Spine Approach

Michael Glotzbecker

University Hospitals
Rainbow Babies & Children's

School of Medicine
Case Western Reserve University

Acknowledgments

John Emans
Dan Hedequist
Tim Hresko
Larry Karlin

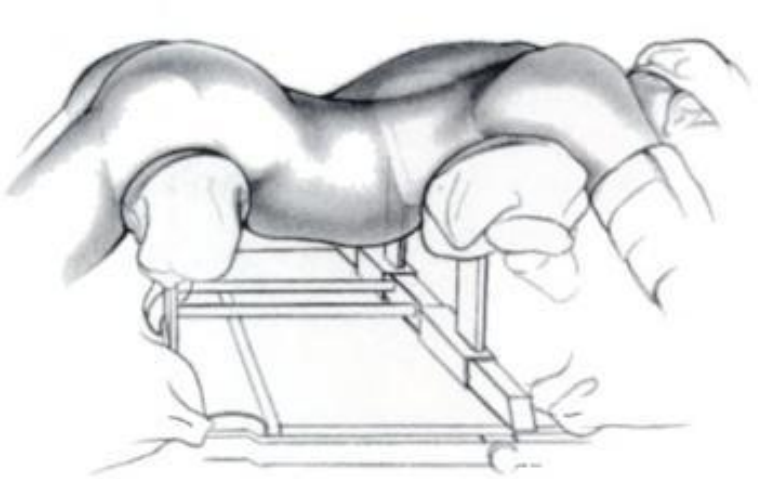
Goals/Objectives

- Understand basic spinal anatomy
  - Facets/Pedicles
- Perform a facetectomy
- Place a pedicle screw
  - Starting point, steps, danger
- Place a pedicle hook
- Place a transverse process hook
- Correction techniques

