruction, better fusion?





# Interbody Fusion Load Sharing

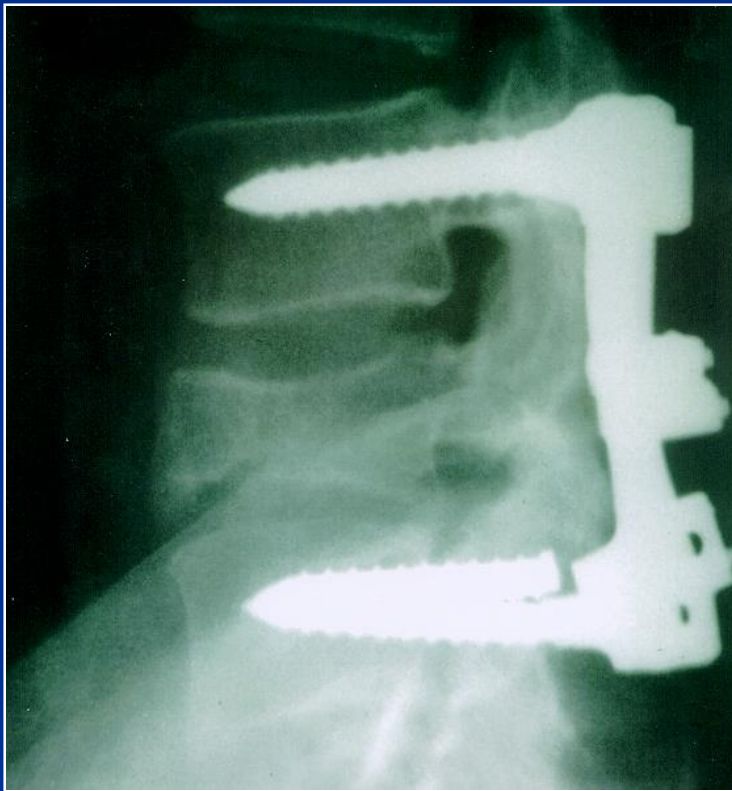
- 80/20 relationship
- Restore Physiologic Lordosis
- Construct Stability
  - Tension Band
- Disk Space/Foraminal Volume
- Pain Generator



# Load Sharing

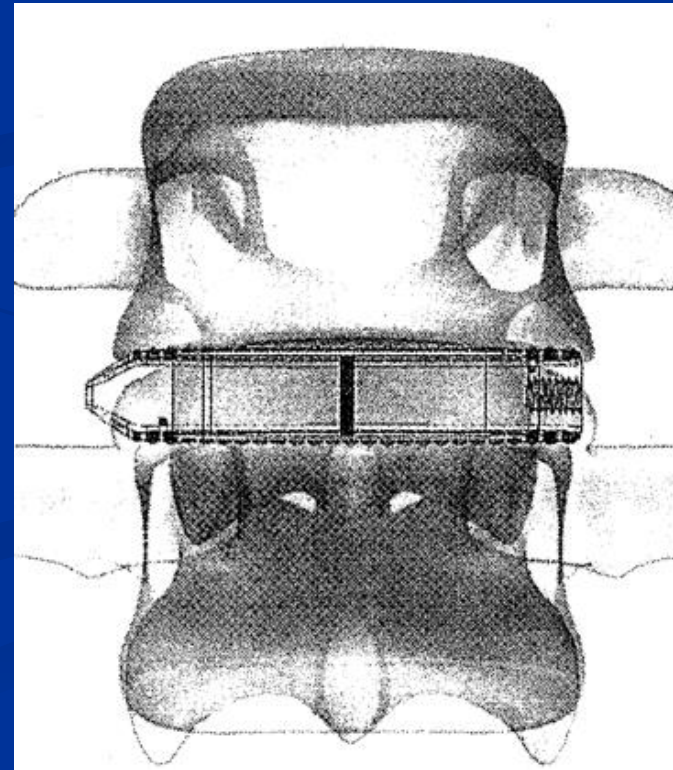
“Without adequate anterior column support-physiologic loads will exceed the bending strength of any pedicle based system”

Cunningham, Spine  
1993



# INTERBODY FUSION: INDICATIONS

- Spondylolisthesis
- Degenerative Disc Disease
- Scoliosis
- Pseudarthrosis
- Failed Laminectomies
- Junctional Degen/ASD
- Osteo/Diskitis
- Trauma



# INTERBODY AMAMENTARIUM

- ALIF
- PLIF
- TLIF
- Lateral

- OPEN
- MINI-OPEN
- LAPAROSCOPIC
- MIS
- STAND-ALONE
- 270°
- 360°



# Interbody Approach

## ALIF

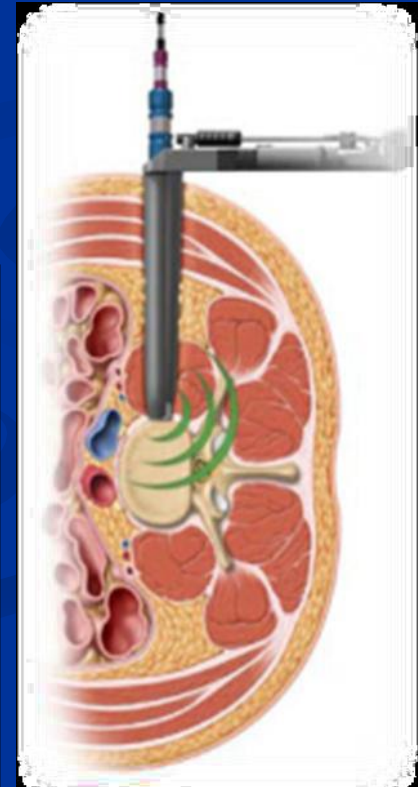
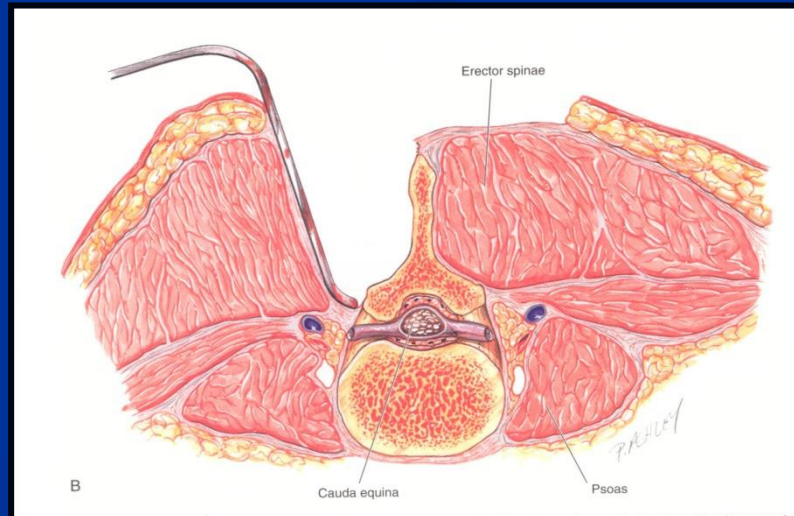
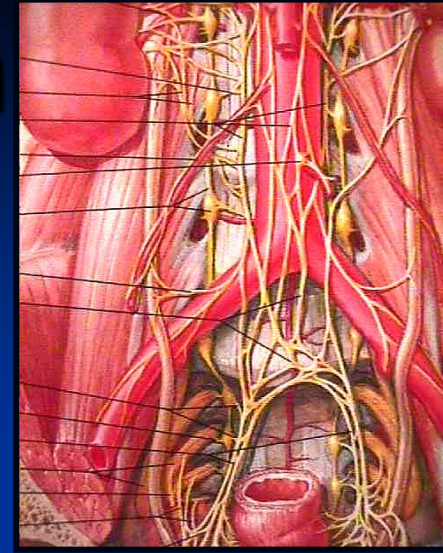
- Vascular laceration
- Injury to ureter/kidney
- Ileus
- Retrograde ejaculation
- DVT

## TLIF & PLIF

- Dural tear
- Injury to nerves
- Transition syndrome
- Infection (open)

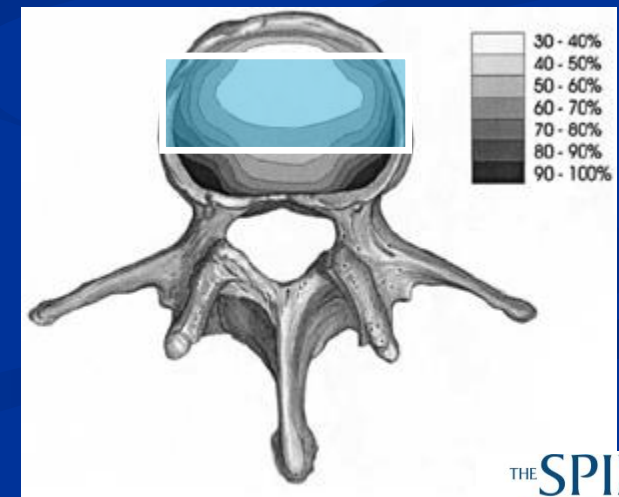
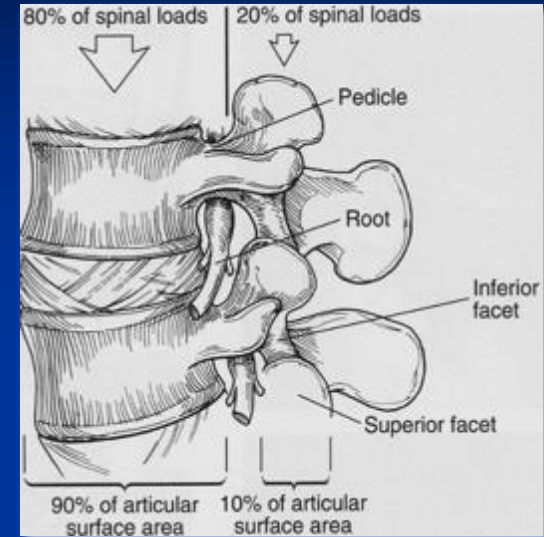
## Lateral

- Lumbar Plexus
- Setup
- Radiation



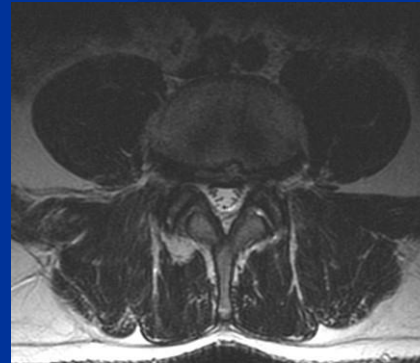
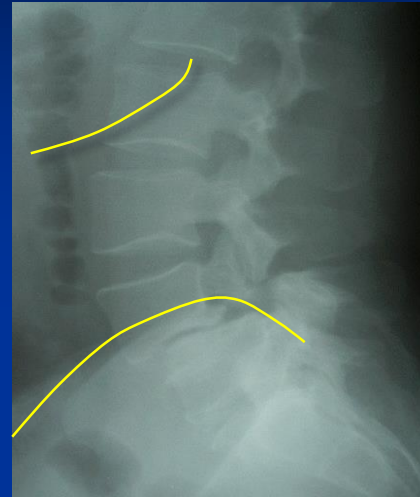
# Lateral Interbody Indications

- Similar to those for any interbody fusion
  - But it is **NOT** a panacea!
- I have used it for:
  - Degenerative scoliosis
  - Isthmic spondylolisthesis
  - Non-union
  - Revisions, recurrent compression
  - Adjacent segment disease
  - Infection
  - Trauma
  - Tumor
  - **NOT** back pain
  - **Not** DDD
- Lateral interbody fusion benefits:
  - Excellent support of axial load
  - Broad fusion surface
  - Can perform bilateral releases



# Pre-op Planning Pearls

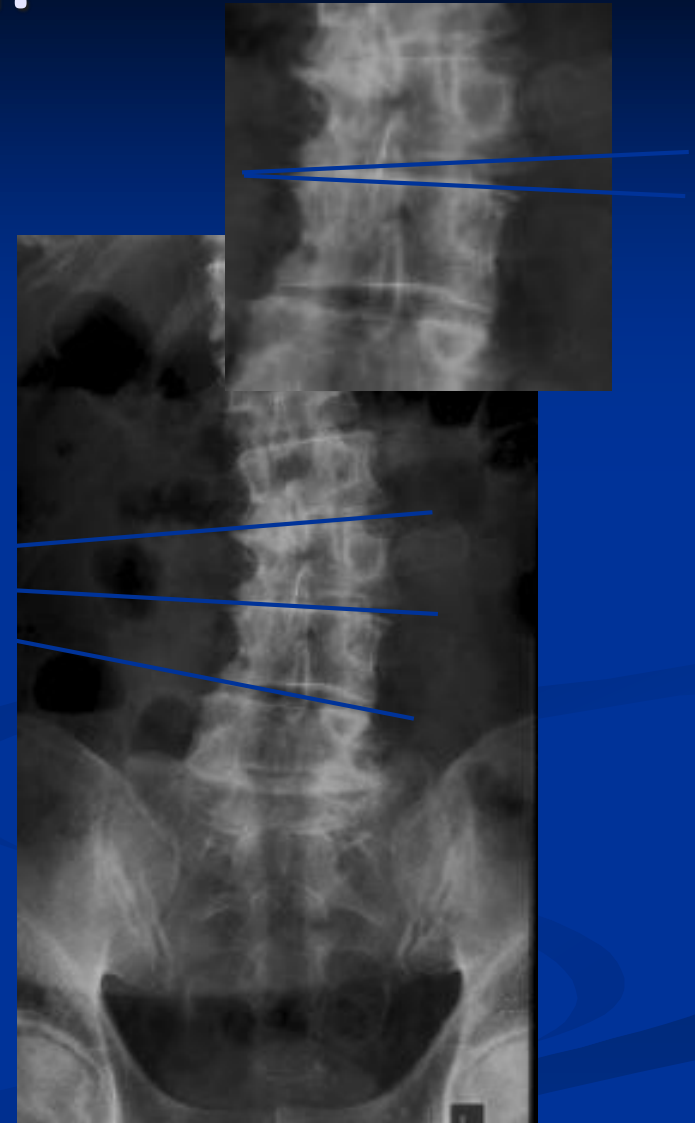
- Standing X-rays:
  - Check for unfavorable anatomy
  - High iliac crest at L4-5
    - More problematic in males
  - Long 11th and 12th ribs
    - Go intercostal or remove part of ribs
- MRI:
  - Find the vessels
    - (esp in DEFORMITY)
  - Find the ureter
  - Psoas size, shape, position?
    - Beware **Mickey Mouse Sign**



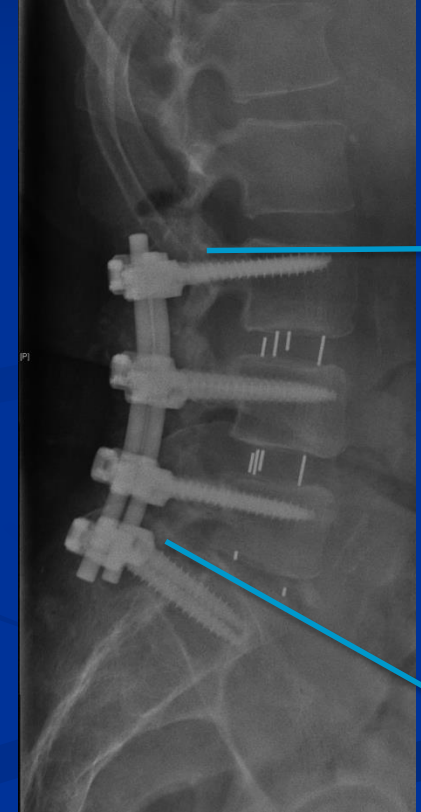
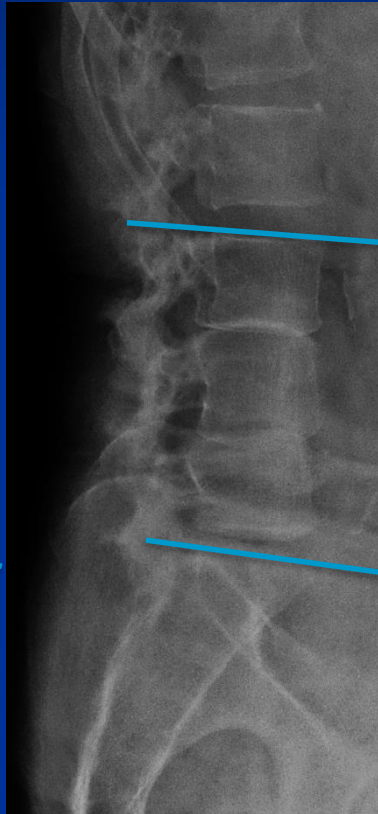
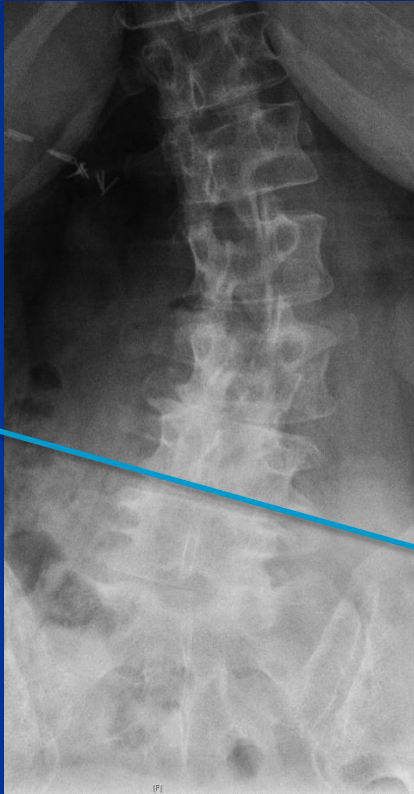


# Left or right approach?

- Deformity correction good on either side
  - Go on side easiest to enter disk
  - Convex side for easier entry
  - Concave side for multilevel
  - **L4/5 often has only one option**
- Retroperitoneal anatomy – **look at MRI**
  - Psoas, lumbar plexus, ureter
- Prior retroperitoneal surgery
  - Use contralateral
- Tough lateral osteophyte
  - Use contralateral
- Patient leg pain
  - Use ipsilateral

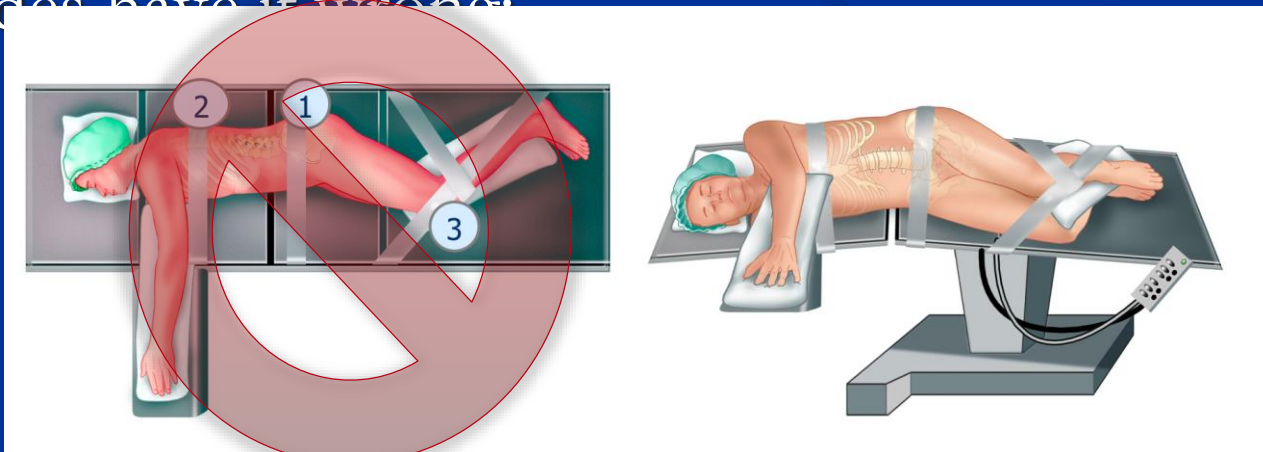


# Example; Degenerative scoliosis, stenosis



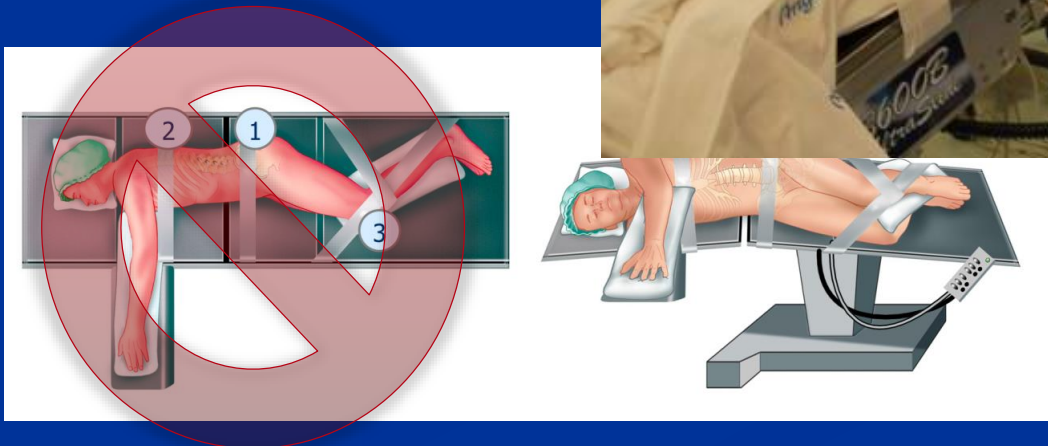
# Positioning Pearls

- Secure pelvis and leg to lower half of table
  - Use 3 inch cloth tape directly on skin...
  - Beware fibular head
- Some technique guides here [it is wrong](#)



# Pearl; flex table *before* securing chest

- If chest is taped before flexing table, can
  - Tear skin
  - Break ribs
  - Over-bend patient
- Watch effect of flexing table on patient position (and safety of position)



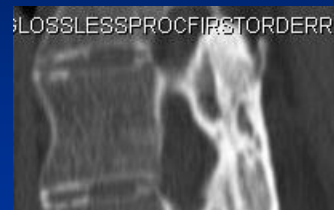
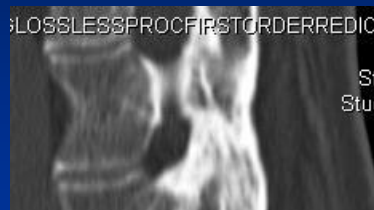


# Pearl; use lateral positioners when limited spine flexibility

- Patient may roll when table flexed if spine rigid
- Use lateral positioners to maintain position
- If patient rolls intra-operatively, can create dangerous situation where a previously “direct” lateral trajectory is now ventral or dorsal.