Positioning

Positioning

A



Pads placed on chest, ASIS

Neck neutral

Axilla free

Positioning

Wide draping

Neck to gluteal crease

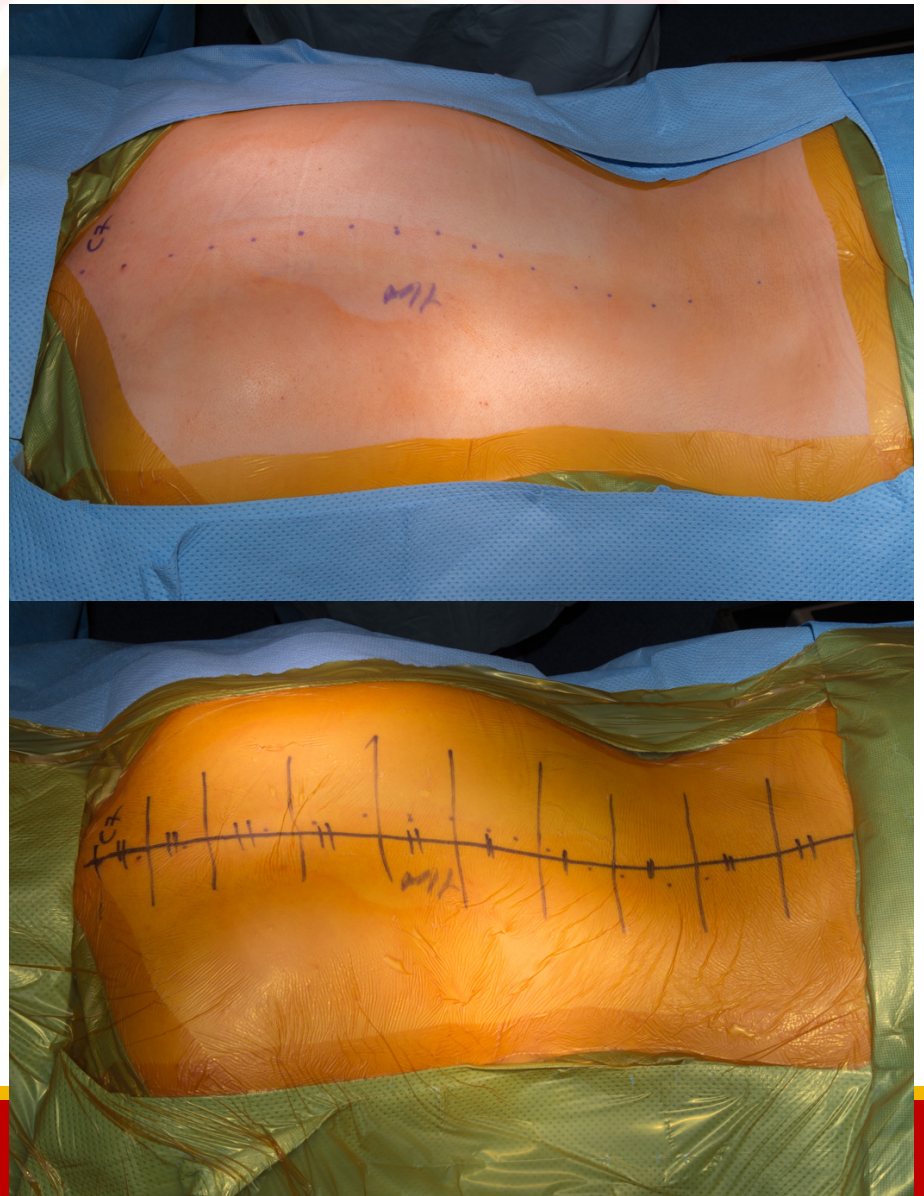
Positioning

Preop chlorhexidine
Alcohol/Hydrogen peroxide
Chloraprep

Mark spinous processes

- Count down from C7

Ioban sticky drape



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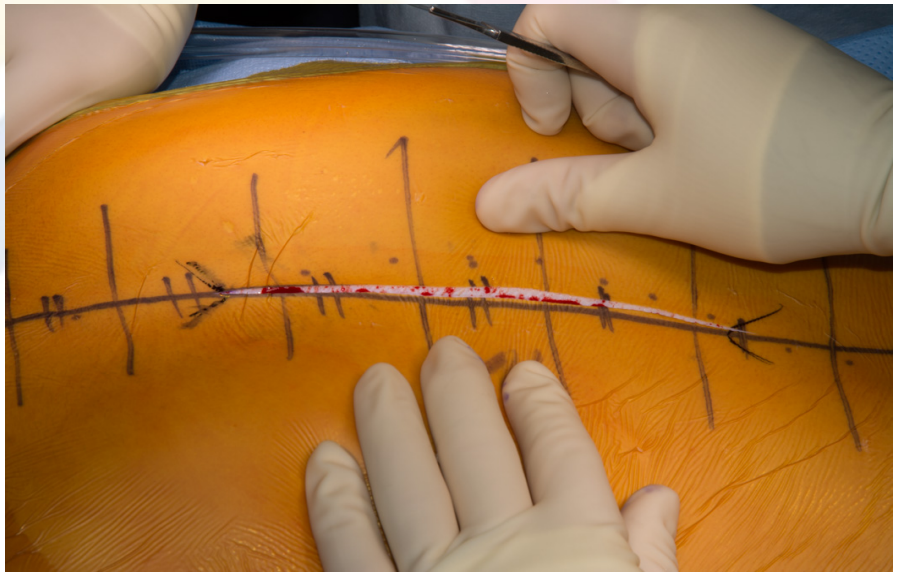
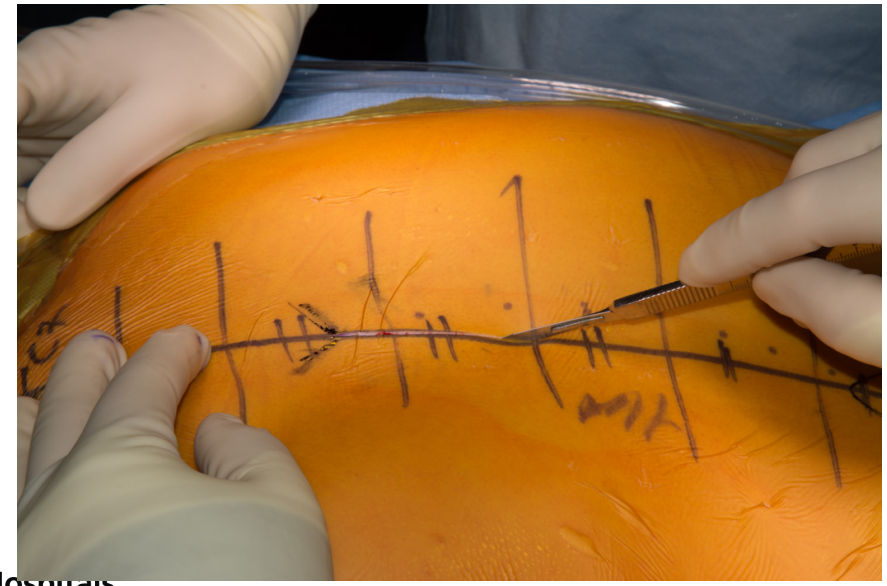
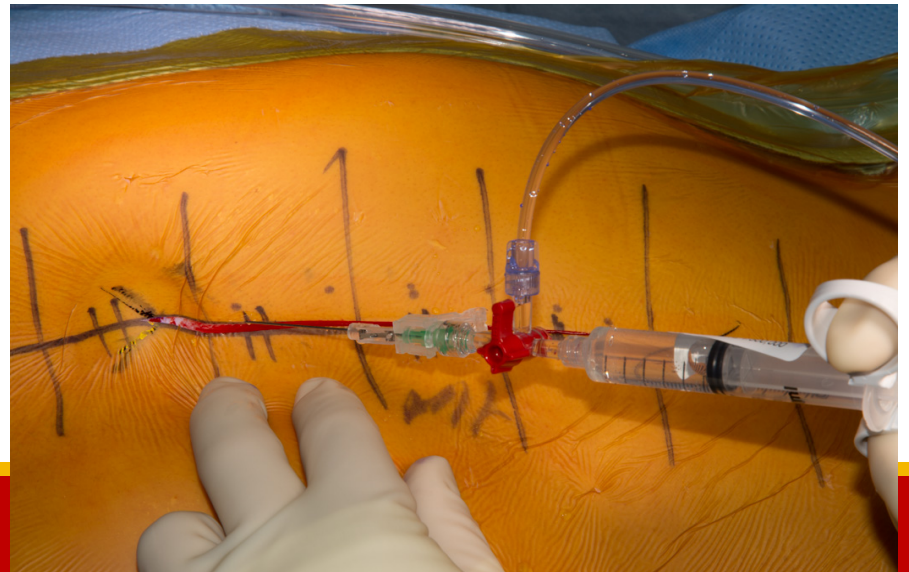
Superficial Dissection

Scratch skin without penetrating dermis

Inject infiltrate to reduce bleeding







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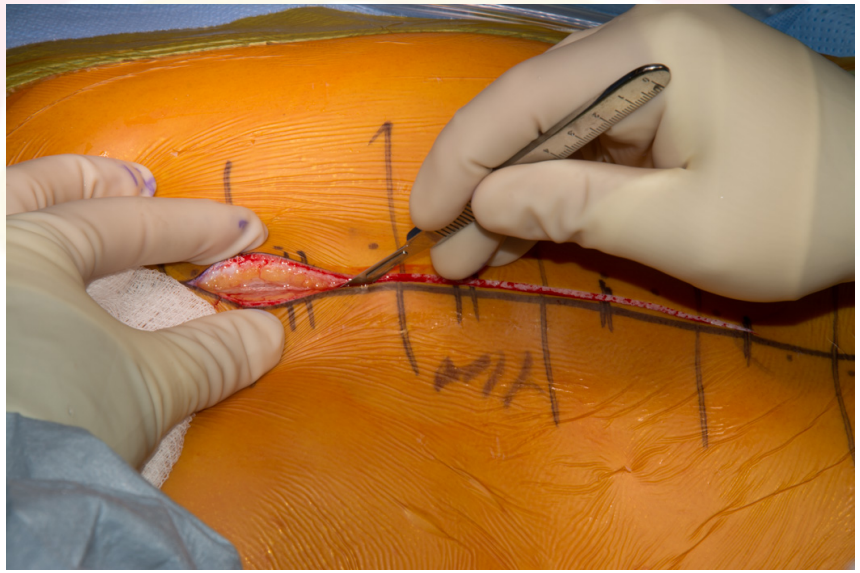
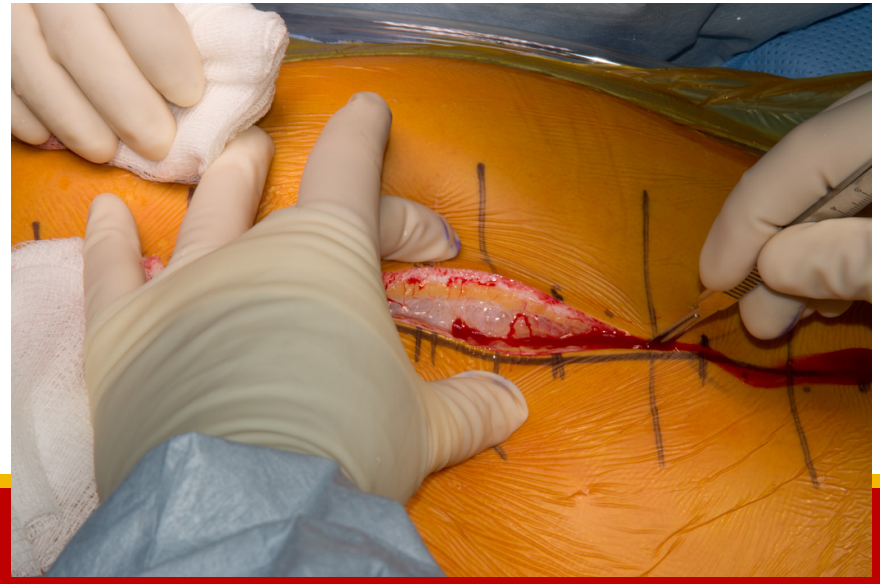
Superficial Dissection

Definitive single cut into fat

Don’t penetrate fascia

Note single clean tissue plane





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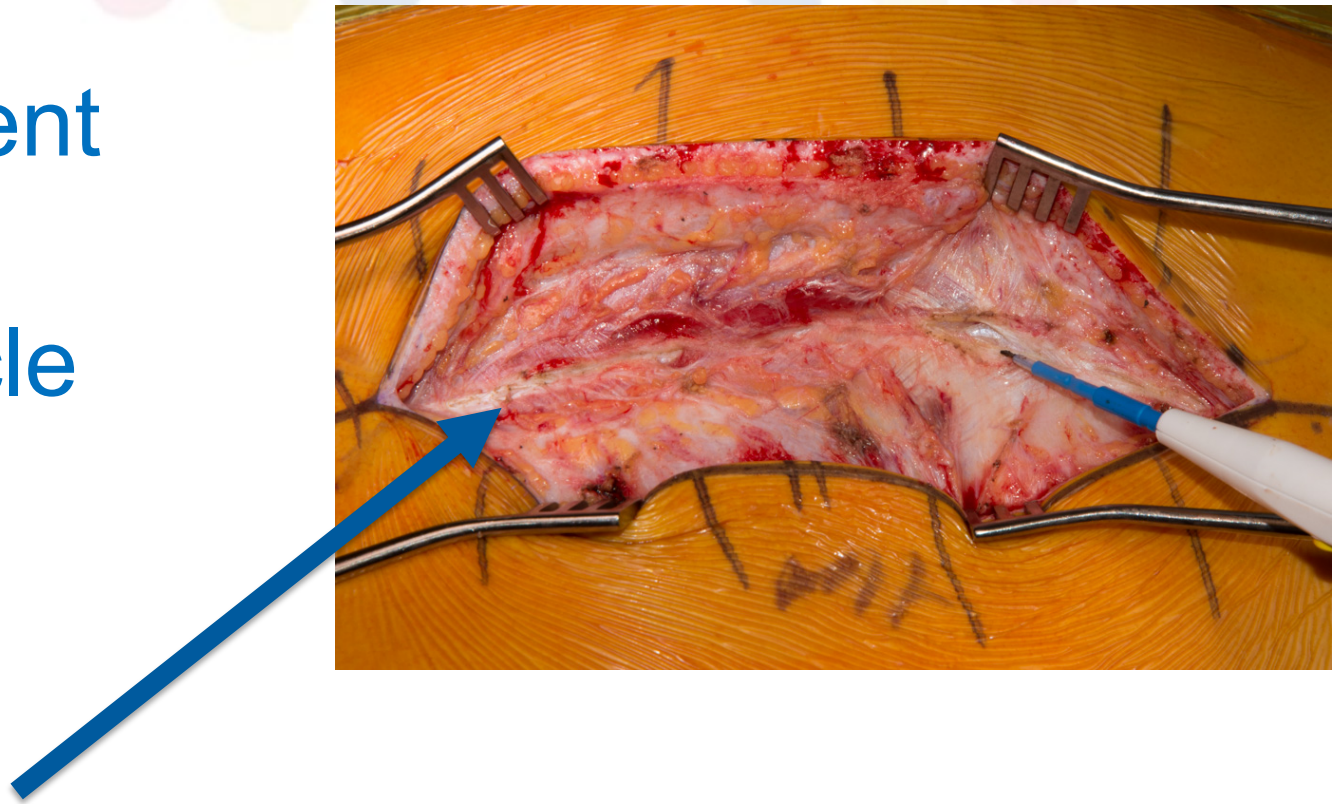
Superficial Dissection