# Case example: limited flexibility...



# Secure chest to table after flexing

- Secure chest to table AFTER flexing table
- Flex table to open interval between 12th rib and iliac crest





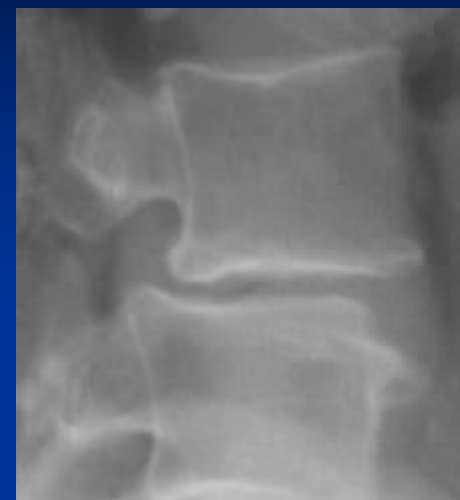
# Fluoroscopy Pearls...

- Make c-arm projection parallel to floor.
- I use two c-arms but most use one

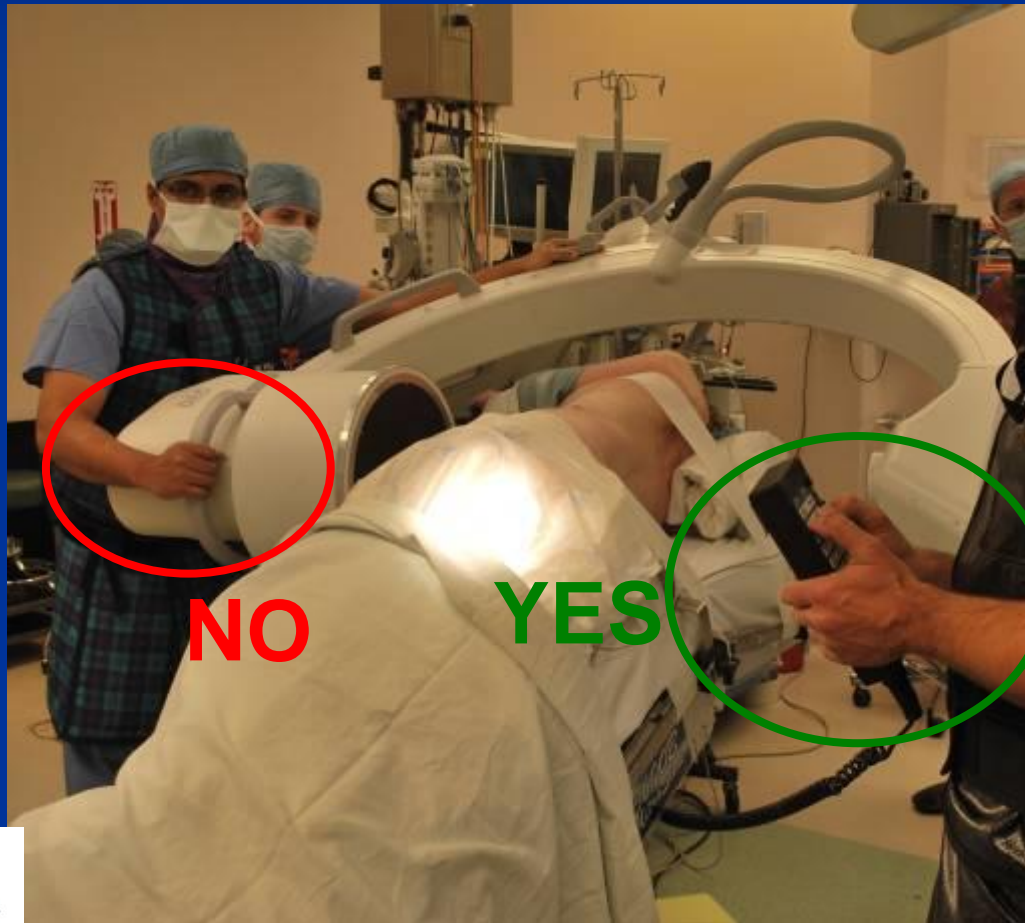


# Positioning for orthogonal x-rays

- Make the endplate orthogonal to the wall!
- Move the bed NOT the fluoro
- Get true AP and lateral with fluoroscopy at 0 and 90 deg
  - Spinous processes at midline
  - Pedicles equal bilaterally
- Goal is to position so that you can operate in the trajectory perpendicular to floor
- In multi-level cases, readjust table for perfect image at each level



**Pearl: Move table (not c-arm) for orthogonal x-rays. Keep beam parallel to floor.**





# Second c-arm – Optional



Second c-arm  
projection is  
parallel to walls



THE **SPINE**  
**CENTER** at

BONE & JOINT CLINIC  
OF BATON ROUGE

THE **SPINE**  
**CENTER** at

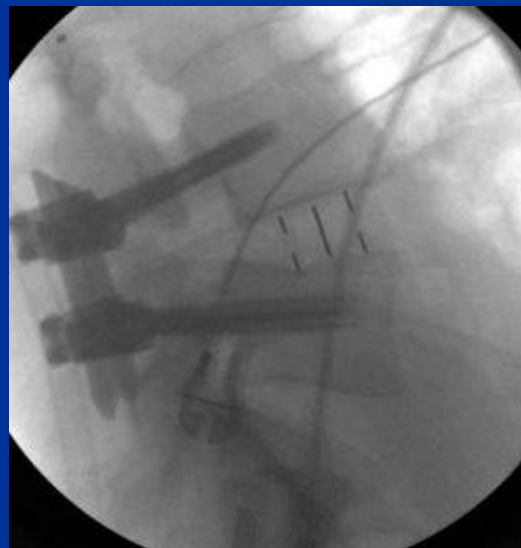
BONE & JOINT CLINIC  
OF BATON ROUGE

# Pearl; fluoroscopy management

- Make it easy for the tech (to NOT screw it up)
  - Do not move cross table (AP) c-arm
  - Drive lateral c-arm in and out of field on **tape “runway”**





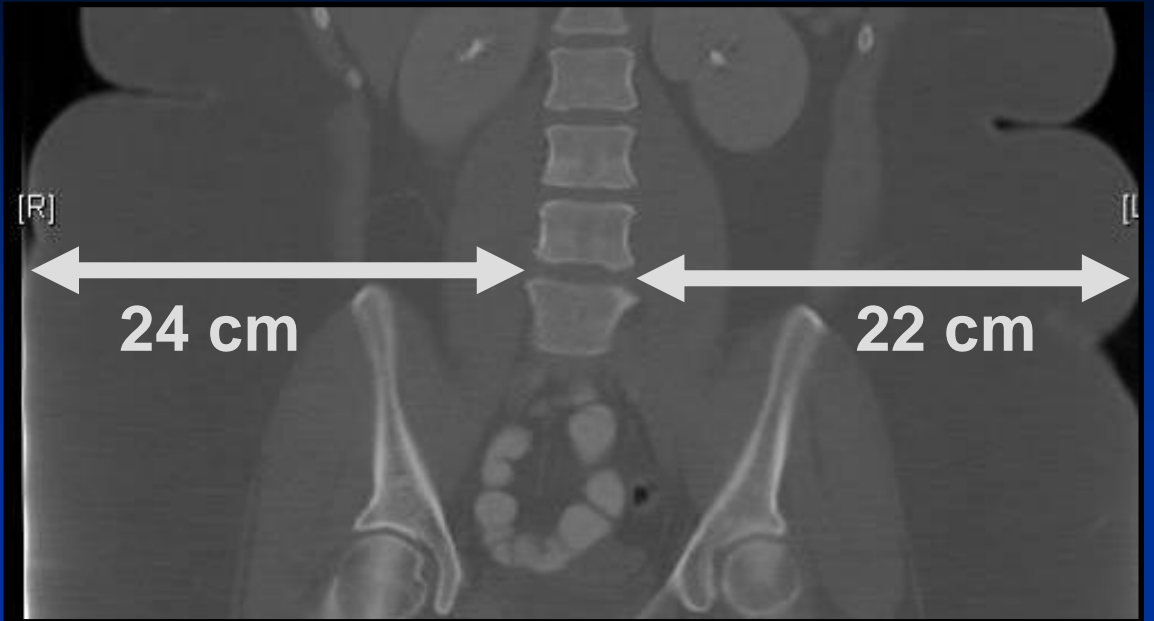
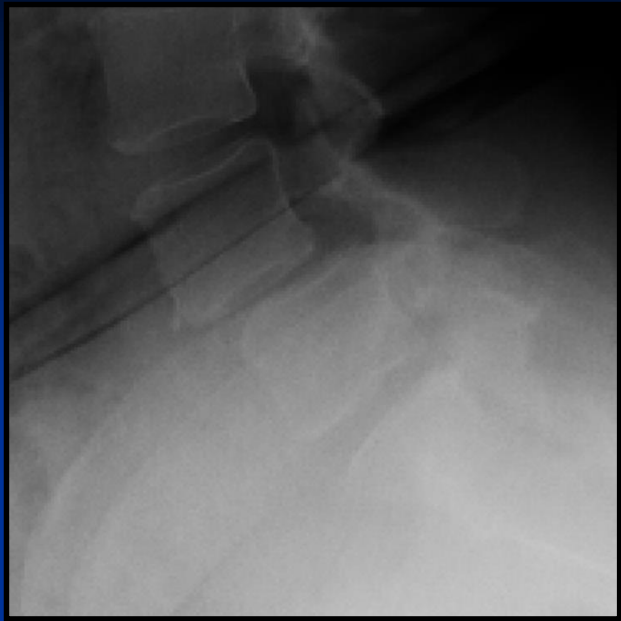




# Pearl: consider this procedure in obese patients

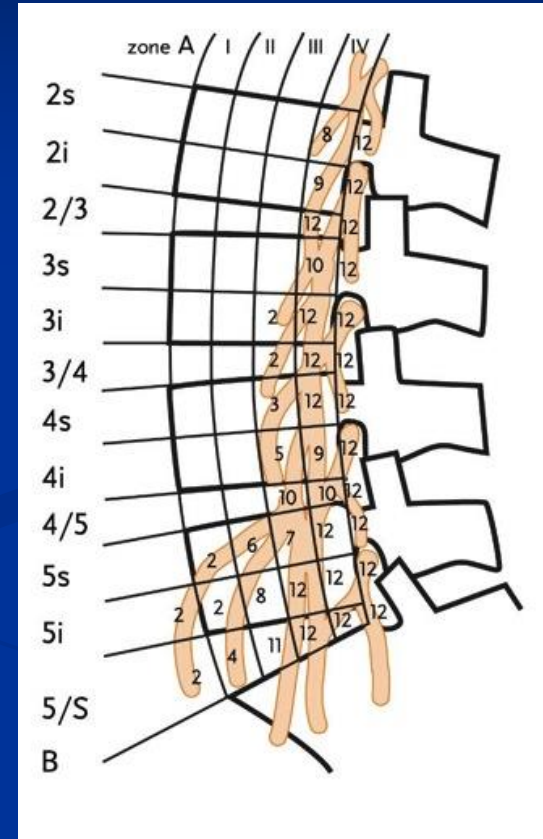
- In lateral position, the abdominal and peritoneal fat fall anterior
- The trans-psoas procedure is not much different (or harder) in obese patients
- Longer tube / portal



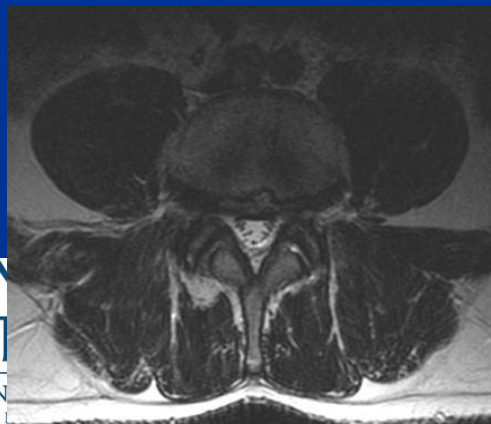


# Nerve Injury Avoidance Pearls: **Pre-op**

- Consider risk of encountering nerve based on
  - Disk level
  - Anterior or Posterior passage through psoas
  - Psoas size, position, shape
    - Beware the Mickey Mouse Sign

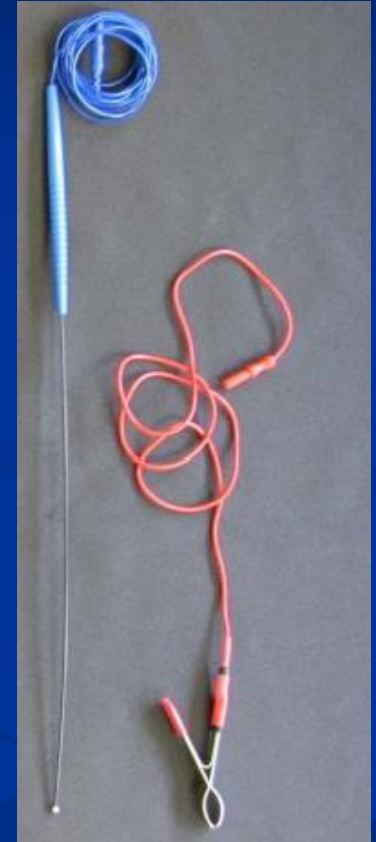


Moro et al, Spine 28, 2003



# Nerve Injury Avoidance Pearls: **Intra-op**

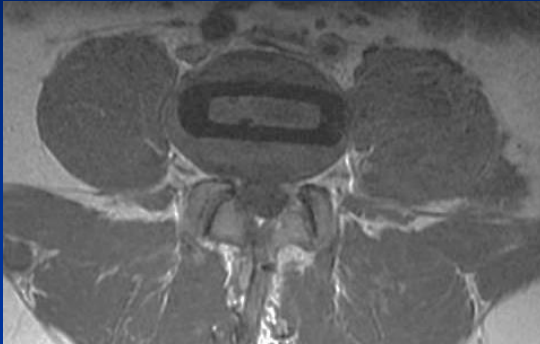
- Use REAL neuro-monitoring
  - Experienced and familiar technician
  - Cremaster leads
    - **Two** alerts so far...
  - Redundant femoral nerve monitoring
    - **Two** compelling examples so far...
- Pearls:
  - IONM stimulation inside and outside retractor
  - Get a true positive!
- Consider **tcMEP**
  - Hypothesis: *prolonged* retraction / compression of plexus nerve has an adverse effect.
  - I have **three** true positive MEP alerts so far (with no EMG changes)... all in longer cases...





# Neurological complication Case 1 (of 3)

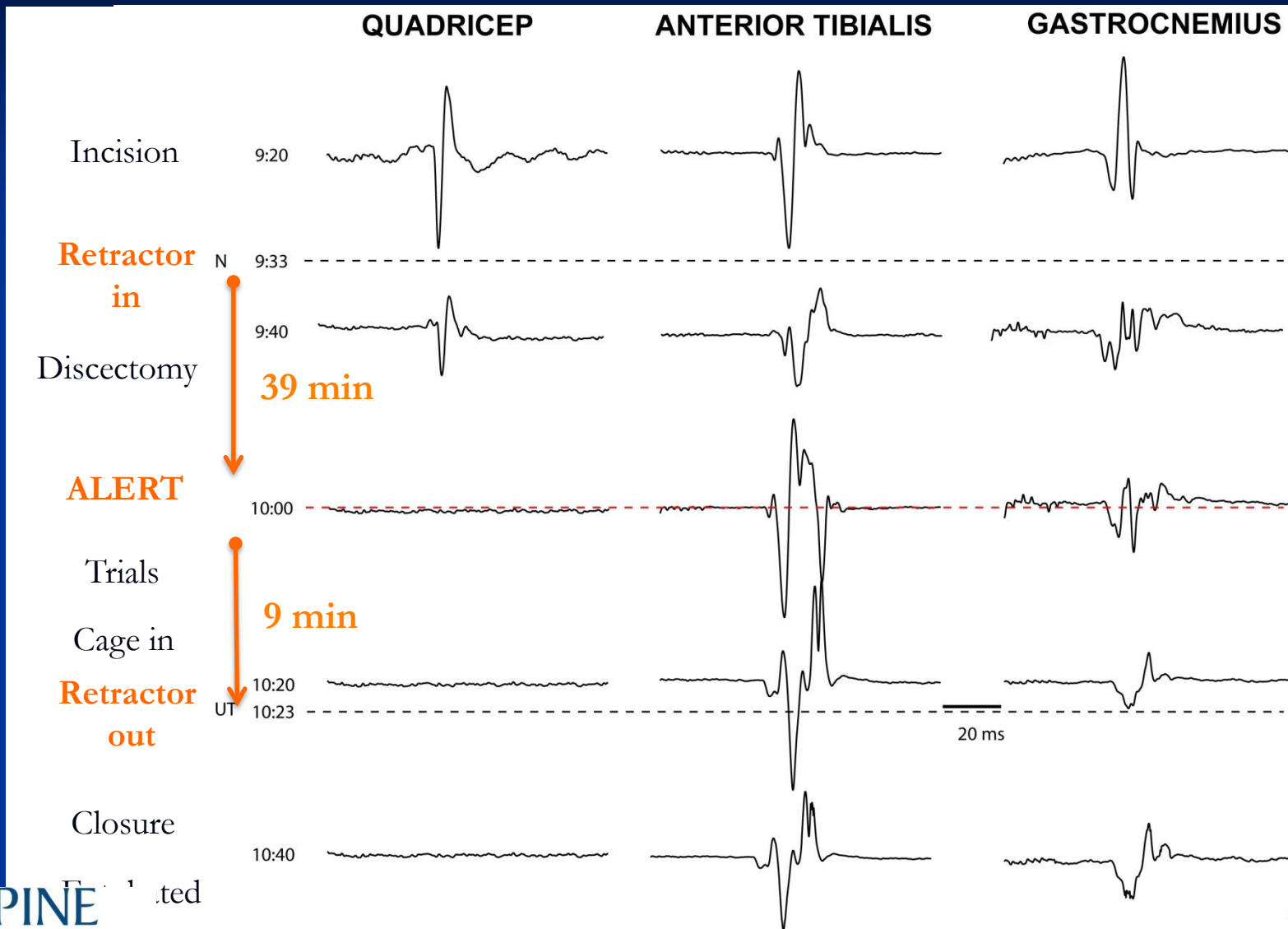
- 40 yo male with 2 prior L4/5 decompressions
- Lost MEP during trans-psoas surgery
  - Quad 3/5 at extubation
  - MRI looked okay...
- Did posterior decompression, fusion subsequently.