Continue dissection to fascia

Identify intraspinous ligament

Avoid entering fasica/muscle



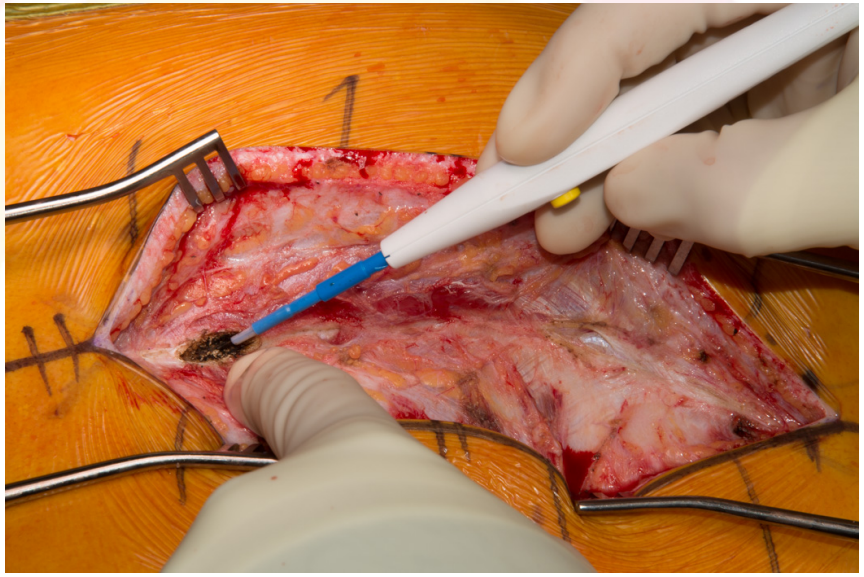
Deep Dissection

Deep Dissection

Split each apophysis

Keep in midline

Follow spinous process down to next

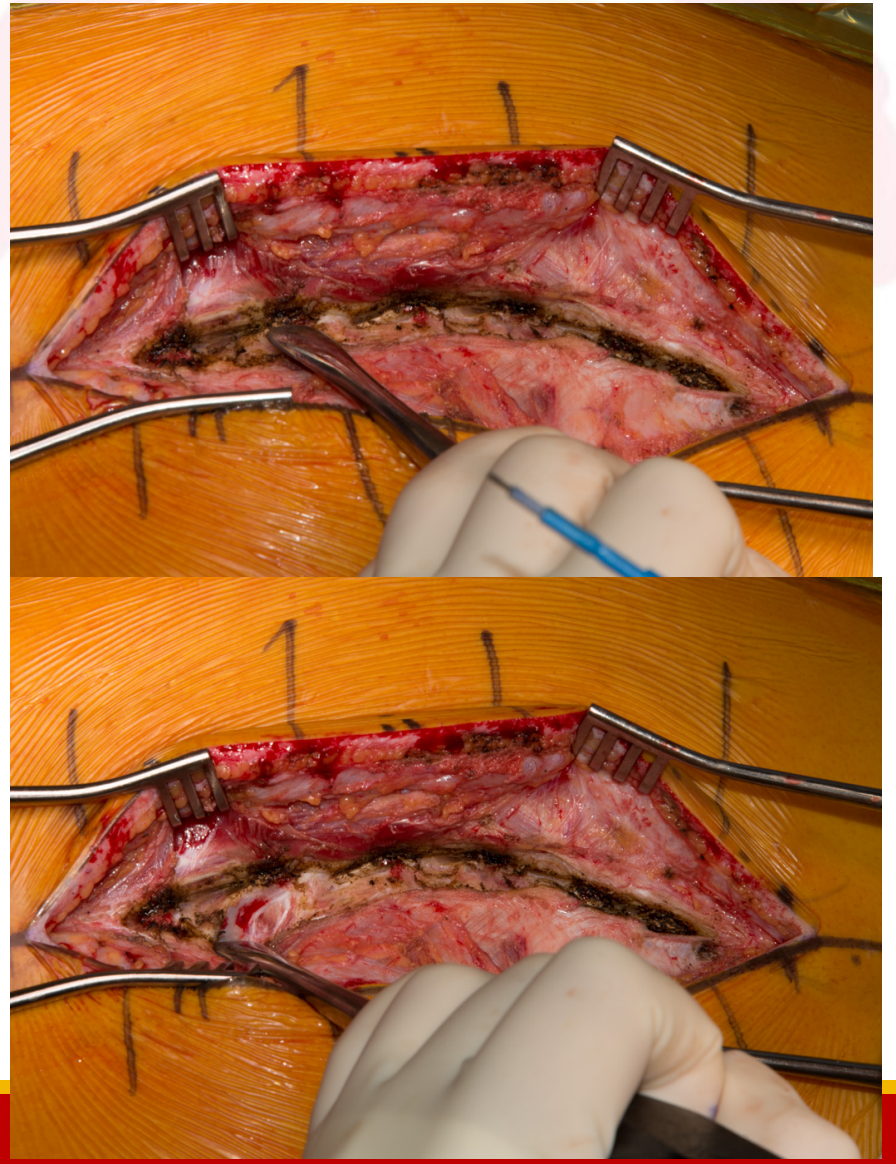


Deep Dissection

Use a Cobb to pop apophysis

Sub periosteal dissect down spinous process

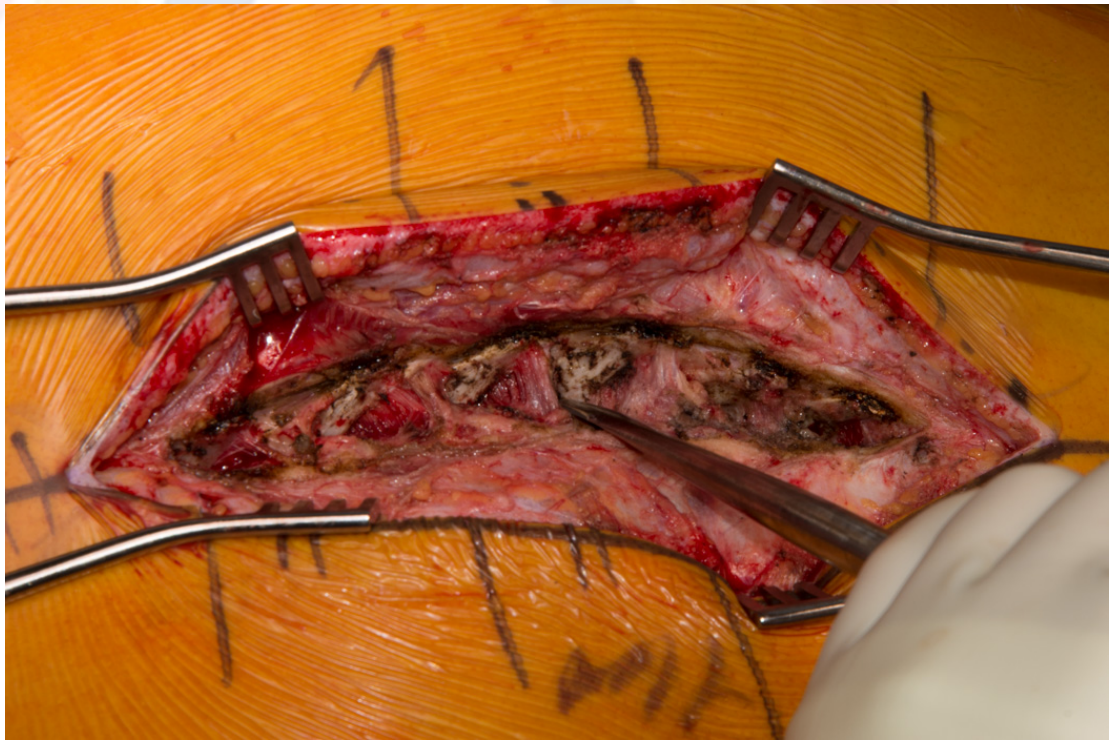
Do not tear trailing edge



Deep Dissection

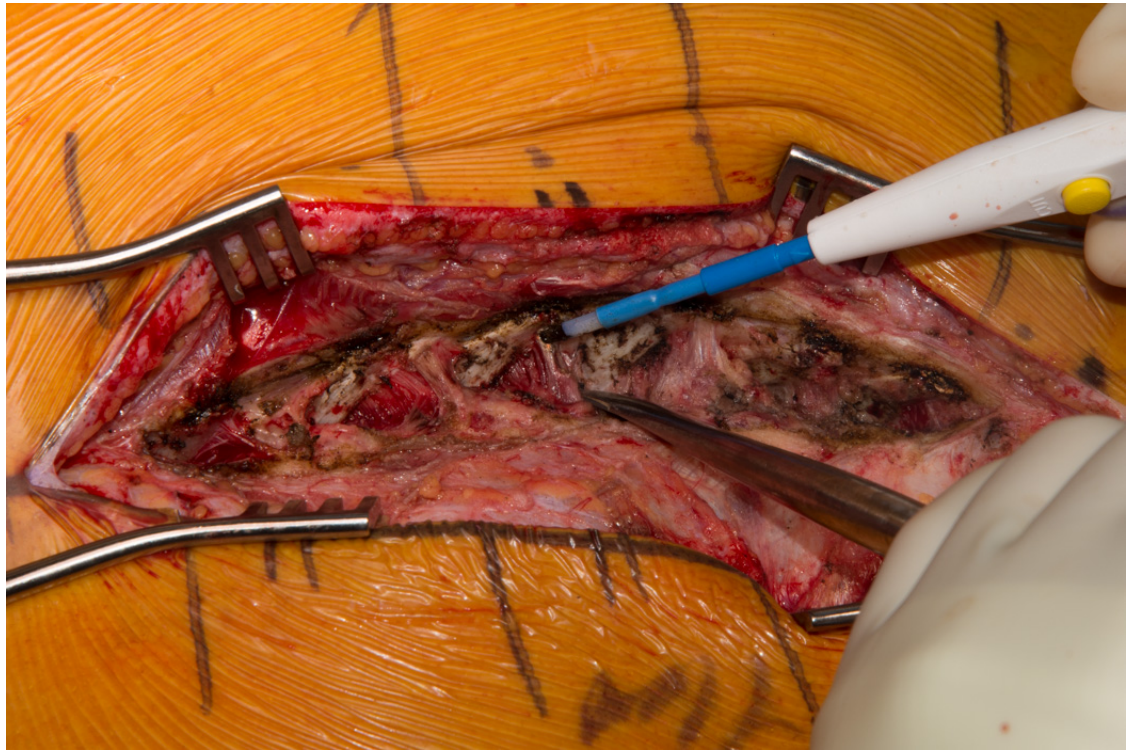
Note spinous processes exposed