# Case 1

## TcMEP

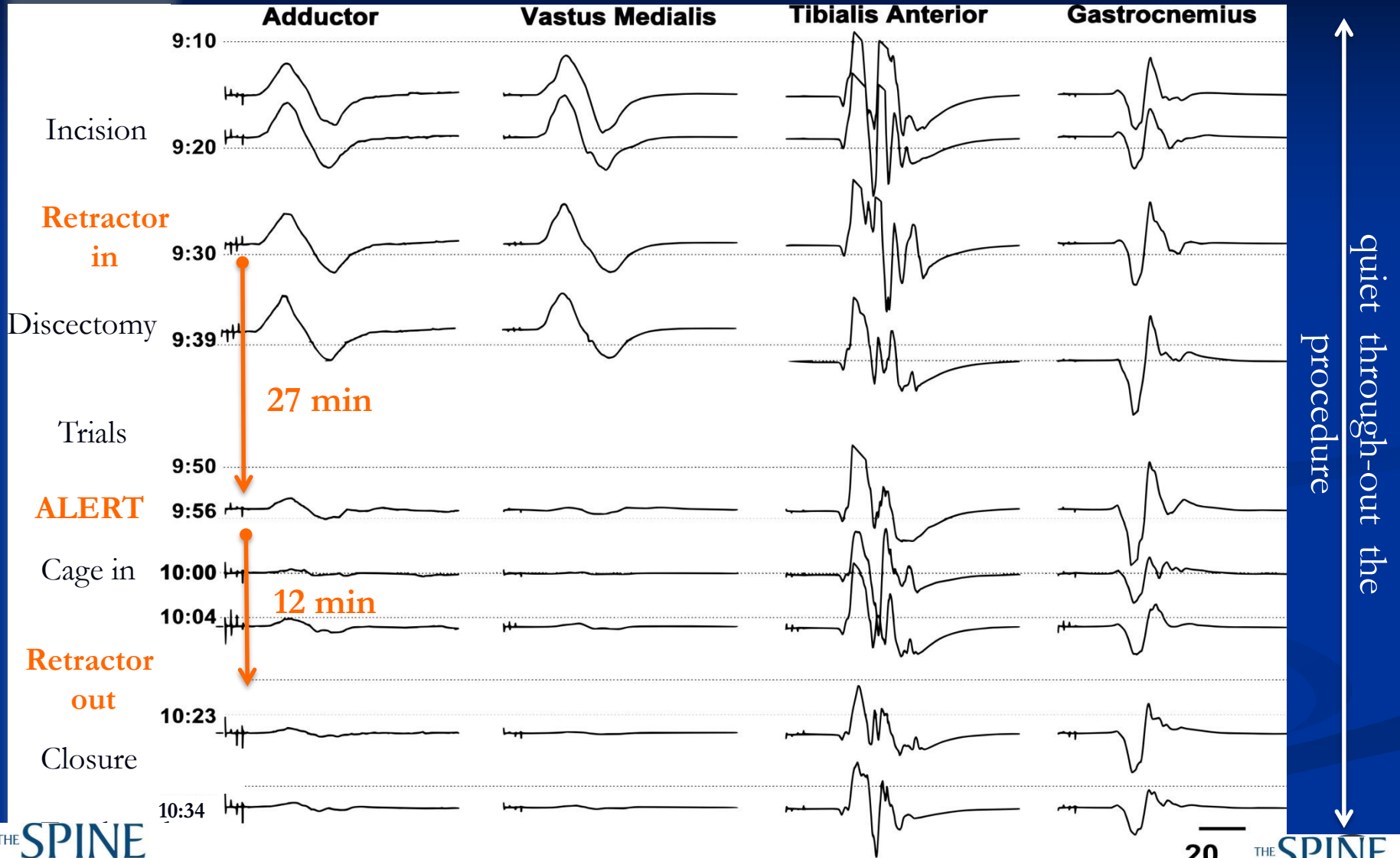
## EMG



# Case 2

# TcMEP

# EMG

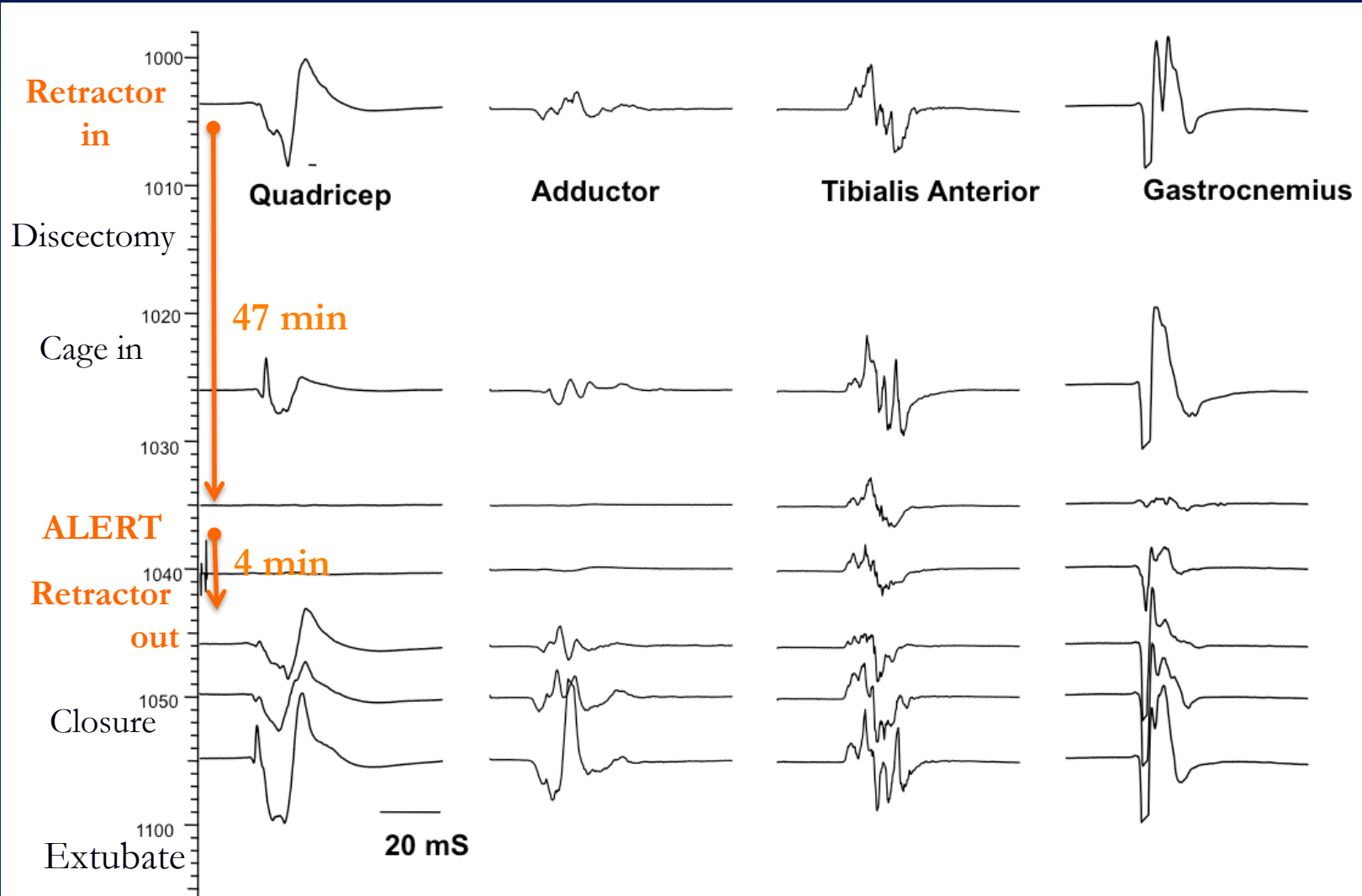




# Case 3

## TcMEP

## EMG



quiet through-out the procedure

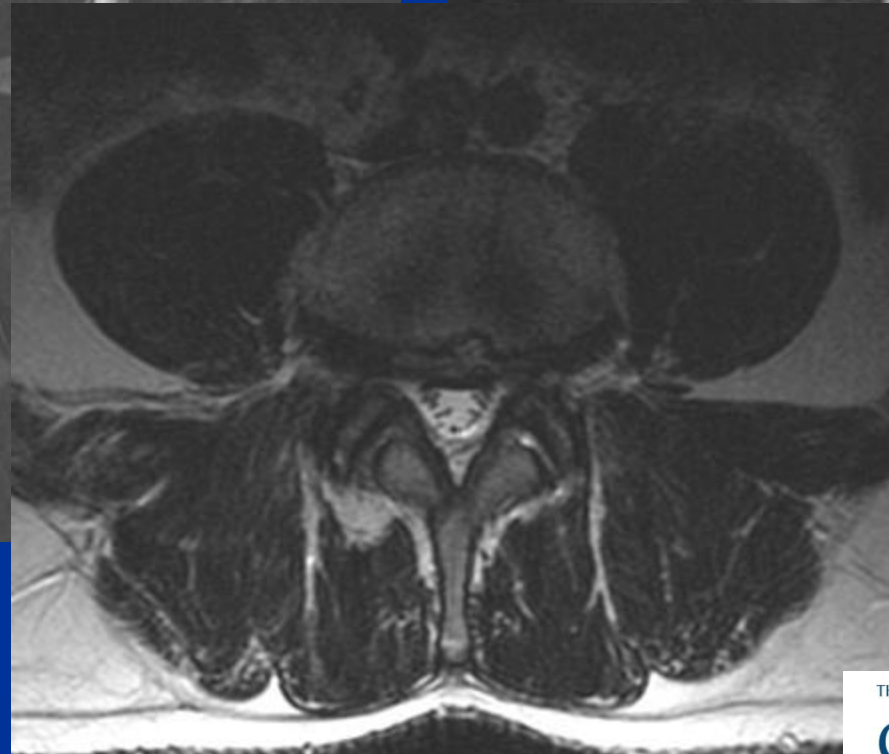
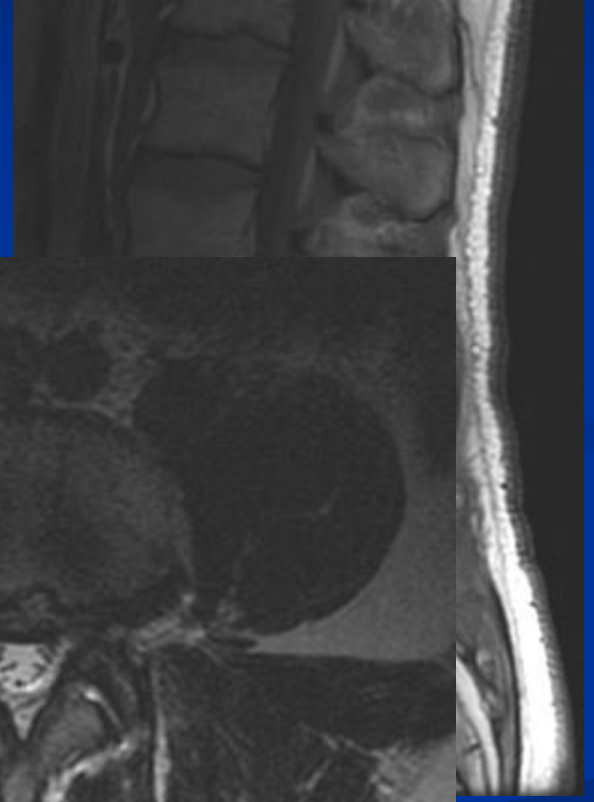
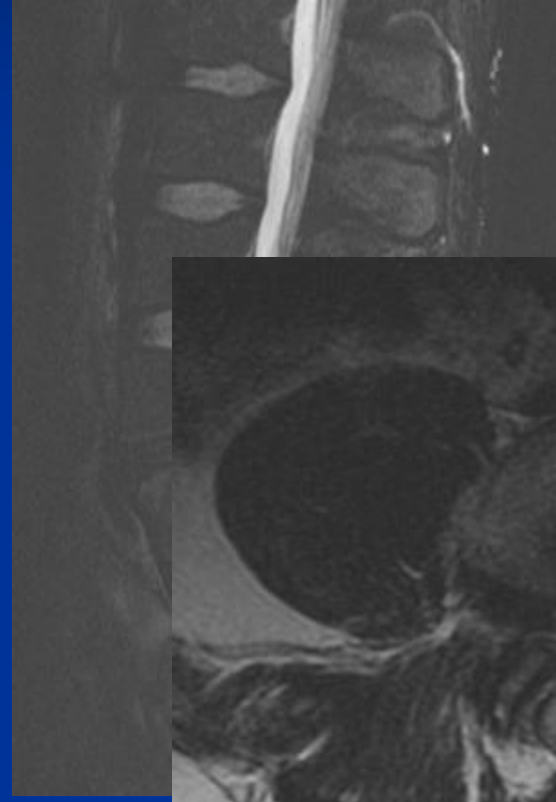
# Leg symptoms after MEP Alert

	Case 1	Case 2	Case 3
Loss of TcMEP after retractor placement	39 minutes	27 minutes	47 minutes
Removal of retractor after the initial TcMEP alert	9 minutes	12 minutes	4 minutes
Post-op Motor deficit	Psoas 4/5 Quads 3/5	Psoas 4/5 Quads 2/5	None
Sensory symptoms	Ant. thigh numbness	Ant. thigh numbness	Ant. thigh pain and numbness
Outcome of deficits	Psoas 5/5 (6w) <b>Quad 5/5 (7d)</b> Numbness + (6m)	Psoas 5/5 (3m) <b>Quad 5/5 (4d)</b> Numbness +(6m)	Numbness pain resolved (6w)

# Leg symptoms after MEP Alert

	Case 1	Case 2	Case 3
Loss of TcMEP after retractor placement	39 minutes	27 minutes	47 minutes
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# Case; Isthmic Spondylolisthesis

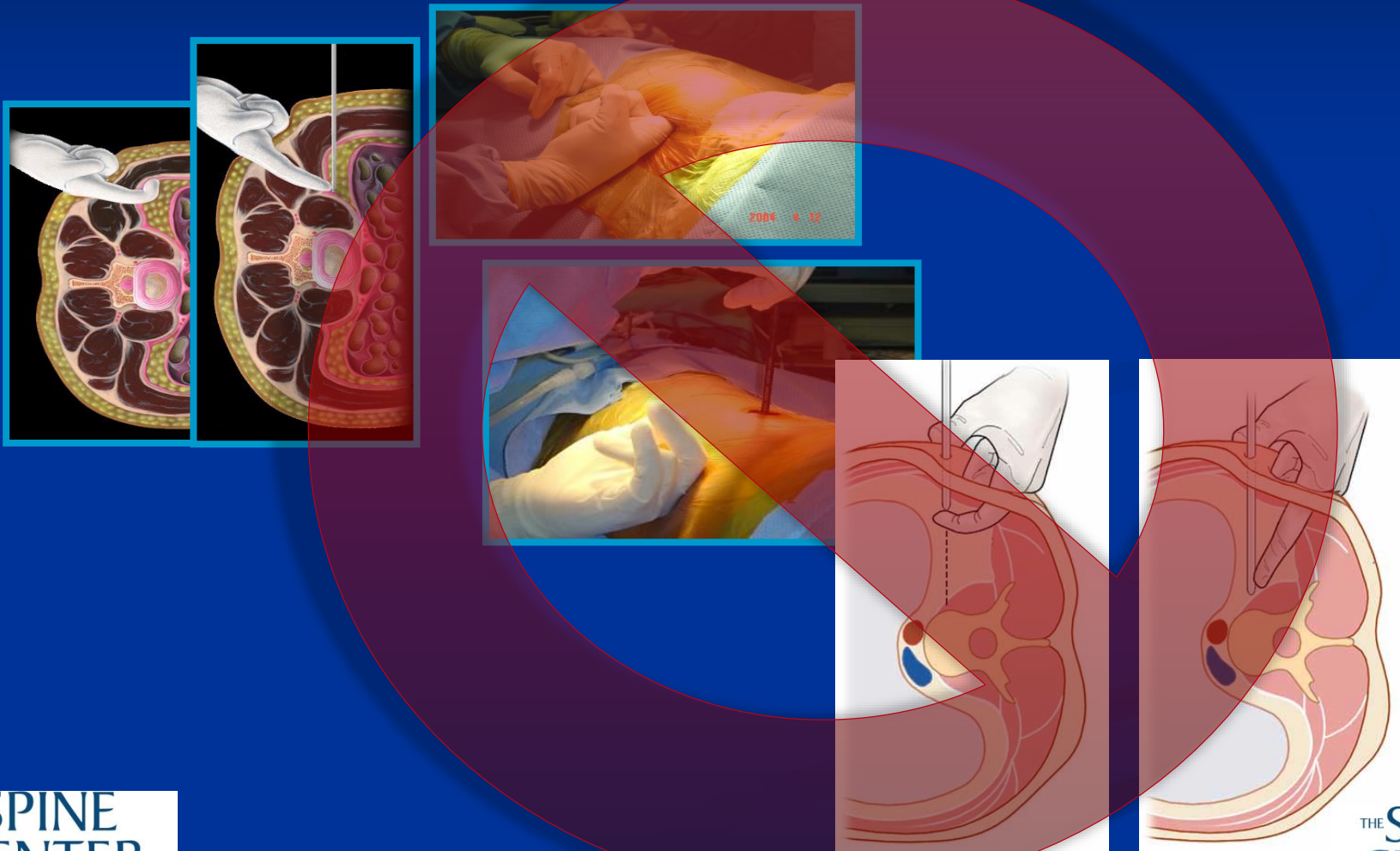




# Postop Isthmic Spondylolisthesis

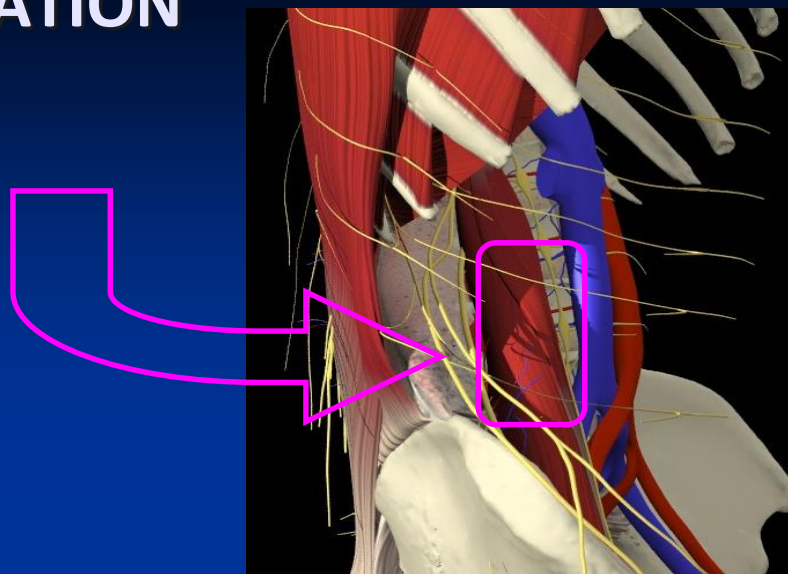


# Two Incision Method Approach by feel and fluoroscopy



# Pearl; use DIRECT VISUALIZATION

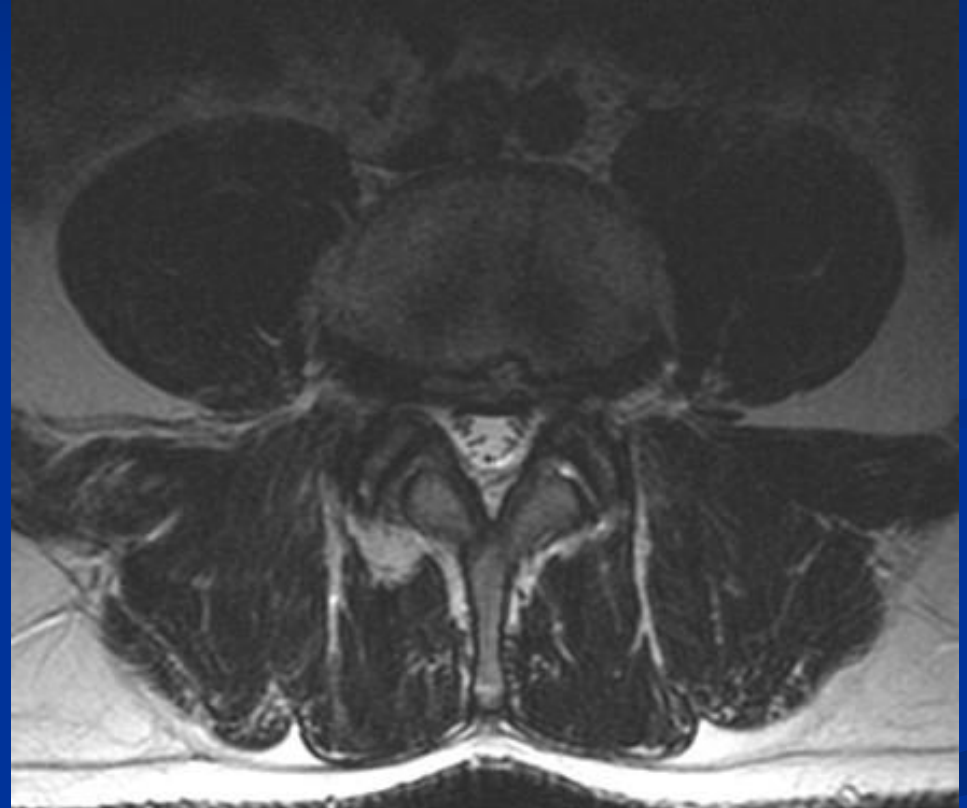
- Split muscle layers under direct visualization:
  - External Oblique
  - Internal Oblique
  - Transversalis
- See the retroperitoneal fat
- Sweep posterior to anterior:
  1. Quadratus Lumborum
  2. Transverse Process
  3. Psoas
- Look around - **visualize**:
  - Psoas shape and position
  - Vessels?
  - Ureter?
  - Genito-femoral nerve?