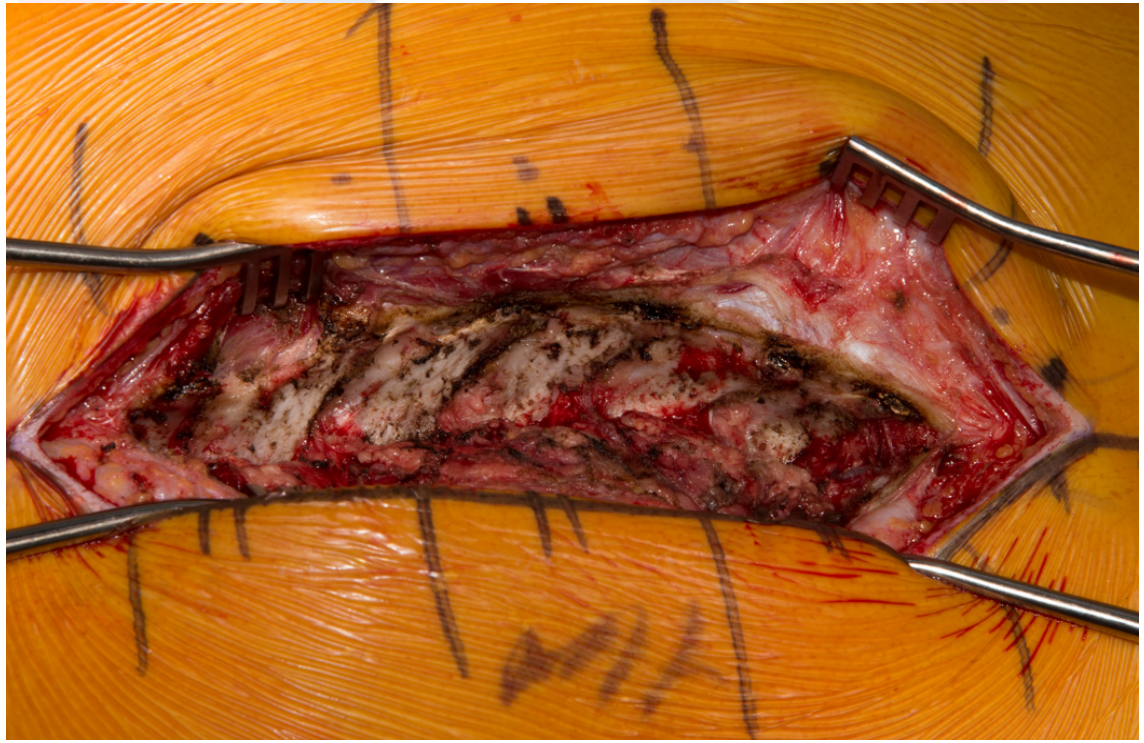
Trailing edge intact



Deep Dissection

Take down each trailing edge to level of facet



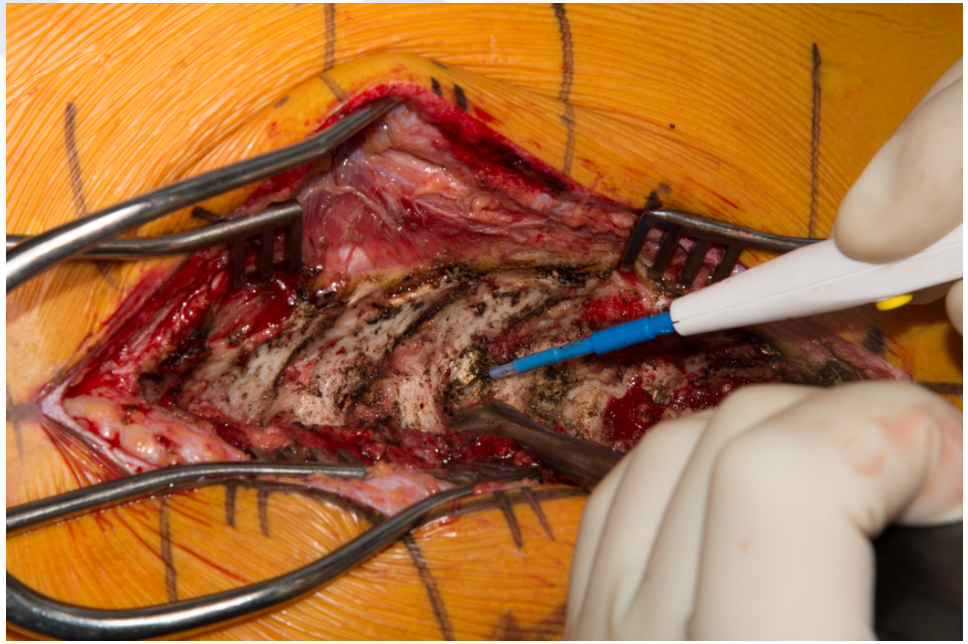


Deep Dissection

Clean facet with Cobb and/or bovie

This leads you to the inferior TP

Pull out on TP to tip

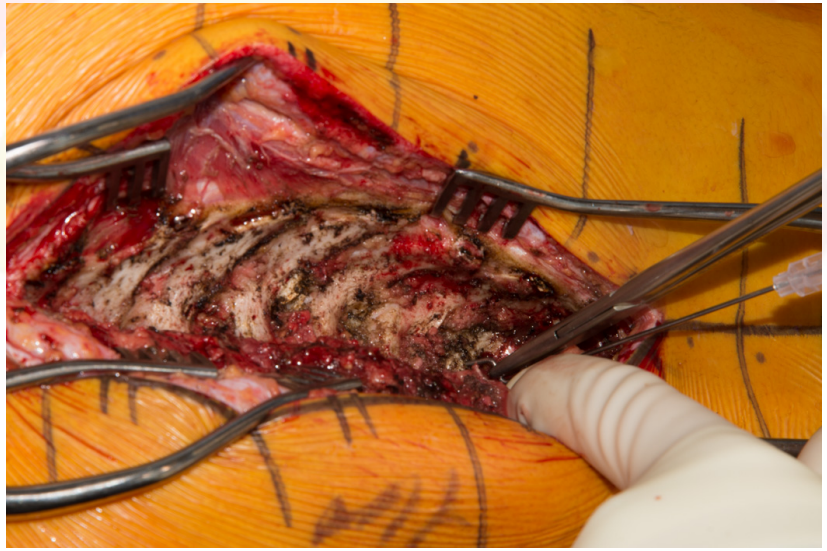


Deep Dissection

Dissect 1-2 levels less than you think you need to

Check level

Use two points of reference

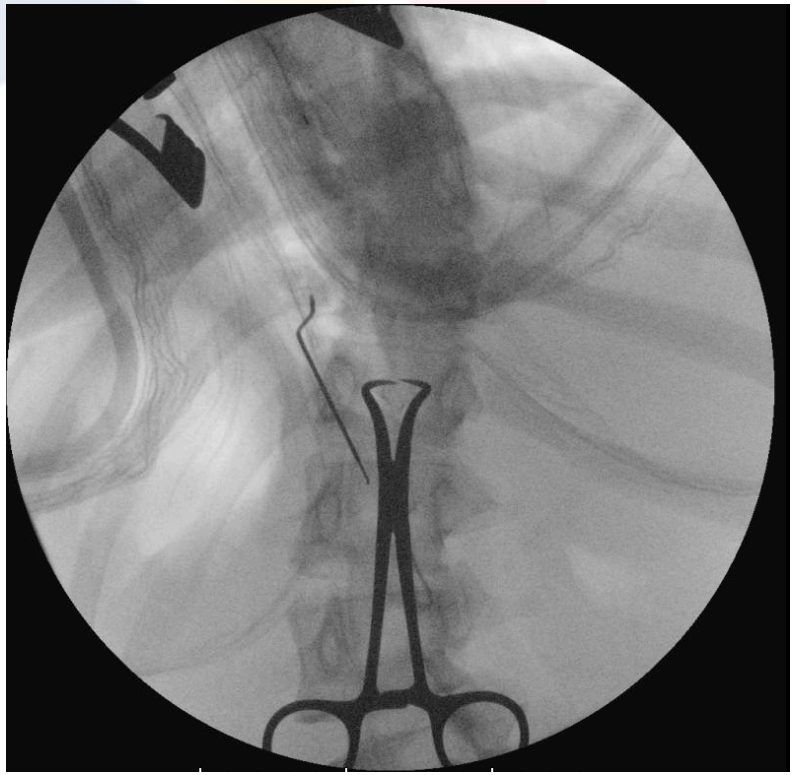


Deep Dissection

Towel clip on SP (inferior structure)

Spinal needle on approximate pedicle

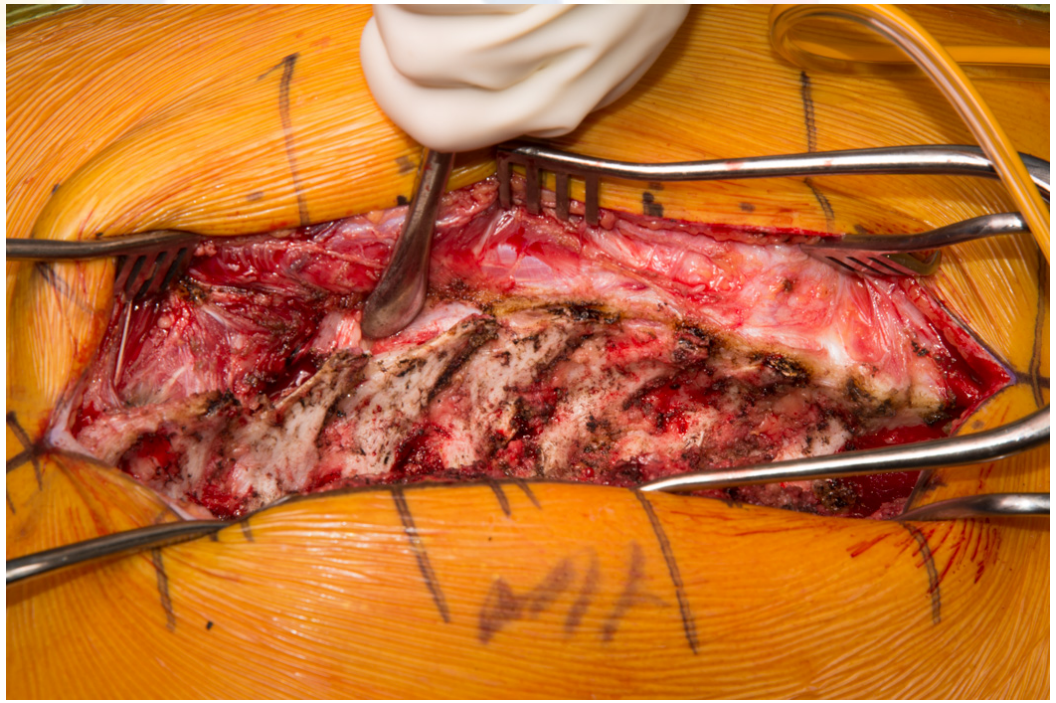
Ask least experienced in room to identify level first



Deep Dissection

Repeat steps other side

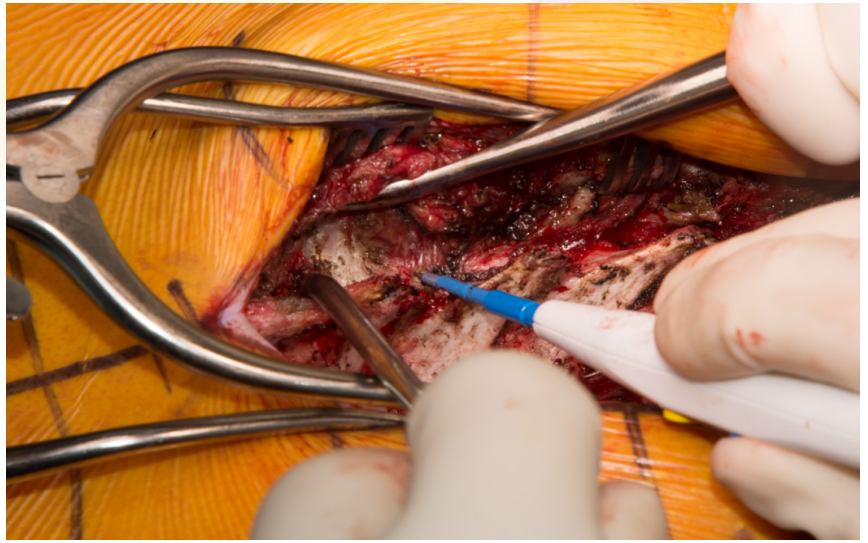
Note periosteum and lack of bleeding



Deep Dissection

Opposite side, facet leads you to TP

Subperiosteally pull up on TP



Deep Dissection

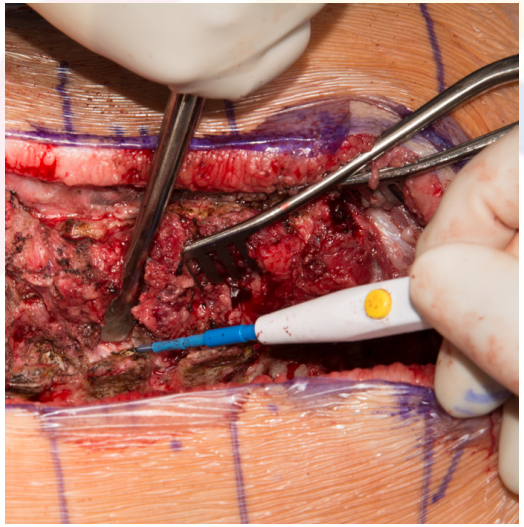
Technical tip

Keep intraspinous ligament intact at top level

- Especially in kyphosis!

Deep Dissection

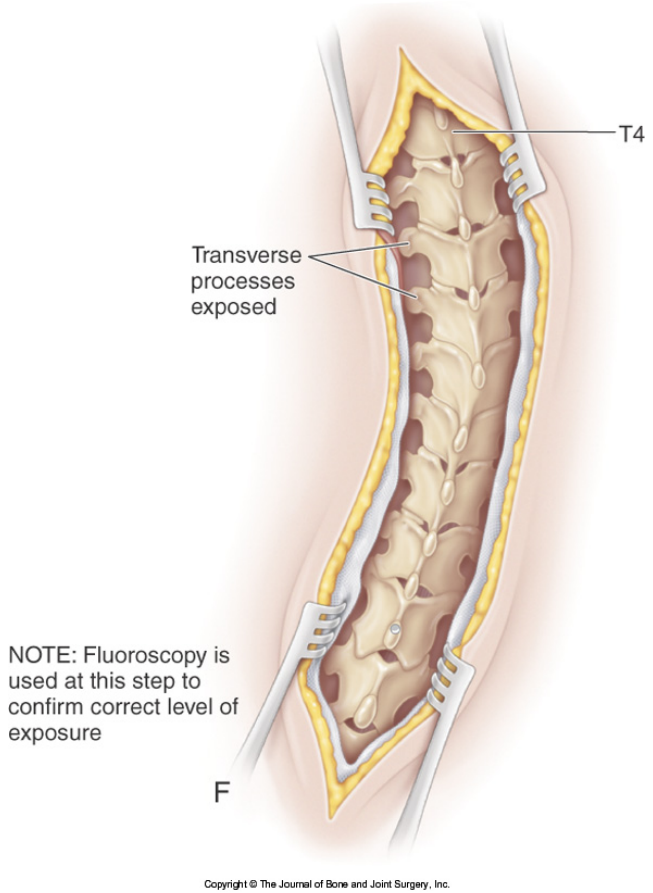
For lumbar facets laterally retract capsule