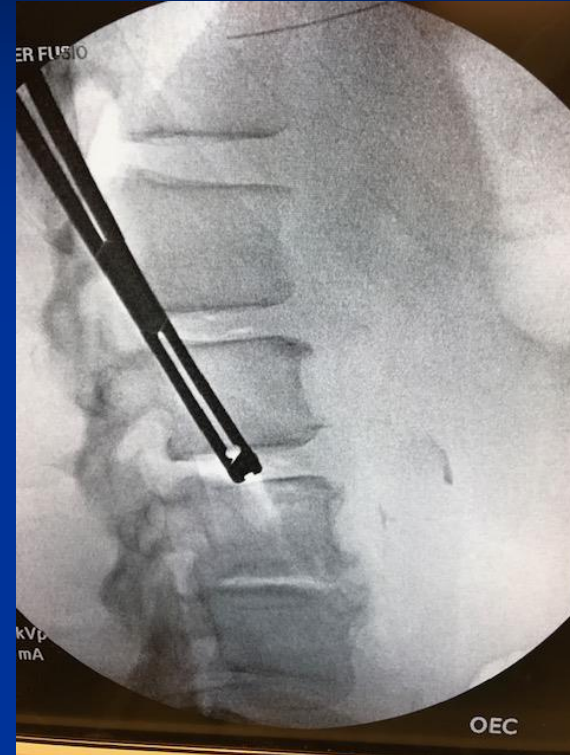
# Pearl: direct visualization

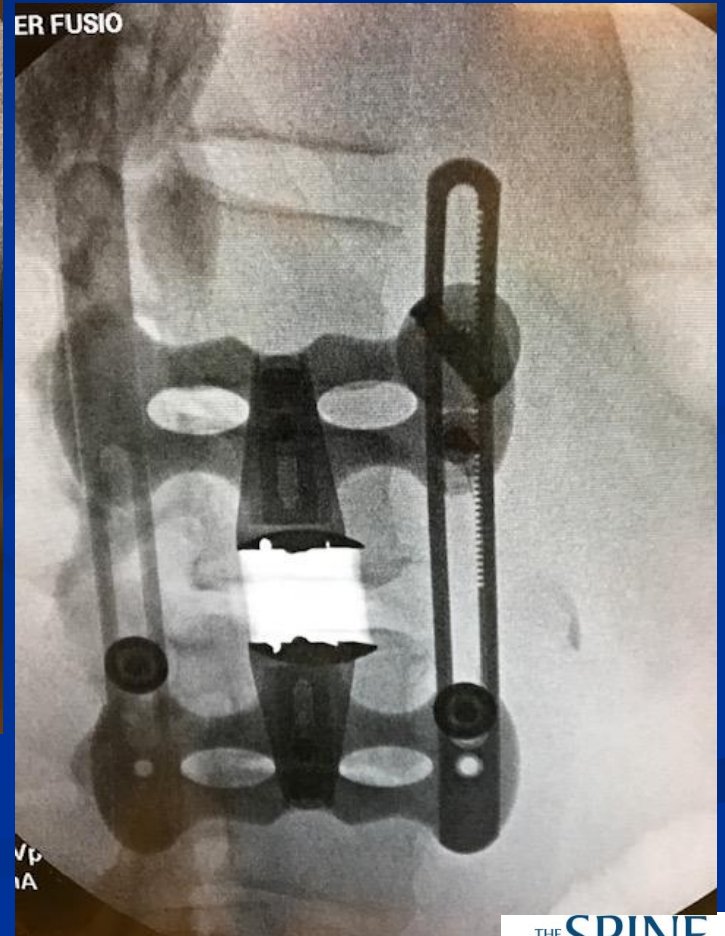
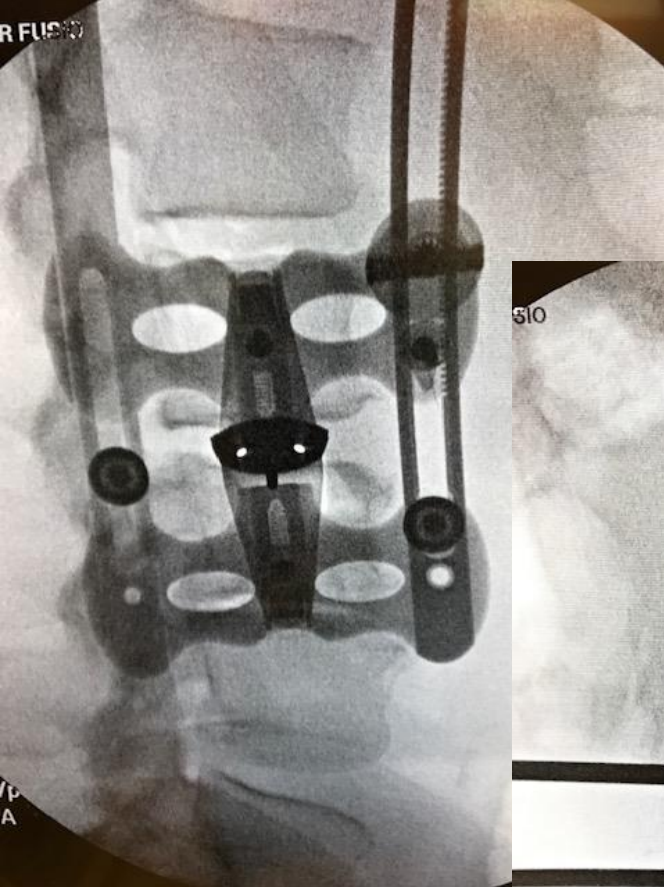
- Use two large Wiley vein retractors to inspect retroperitoneal space
- Ensure that no peritoneum is overlying psoas
- Find ureter, GF nerve if possible
- Observe psoas surface, select the correct point to enter muscle
  - Recall the MRI



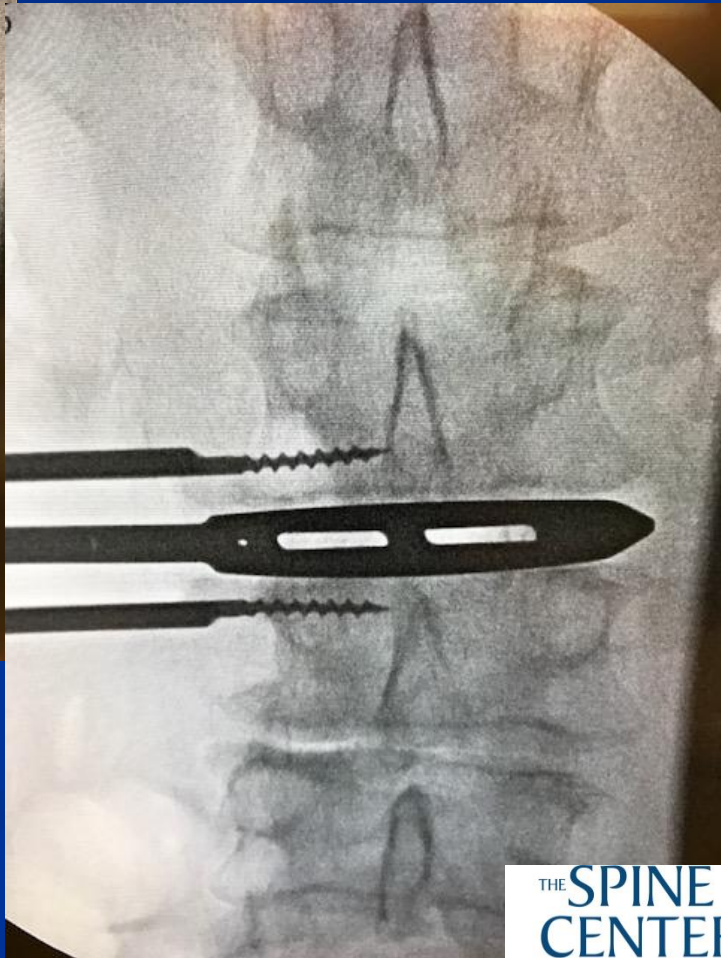
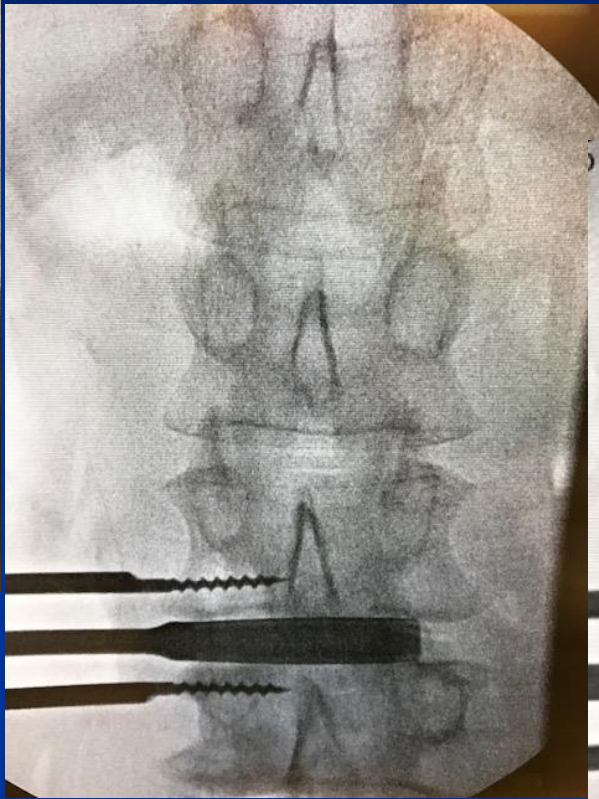
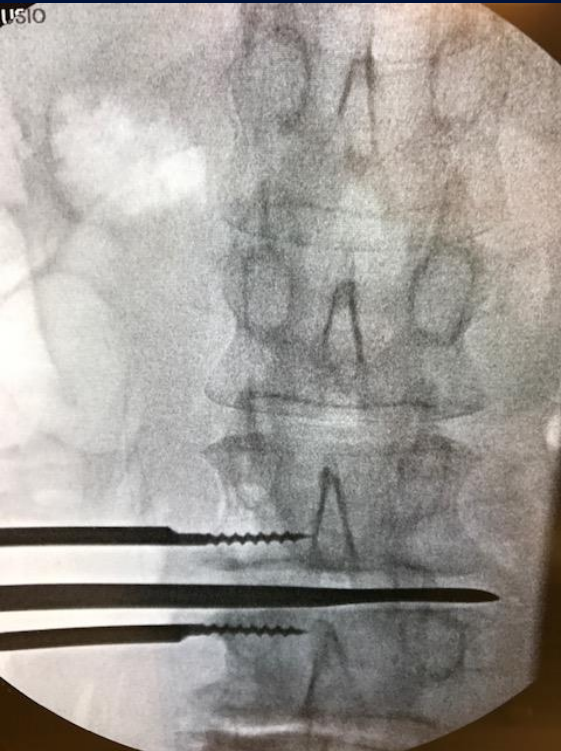


# Traverse Psoas with flouro after direct visualization

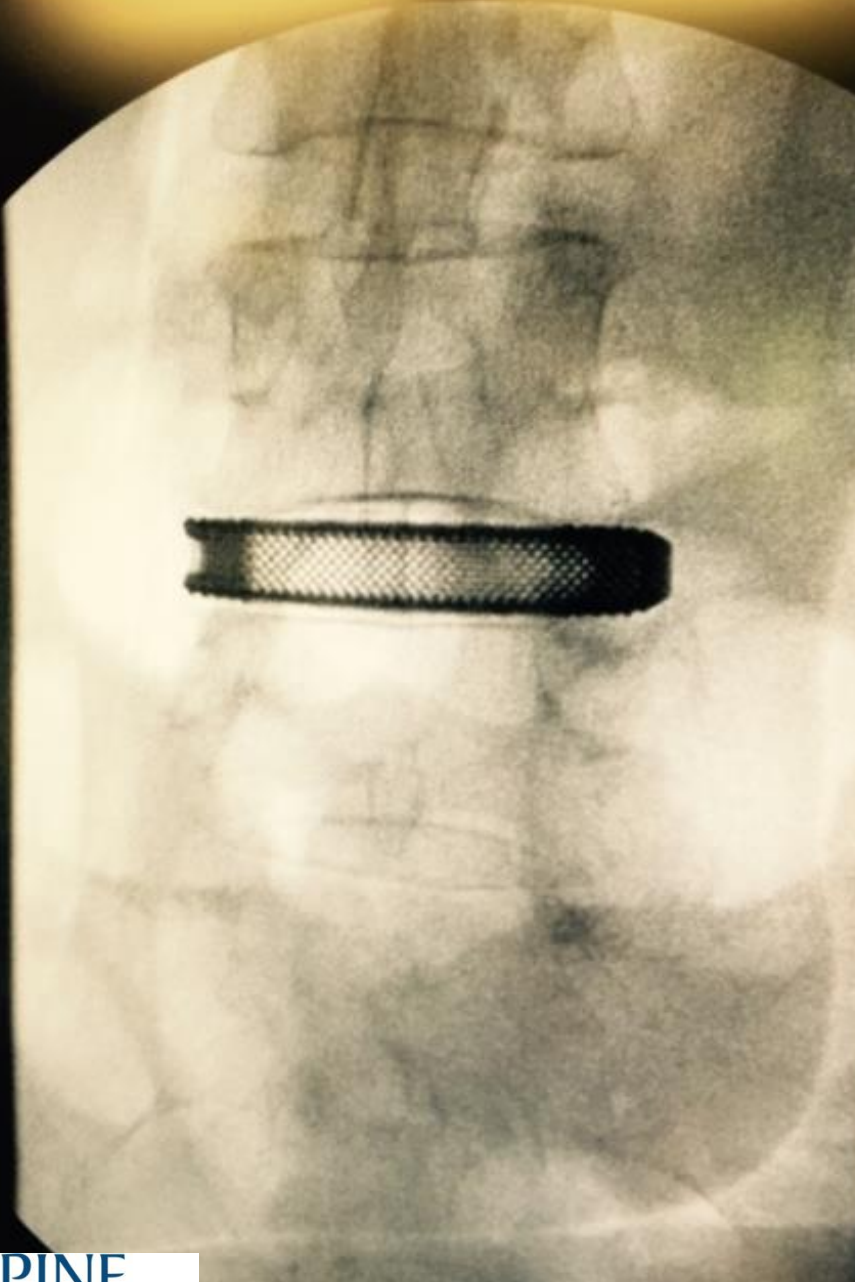








ALIF



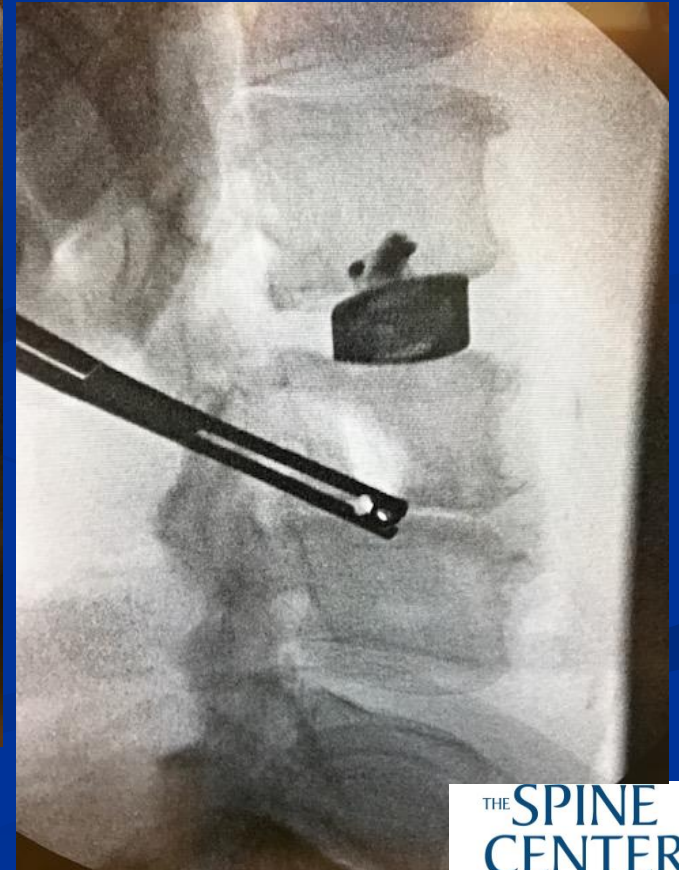
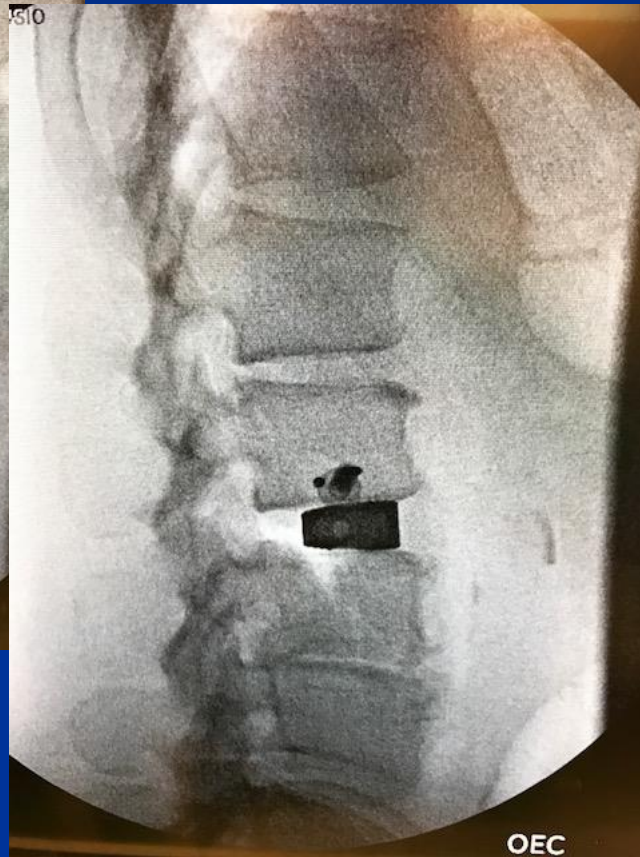
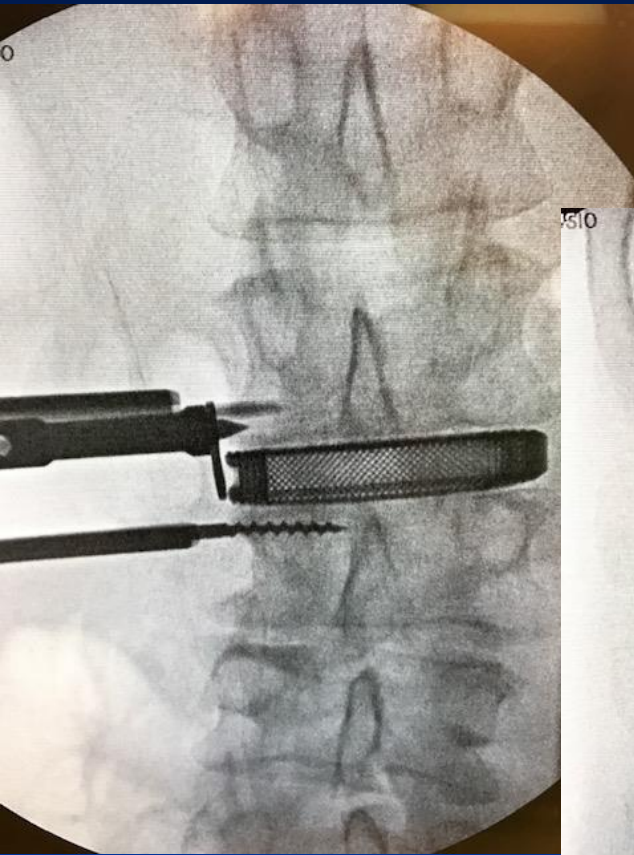
THE SPINE  
CENTER<sup>at</sup>