Identify TP and pull laterally

Remove muscle in between (create bone graft gutter)

Spine Exposed

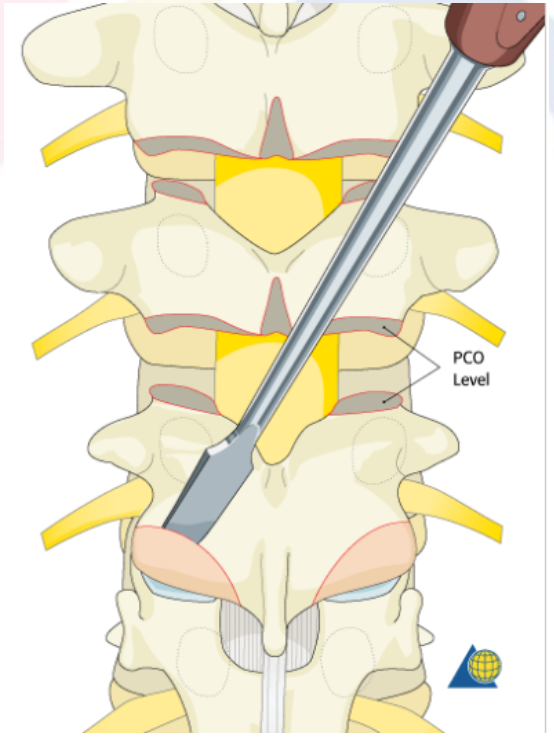


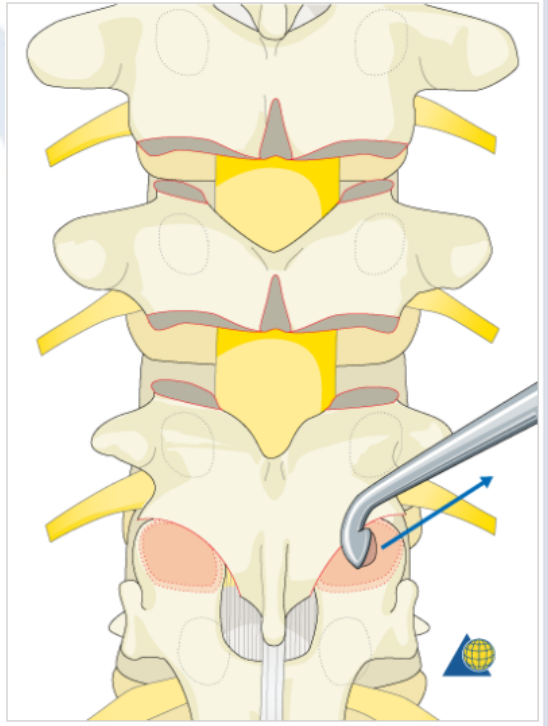
Facetectomies

Facetectomies

Remove inferior articular facet with capener, osteotome, bone scalpel

Clear cartilage with curette or burr





Risks:

- **Superior:**
  - **Foramen/nerve root**
- **Medial:**
  - **Spinal Canal**

Facetectomies

Starting point axilla where TP meets inferior facet (Thoracic)

Facetectomies

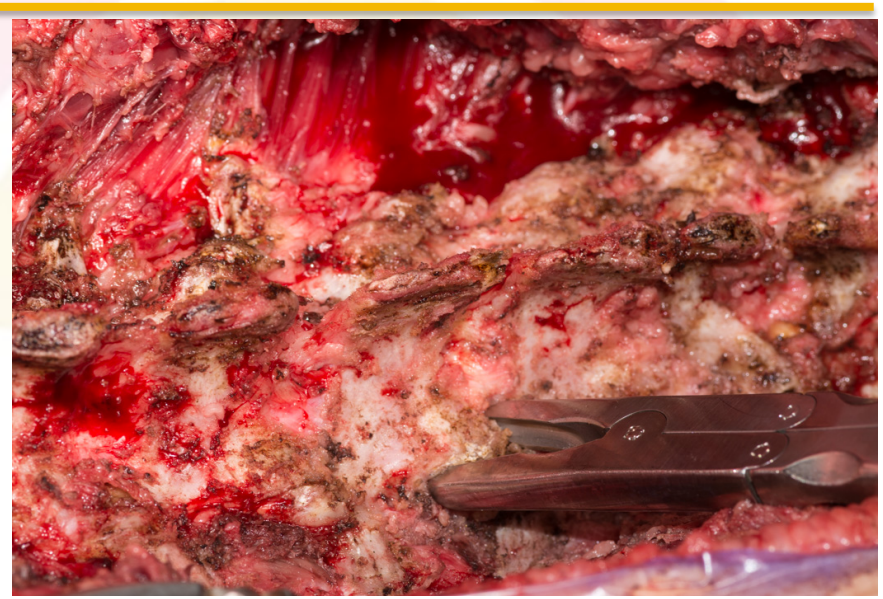
Identify cartilage of superior facet

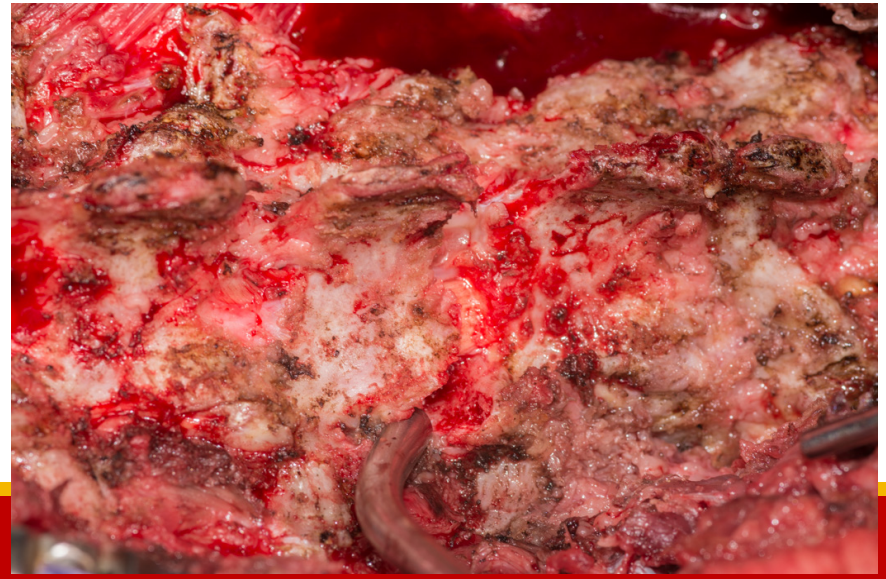
Relationship to ligamentum will give starting point