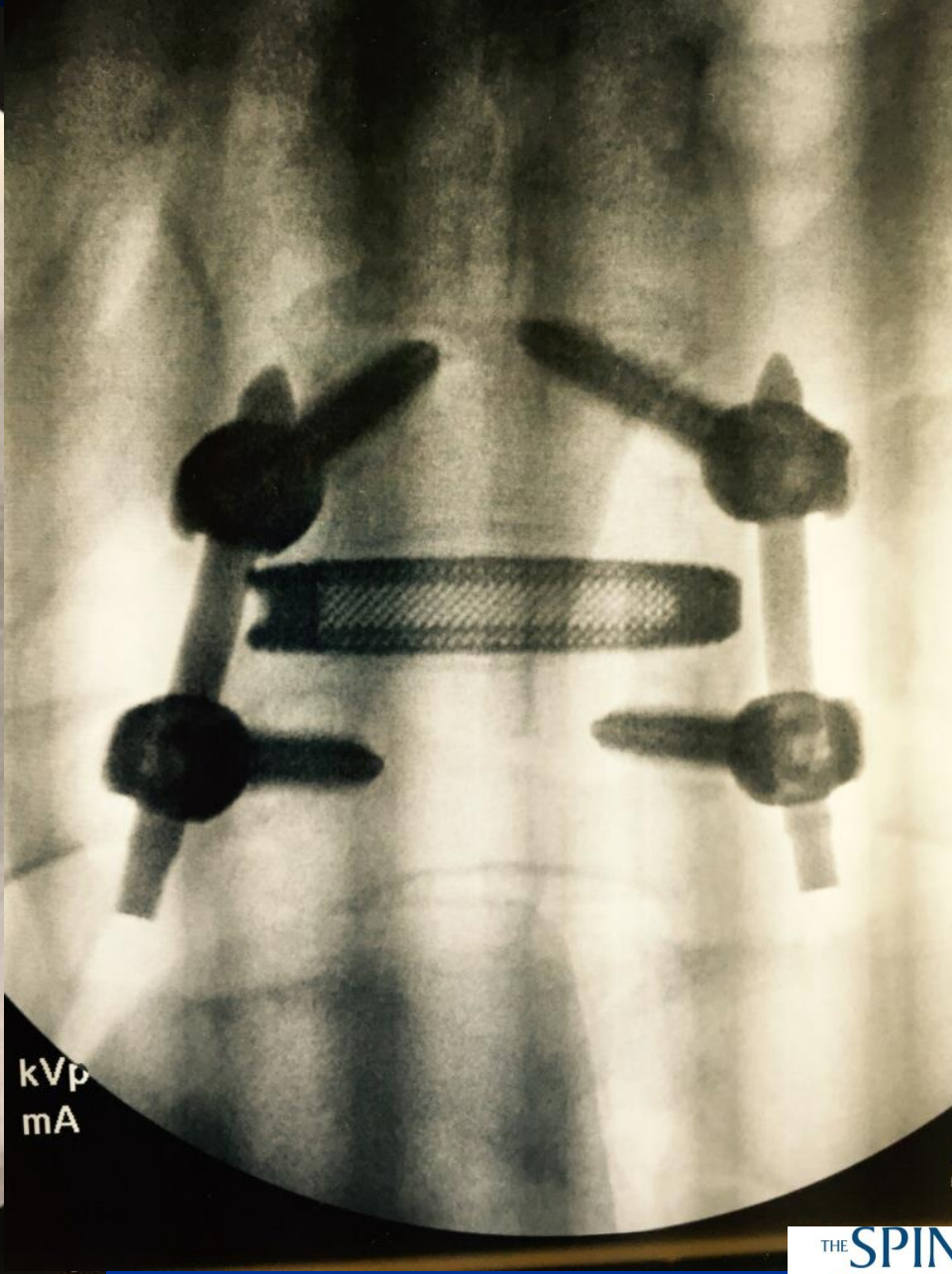
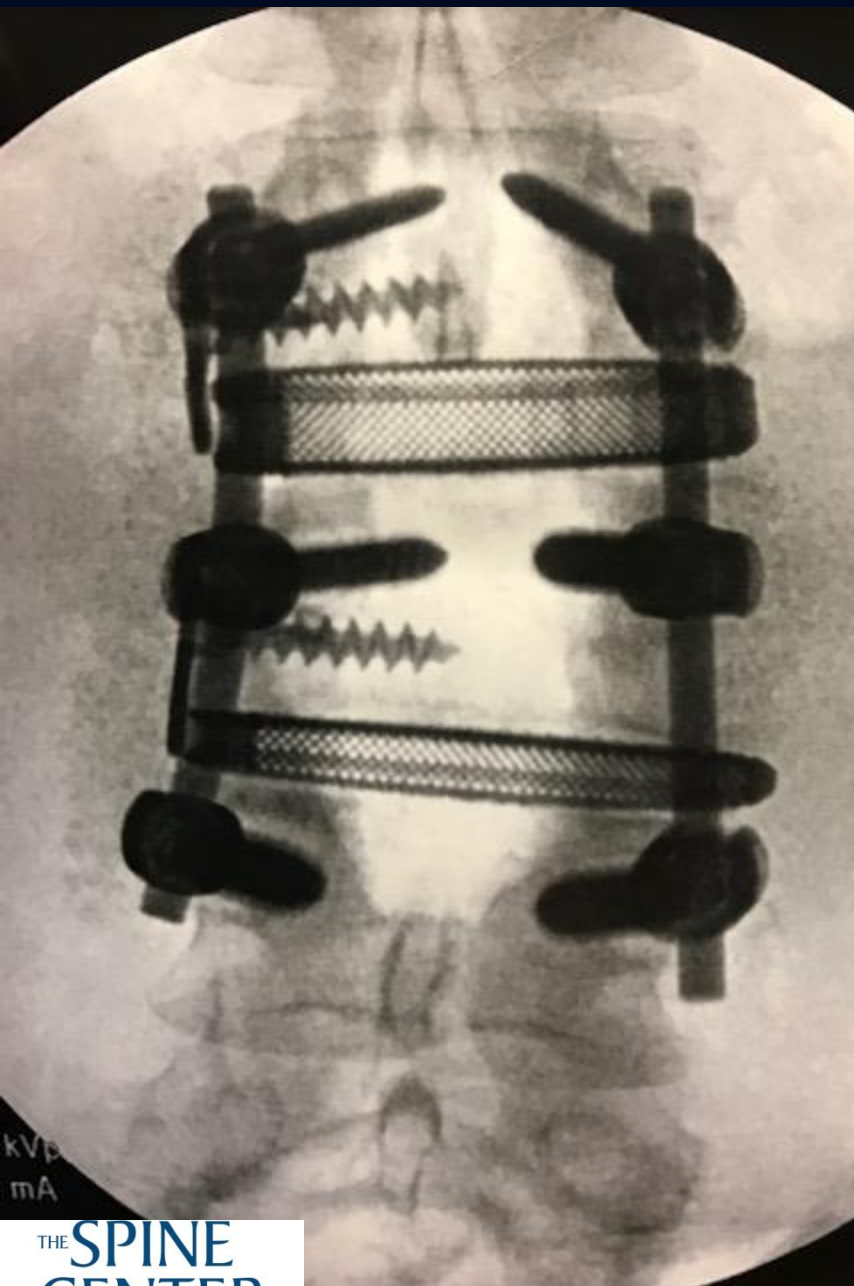
BONE & JOINT CLINIC  
OF BATON ROUGE

THE SPINE  
CENTER<sup>at</sup>

BONE & JOINT CLINIC  
OF BATON ROUGE



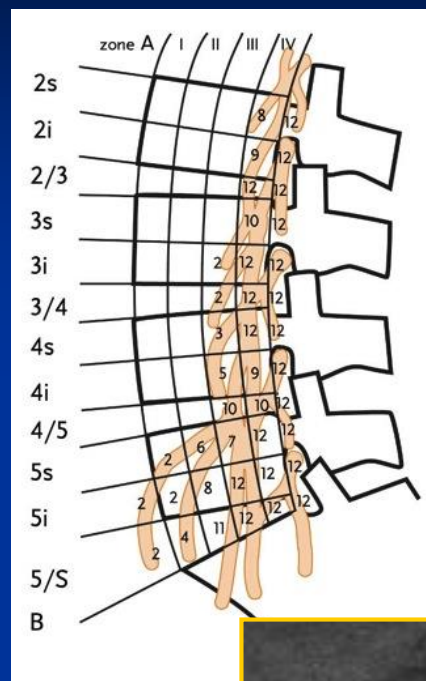






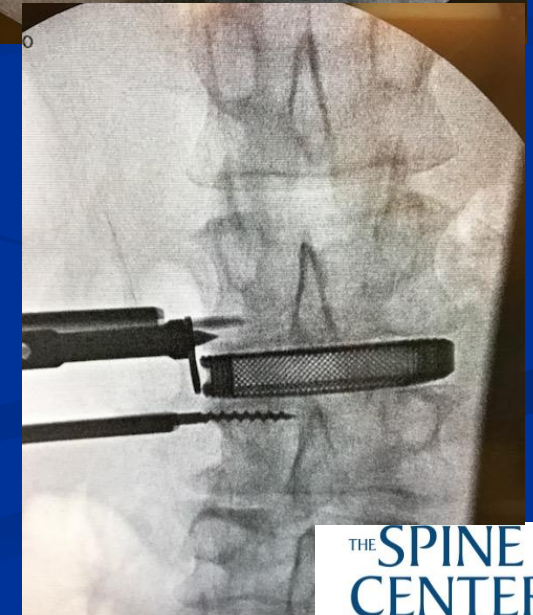
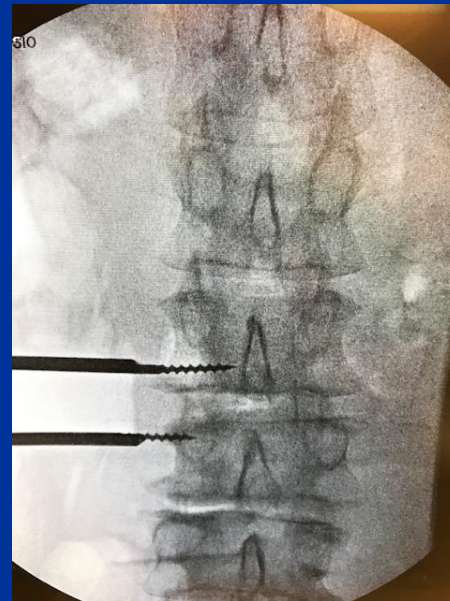
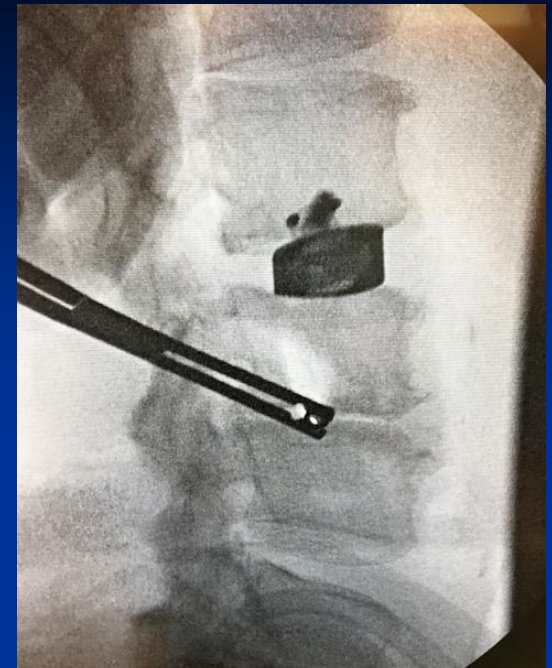
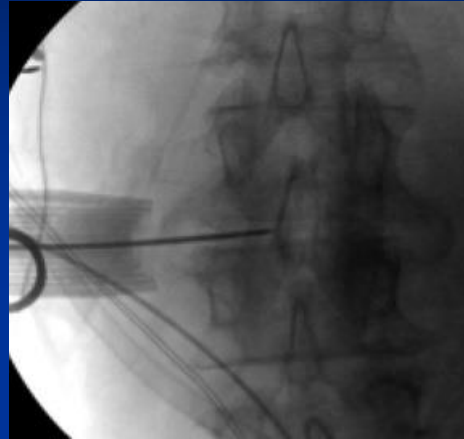
# Pearl: Access disk anterior to mid-body

- More anterior portal / approach may be associated with
- Traversing less psoas (less muscle injury, hematoma)
- Better nerve avoidance
- Lower risk of iatrogenic compressive neuropathy from retractor
- Better lordosis (but worse foramen height restoration)



# Retractor pearls

- Patient Mounted
- Parallel Bladed
- Use osseous fixation with screw if possible
- “Least open”
- Remove one pin for buttress/plating



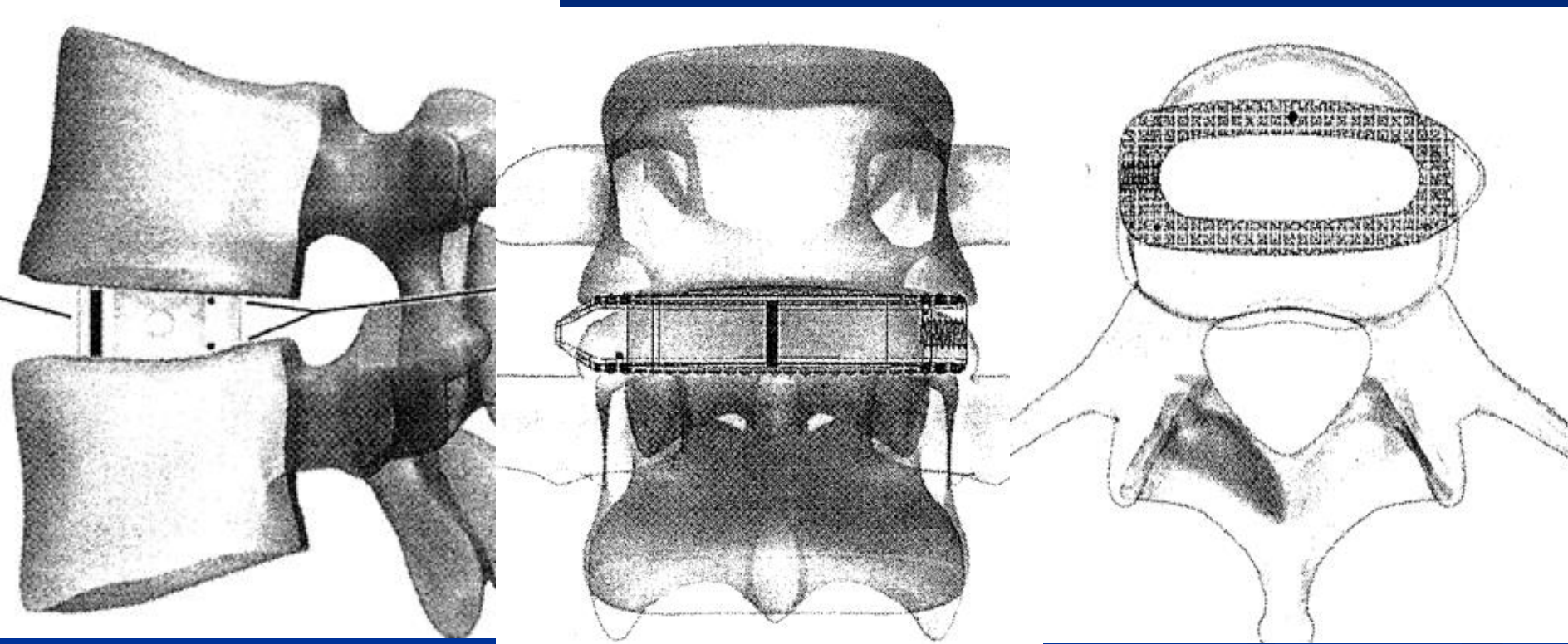


# Pearl; perform balanced release

- Annulotomy contralateral to approach side should match ipsilateral

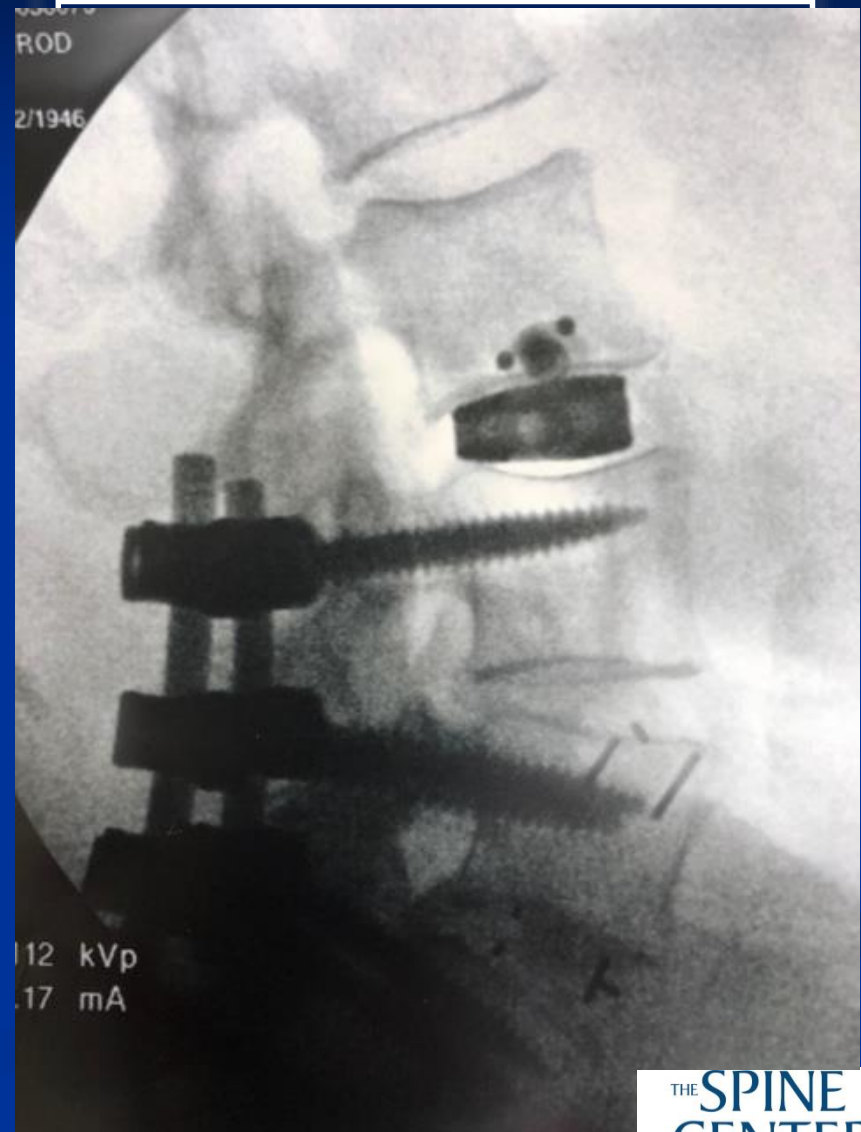


# Pearl; use interbody implant with shape that favors stability



# Pearl: use wide implants when possible

- 18 mm is typical AP dimension
- 22 mm AP dimension may be associated with lower risk of subsidence (Pimenta, 2011)
- This is especially critical when relying on interbody restoration to provide indirect neurological decompression and or deformity correction
- Wide implant may not be applicable with significant listhesis ( $>$  grade 1)

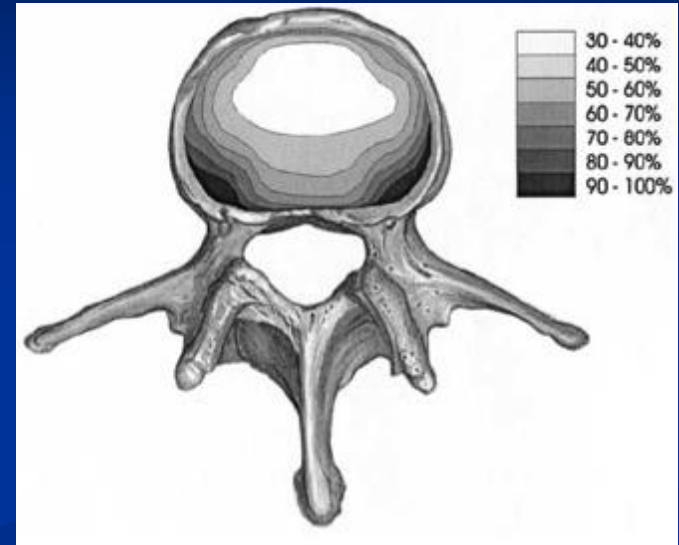


# Implant size selection and location: where is the good bone?

Structural bone is on ring  
apophysis and marginal  
cortex

So where would you like  
your implant?

And where does the TLE



SPINE Volume 30, Number 6, pp 638-644  
©2005, Lippincott Williams & Wilkins, Inc.

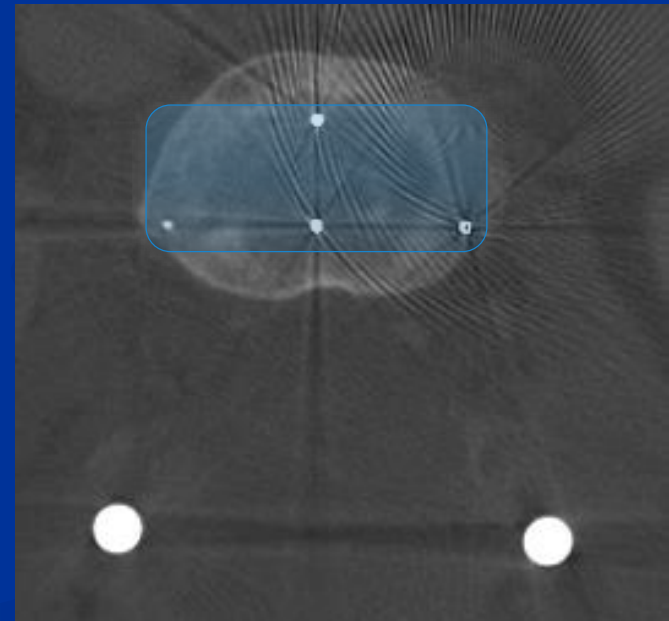
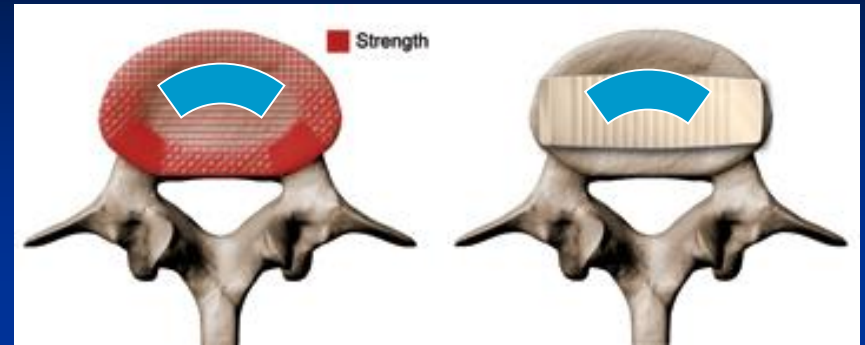
## Interbody Device Shape and Size Are Important to Strengthen the Vertebra-Implant Interface

Juay-Seng Tan, MEng,\* Christopher S. Bailey, MD, MSc(Surg), FRCSC,†  
Marcel F. Dvorak, MD, FRCSC,† Charles G. Fisher, MD, MHSc, FRCSC,† and  
Thomas R. Oxland, PhD\*†



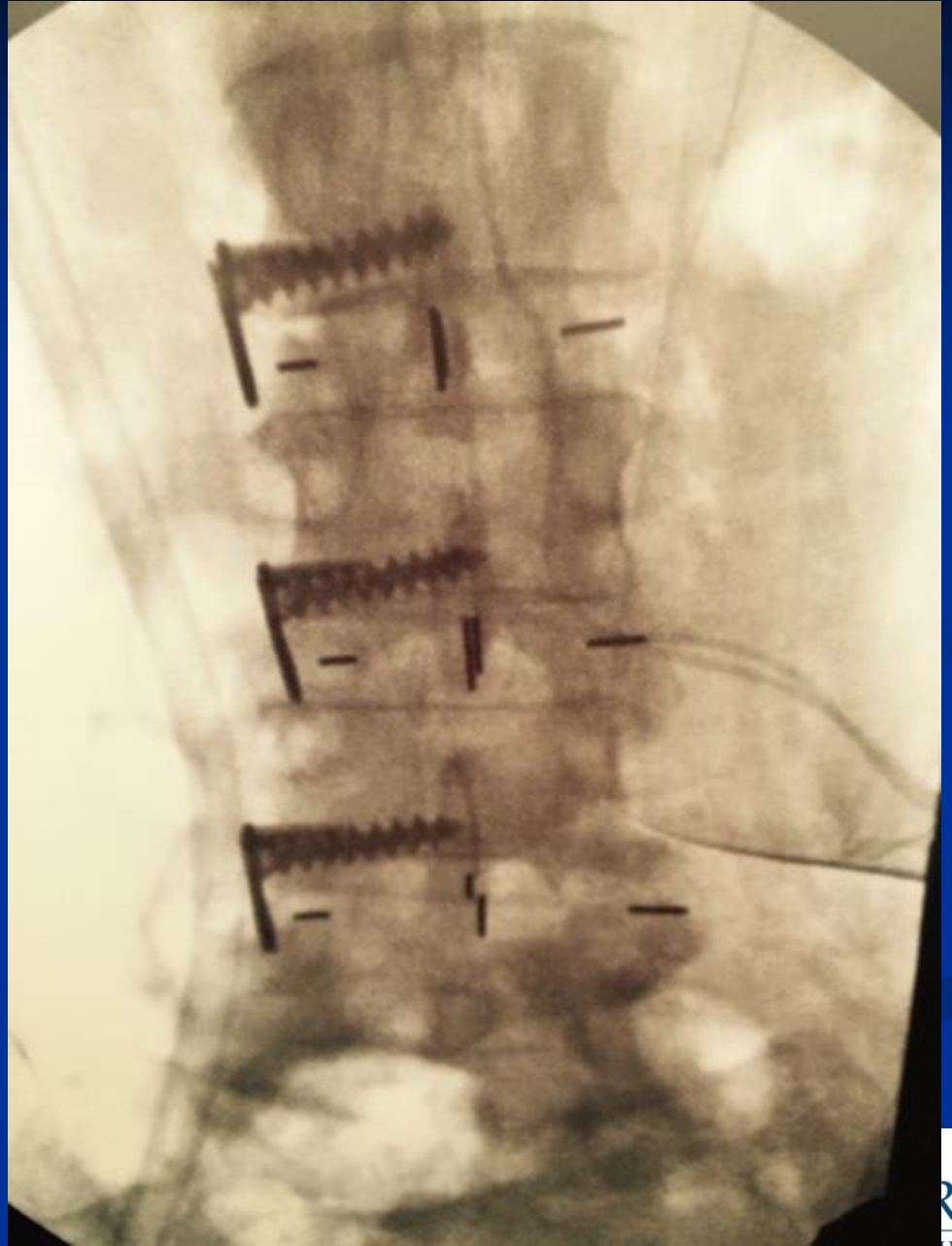
# Biomechanical Rationale

- Consider how:
  - Implant surface area
  - Implant bone interface
  - Implant internal volume
  
- Helps patients with:
  - Osteoporosis
  - Segmental deformities
  - Fusion risks

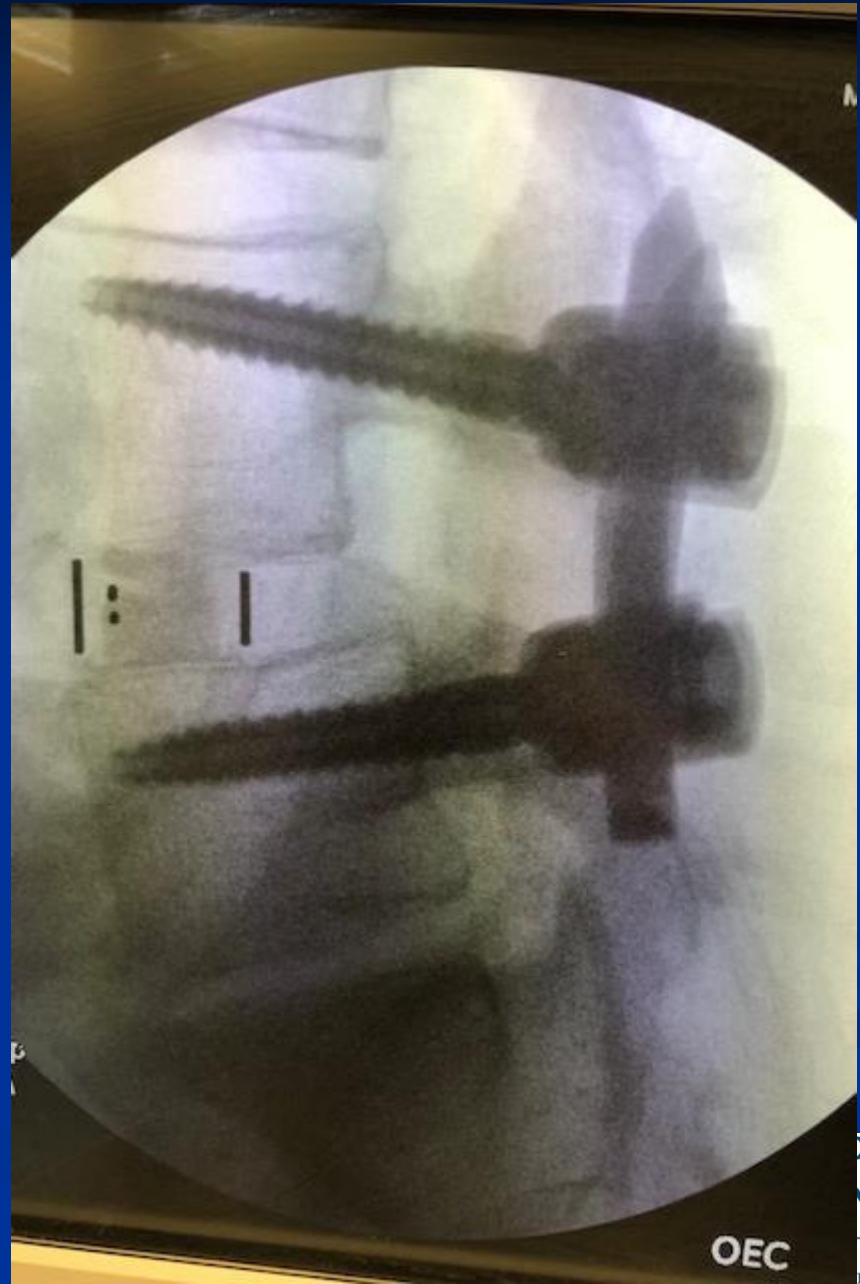


# Cases

# LDS



# Degen Spondy

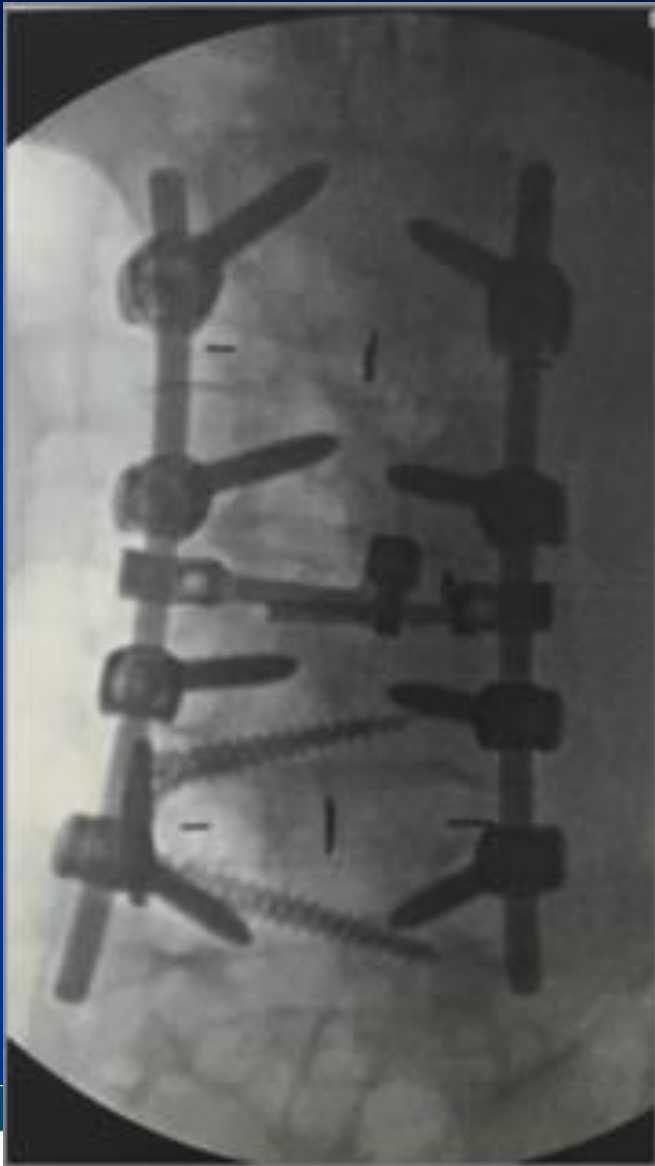




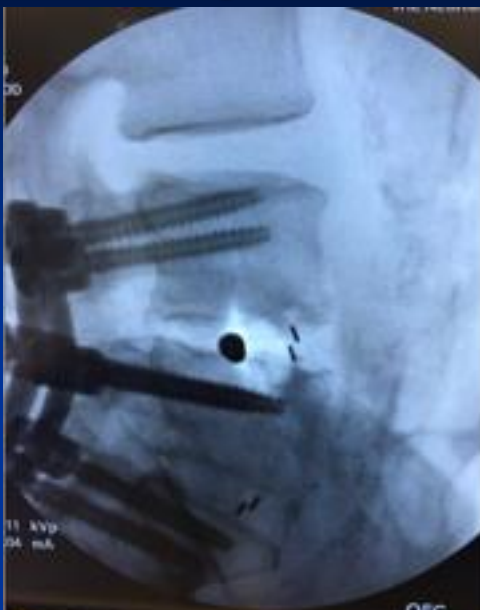
# L4-5 Pseudo s/p PLDF



# LLIF 4-5 with Plate



# 4/5 Pseudo s/p 4-1 TLIF solid 5-1 Rev 4-5 LLIF/PLDF



## Rev 4-5 LLIF/PLDF



# 4/5 MIS TLIF ... Not done well





# LLIF / MIS Post Revision



# Degen Scoli/ASD s/p 4-5 TLIF

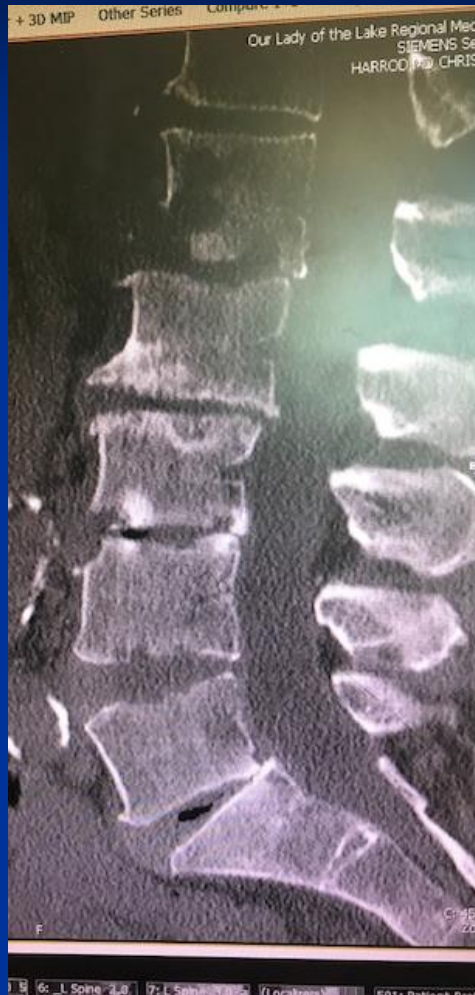


# LLIF 2-4 / ALIF 4-5 / MIS 2-5 Perc





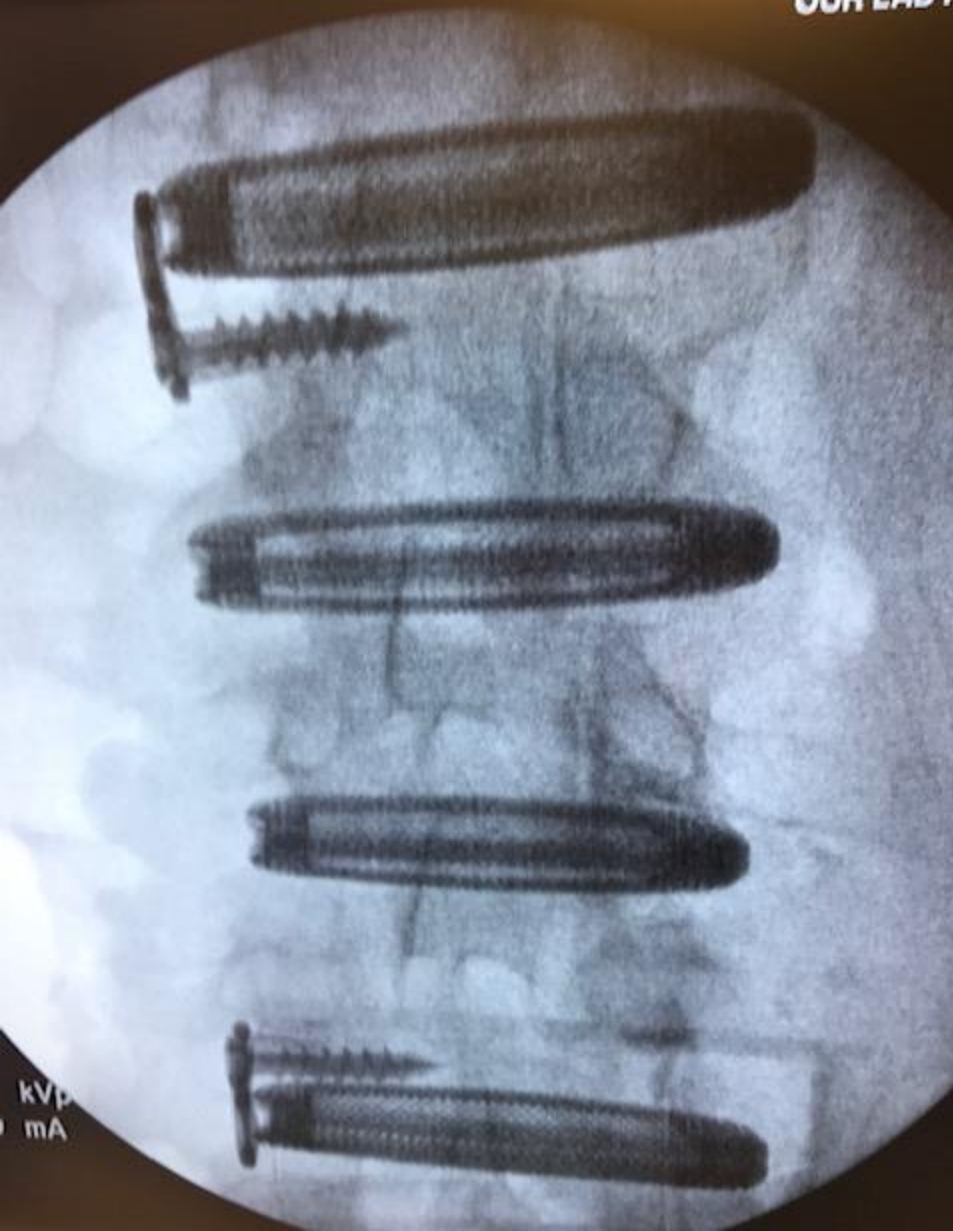
# Osteo





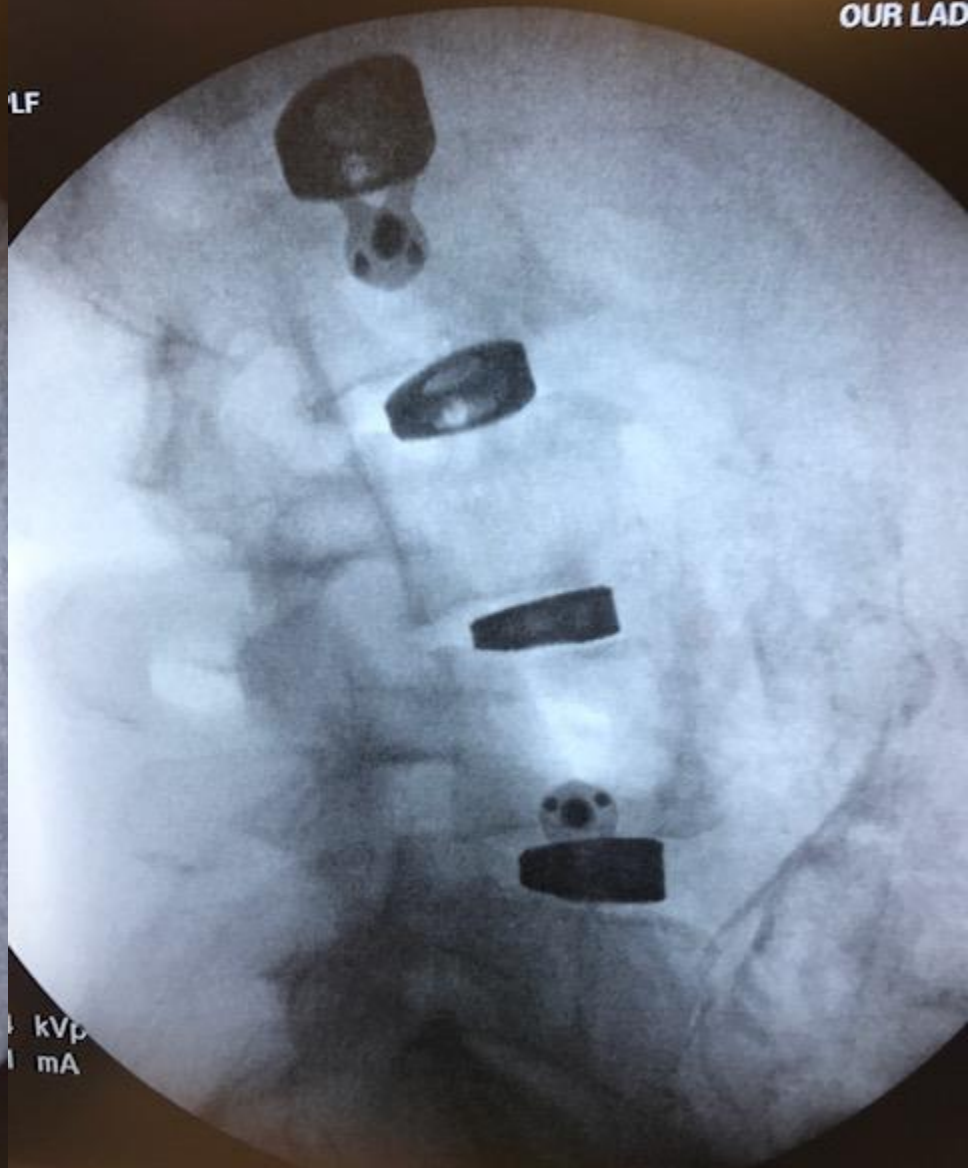
# Osteo

OUR LADY



LF

OUR LADY



kVp  
mA

# Osteo





# Osteo – Combined ALIF-LLIF-MIS to Pelvis



# TRAUMA





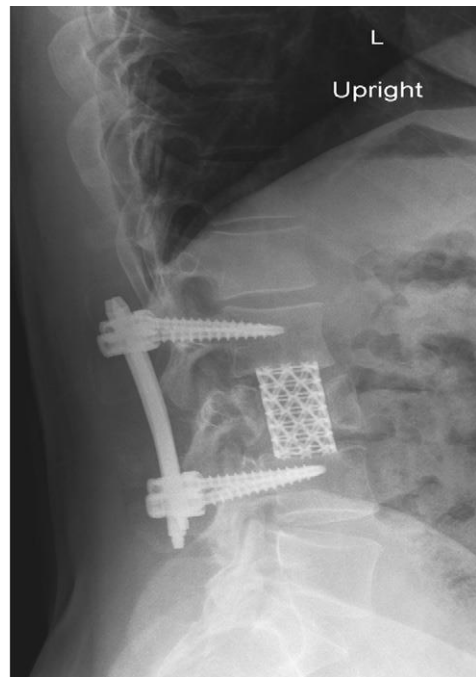
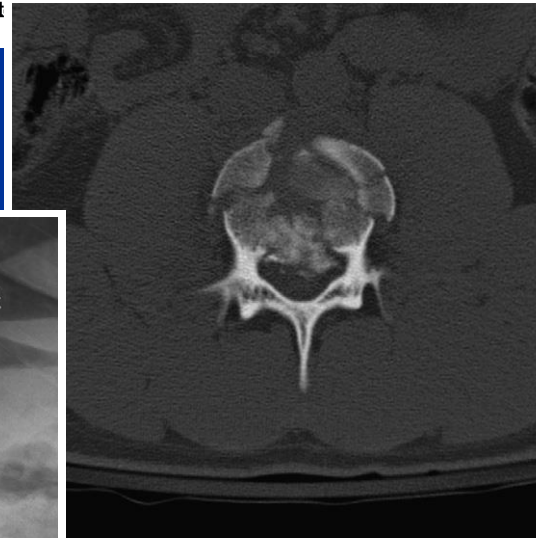
Case Report

# Minimally invasive corpectomy and posterior stabilization for lumbar burst fracture

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Received 5 October 2010; revised 6 March 2011; accept





The Spine Journal 11 (2011) 909–911

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Commentary

## Commentary: “Minimally invasive corpectomy and posterior stabilization for lumbar burst fracture”

Eric Truumees, MD\*

Eck and collaborators are to be congratulated for detailing an elegant treatment approach to thoracolumbar burst fractures in their “Minimally invasive corpectomy and posterior stabilization for lumbar burst fracture” case report [1]. Although satisfying, their report leaves us with questions that these authors (and the hundreds of contributors before them) have been unable to answer. Some of these questions include:

- What is an “unstable” burst fracture?
- What are the indications for surgery in this patient population?
- When is an anterior approach really necessary?
- What are the downsides of a trial of brace management in the neurologically intact or sensory impaired patient?

My recommendations: transpoas and other less invasive techniques should be limited to surgeons and centers with significant trauma experience. The surgeon treating only the occasional burst fracture should maximize his facility with common techniques that are more generalizable across the entire thoracolumbar spine. In the current environment, surgeons must offer not only the best care for their patients but also remain cognizant of the costs associated with that care. Certainly, all surgeons must be vigilant that the possibility of a “less invasive” approach does not liberalize their surgical indications. Someday, we may be able to offer a surgical stabilization modality less morbid than nonoperative management. We are not there yet [3,9,33].

THE SPINE  
CENTER<sup>at</sup>

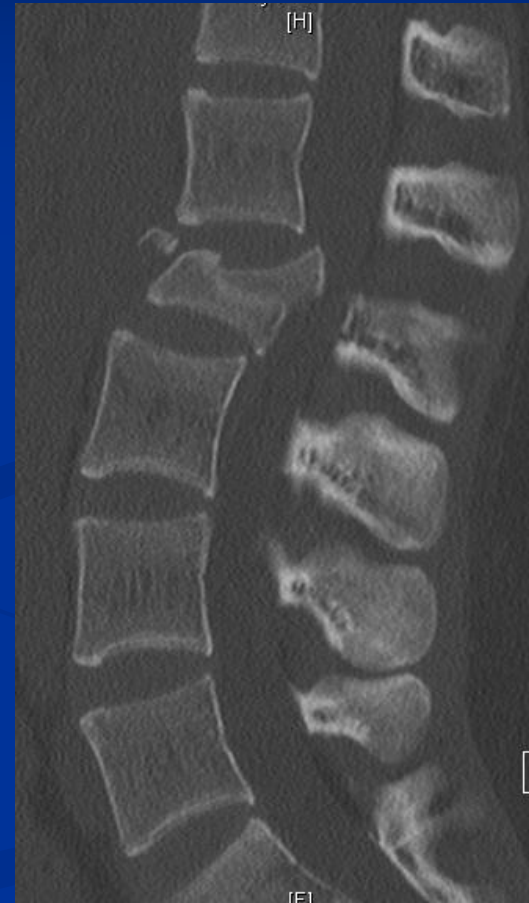
BONE & JOINT CLINIC  
OF BATON ROUGE

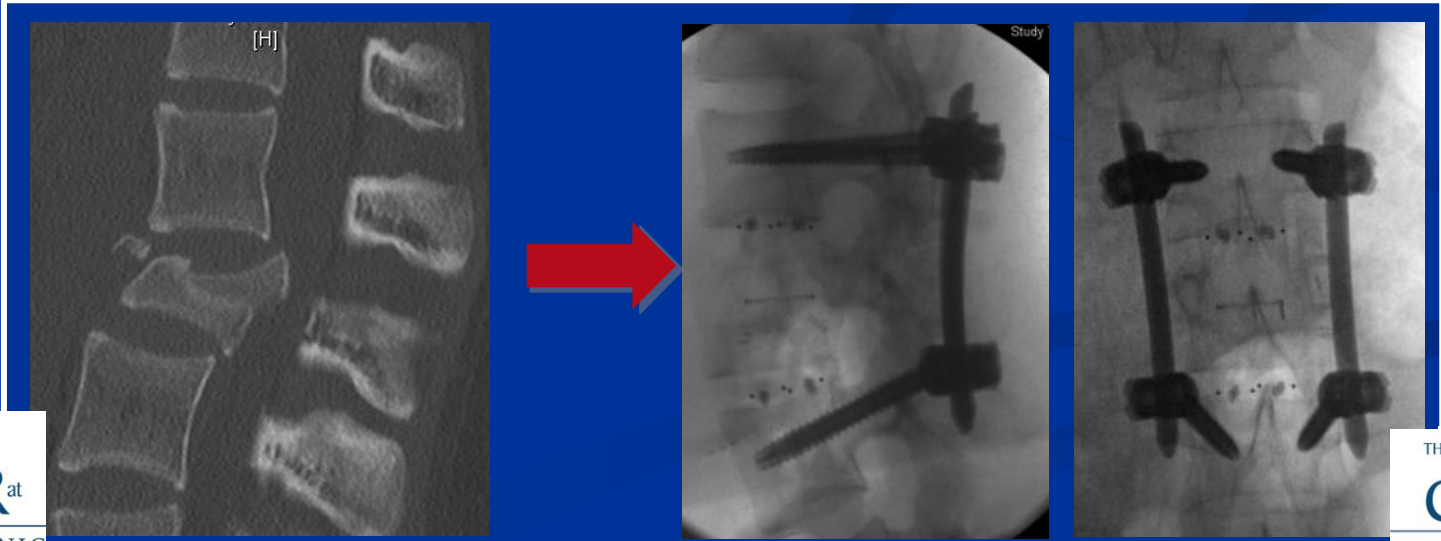
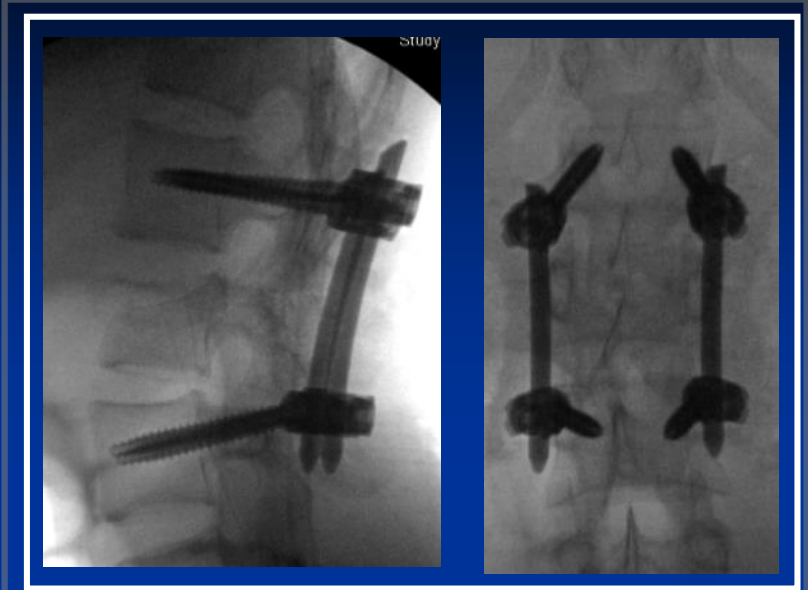
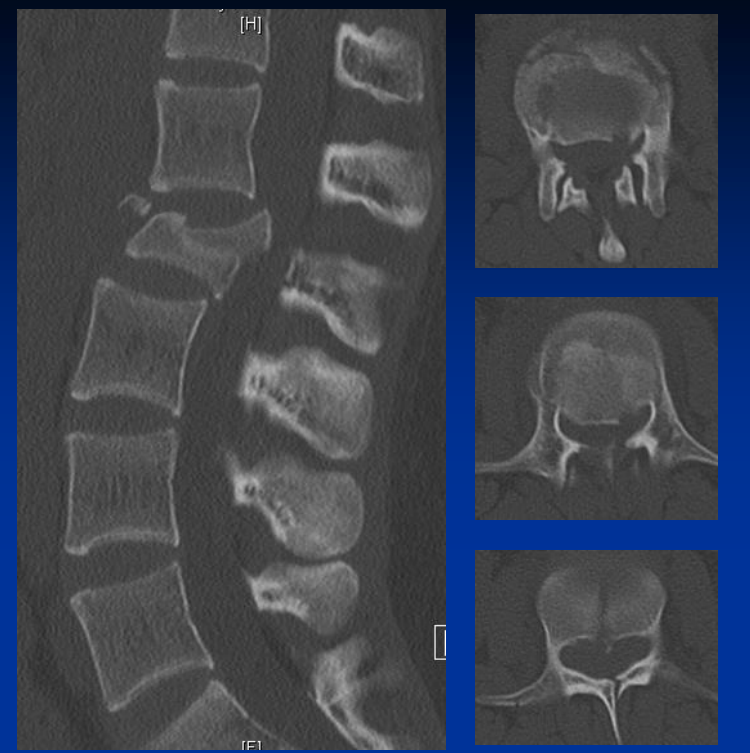
THE SPINE  
CENTER<sup>at</sup>

BONE & JOINT CLINIC  
OF BATON ROUGE

# Corpectomy Pearls

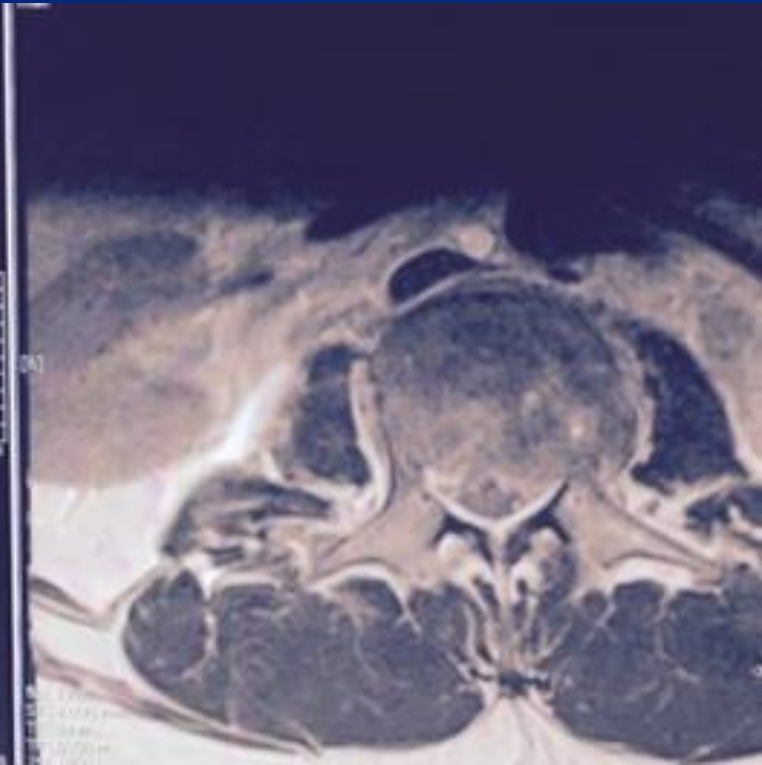
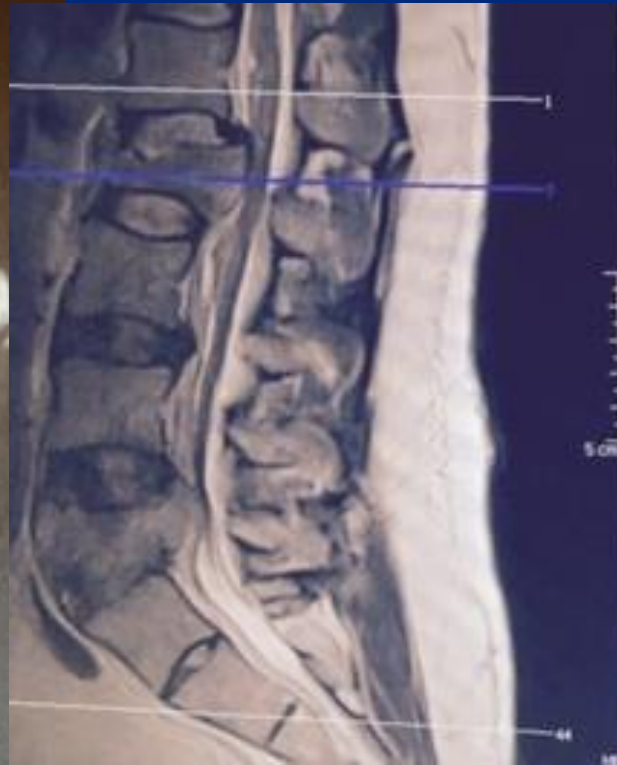
- Diskectomies first to limit prolonged psoas retraction
  - Then central corpectomy
  - Then posterior corpectomy, clear canal of delta fragment
- Care with ligating segmental vessels
- Consider posterior surgery first if alignment can be restored by posterior means...





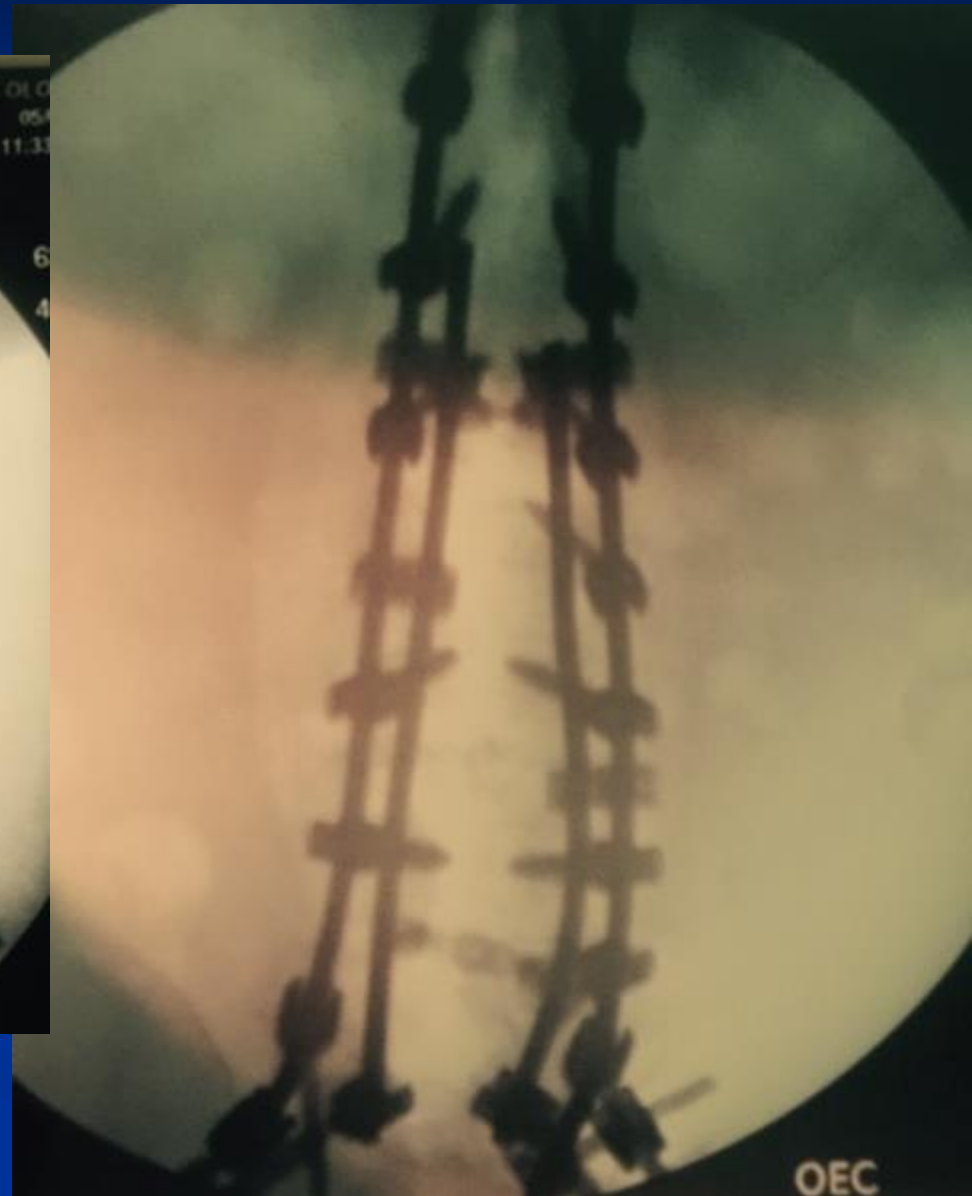
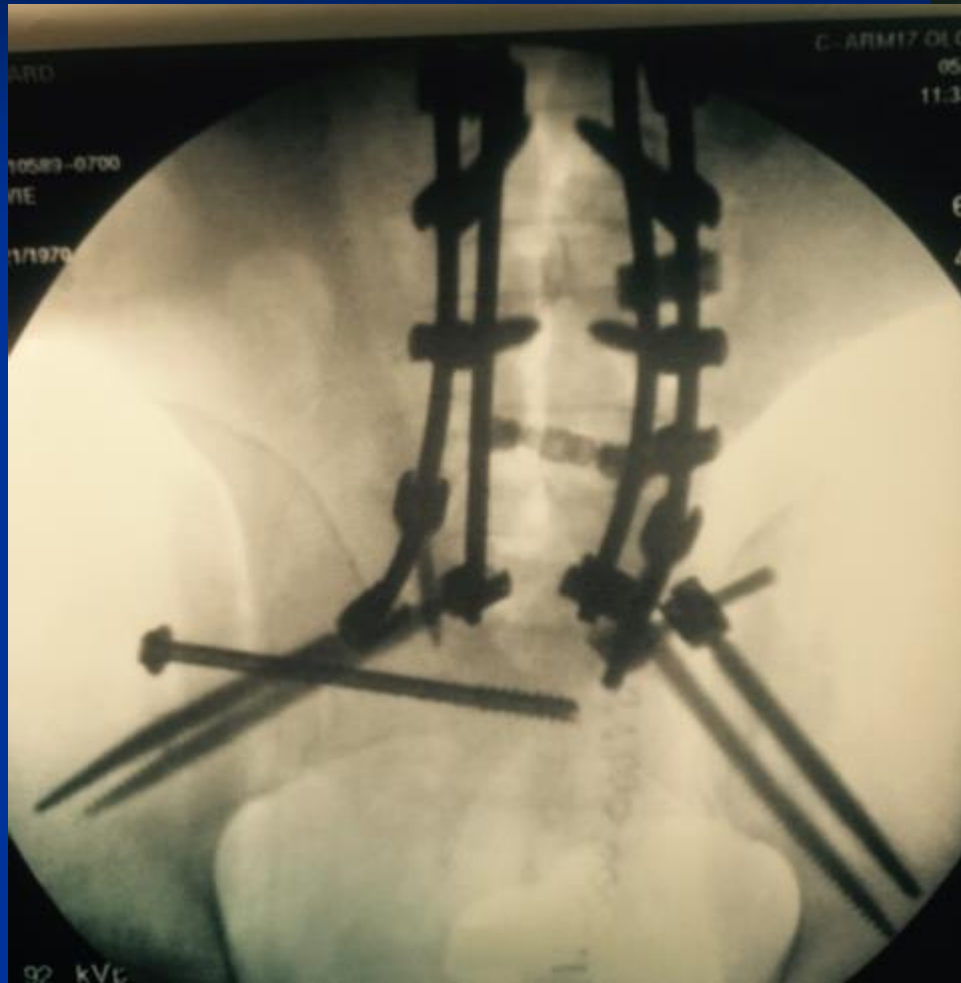


# TRAUMA

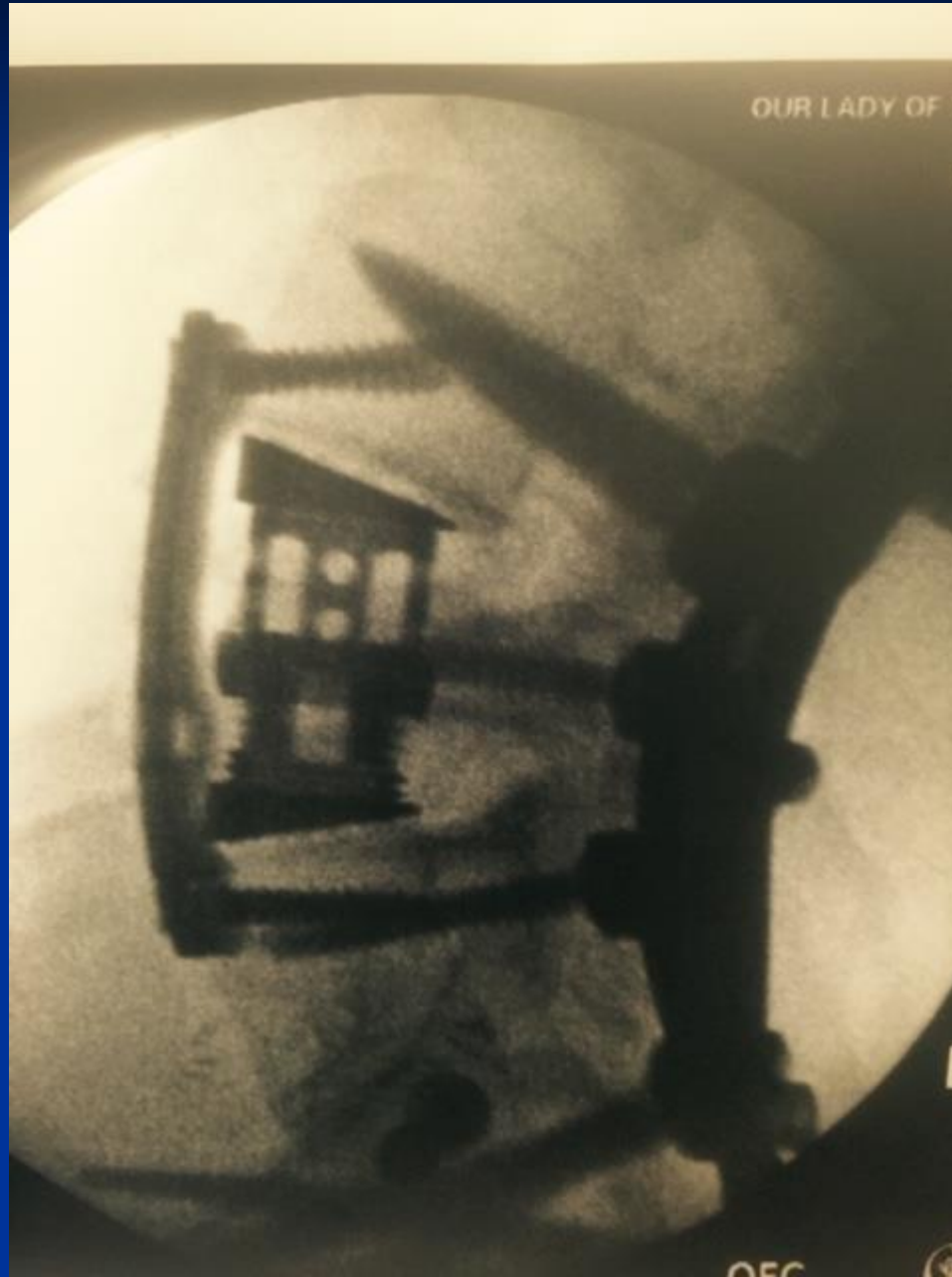


# Stage 1 – Pelvic Ring

## Stage 2 – Posterior Alignment

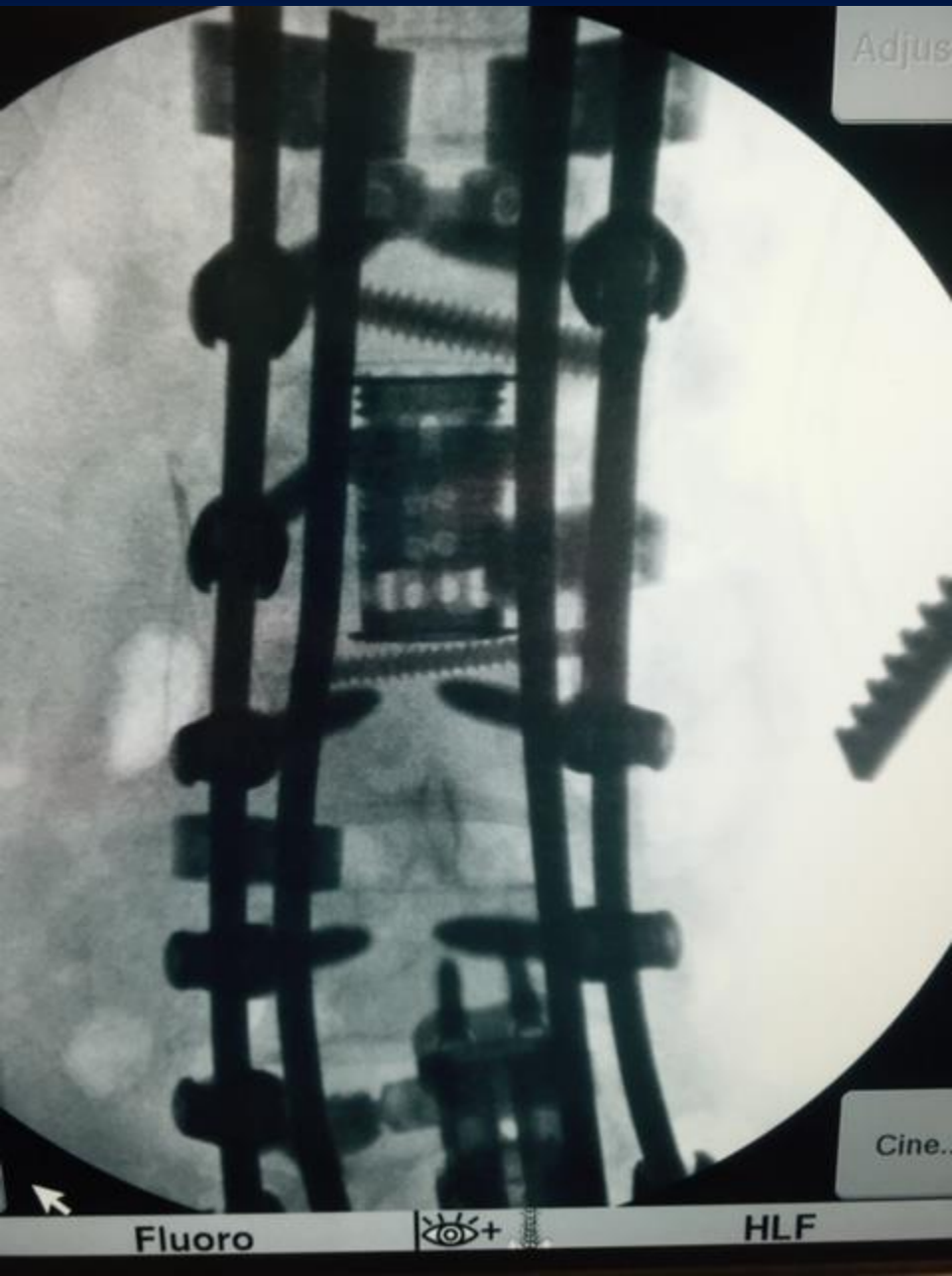


# Stage 3 – Anterior L5 Corpectomy



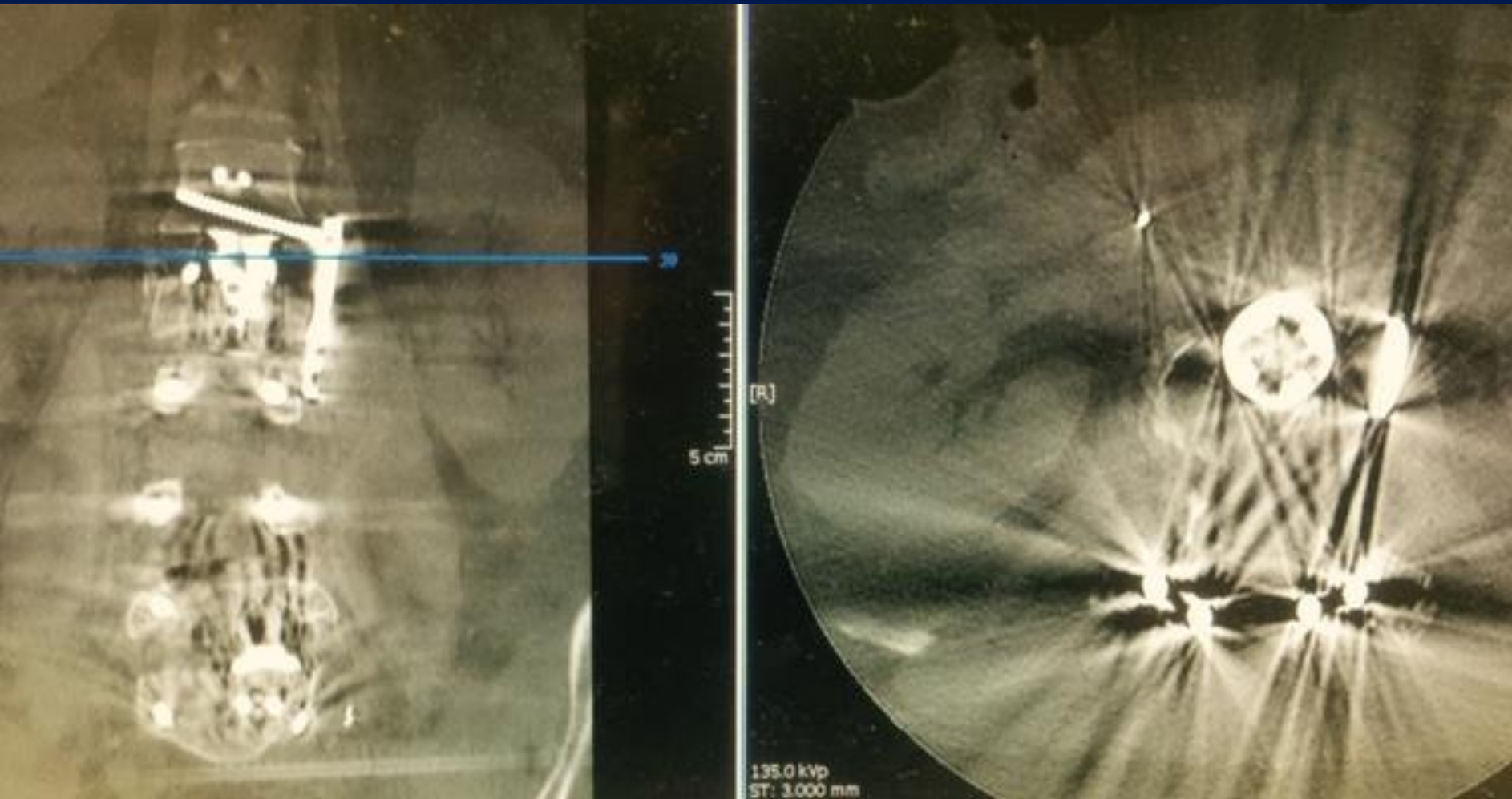


# Stage 4– Lateral L2 Corpectomy

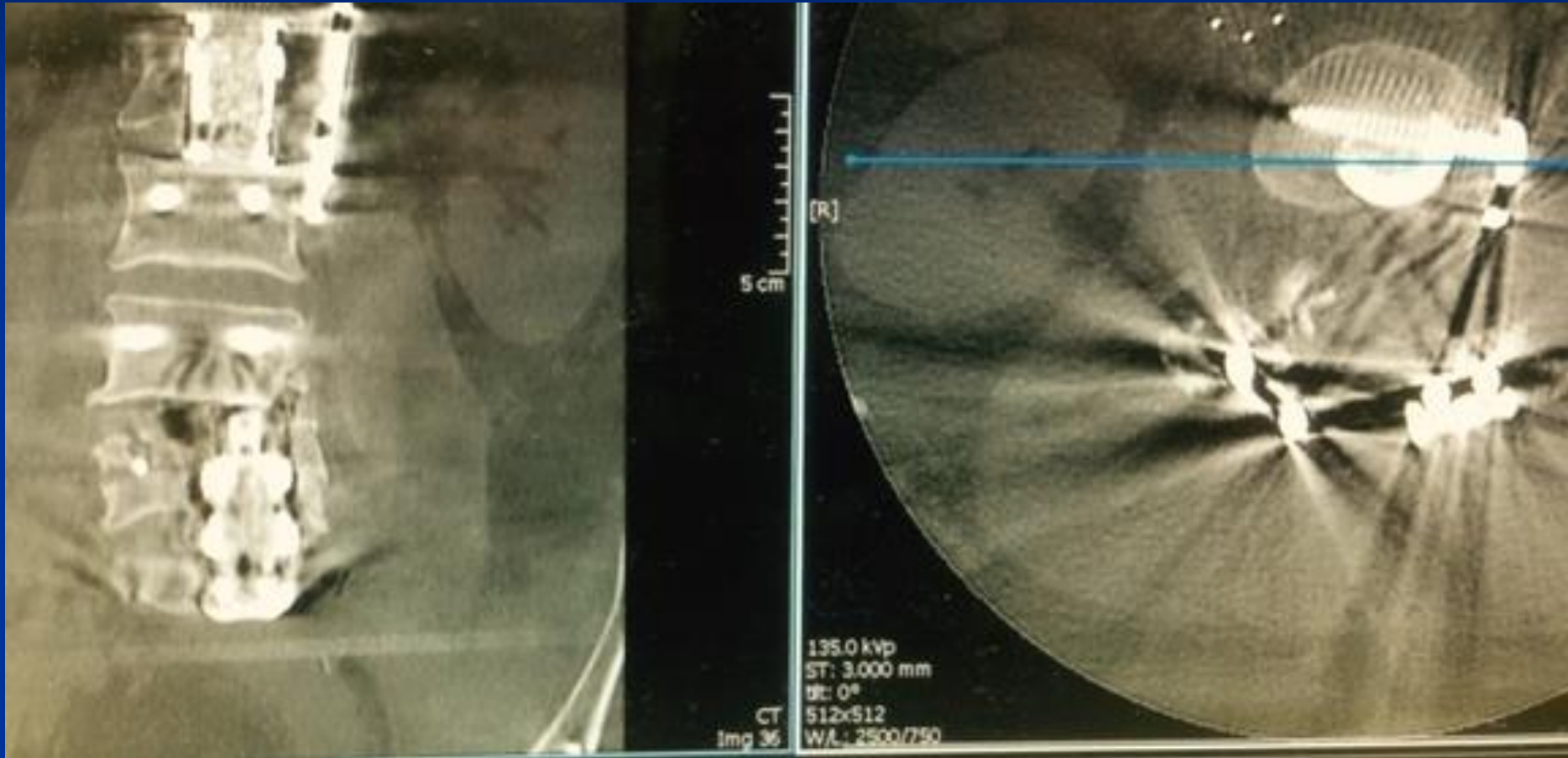




# Stage 4– Lateral L2 Corpectomy



# Stage 4– Lateral L2 Corpectomy



# Pearl: do not overstuff

- Apophyseal and marginal cortex bone provide great support for interbody reconstruction.
- Temptation is to oversize, trying to get more lordosis, or more restoration of foramen height
- Beware of the ability to oversize the height of the device.
- Overstuffing may be associated with
  - Subsidence
  - Iatrogenic trauma including fracture
  - Postoperative pain from over-distraction (I have seen this...)

# Pearl; limit psoas injury

- Limit retraction time
- Limit retraction force (don't open retractor)
- At end of case:
  - Meticulous hemostasis
  - Withdraw retractor and look for bleeders
  - Wax hole from fixation screw
  - Surgiflo in psoas; pull patty last
  - Dexamethasone in psoas muscle
- Consider post op MR
- Inform patient of expectations pre-op (analogous to ACDF dysphagia)



# Pearls / Pitfalls Review

- Pre-op imaging to determine side and reduce risk of injury
- Approach side dictated by coronal deformity, especially for L4/5
- Consider 2 c-arms if available
- Minimize Psoas retraction force and time
- Direct visualization is recommended
- Hemostasis within psoas
- Do not “overstuff”
- Position implant for lordosis versus foramen restoration
- Pre-op patient education
- Interbody device must cover apophyseal ring and marginal cortex
- Consider wide (22mm) implant if risk for subsidence
- Real neuro-monitoring with tcMEP
- Intra-muscular steroid
- Plan the order of levels in deformity correction
- Contralateral release for balanced correction
- Indications for indirect reduction are limited

UNDERSTAND *YOUR* LIMITS



THANK YOU