Facetectomies

Lumbar facetectomy

Use rongeur, osteotome, bone scalpel in between inferior and superior facets





Facetectomies

Lumbar facetectomy

Bone scalpel another option

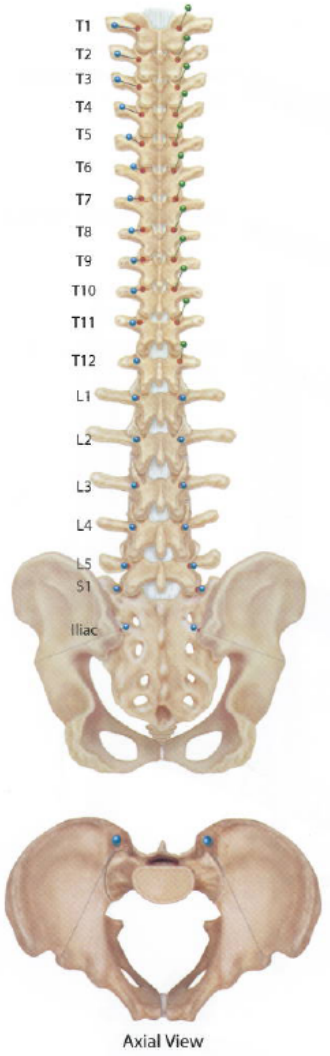
Facetectomies

Identify cartilage of SA facet

Gives starting point for screw

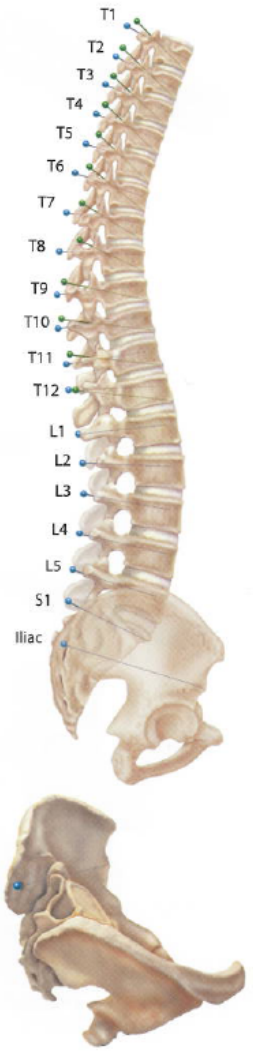
Pedicle Screw Anatomy

Pedicle Starting Points



Axial View

Level	Cephalad-Caudad Starting Point	Medial-Lateral Starting Point
T1	Midpoint Transverse Process (TP)	Junction: TP-Lamina
T2	Midpoint TP	Junction: TP-Lamina
T3	Midpoint TP	Junction: TP-Lamina
T4	Junction: Proximal Third-Midpoint TP	Junction: TP-Lamina
T5	Proximal Third TP	Junction: TP-Lamina
T6	Junction: Proximal Edge-Proximal Third TP	Junction: TP-Lamina-Facet
T7	Proximal TP	Midpoint Facet
T8	Proximal TP	Midpoint Facet
T9	Proximal TP	Midpoint Facet
T10	Junction: Proximal Edge-Proximal Third TP	Junction: TP-Lamina-Facet
T11	Proximal Third TP	Just medial to lateral pars
T12	Midpoint TP	At the level of lateral pars
L1	Midpoint TP	Junction: Lateral pars and superior facet
L2	Midpoint TP	Junction: Lateral pars and superior facet
L3	Midpoint TP	Junction: Lateral pars and superior facet
L4	Midpoint TP	Junction: Lateral pars and superior facet
L5	Midpoint TP	Junction: Lateral pars and superior facet
S1	Midpoint Sacral Ala	Junction: Sacral ala and superior facet
Iliac	1cm Cephalad to Distal Posterior Superior Iliac Spine (PSIS)	1cm inferior to the superior PSIS on the medial slope



Oblique View

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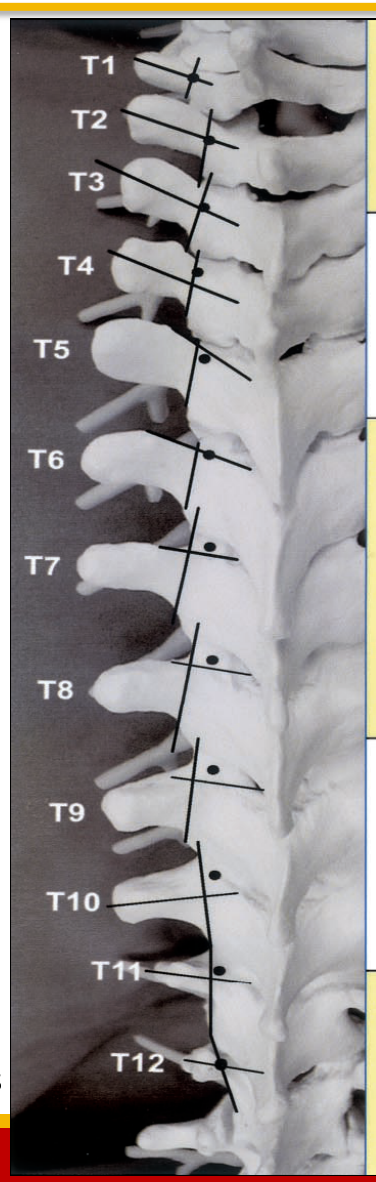
Pedicle Starting Points: Thoracic



Proximal Thoracic (T1,T2)

Junction of the bisected transverse process and lamina at the lateral pars

Trends towards a more lateral and caudad as one proceeds more proximal thoracic region

Mid- Thoracic (T7-T9) : The most medial starting point

Junction of proximal edge of the transverse process and lamina, where it meets the lamina and superior facet, just lateral to the midportion of the base of the superior articular process.

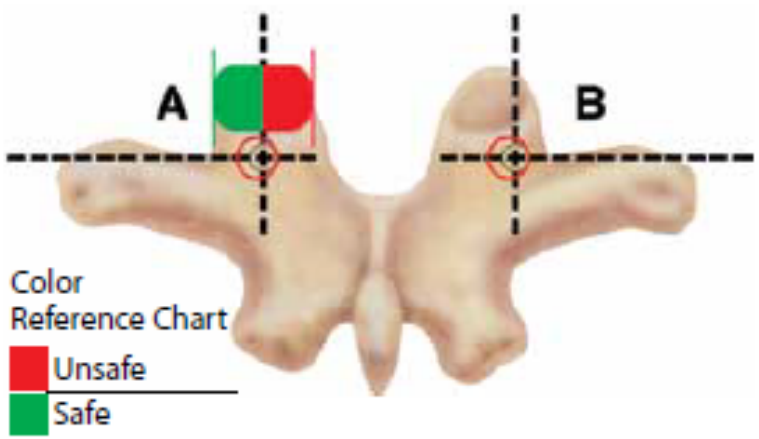
Trend towards a more medial and cephalad as one proceeds to the apical mid-thoracic region

Lower Thoracic (T11-T12)

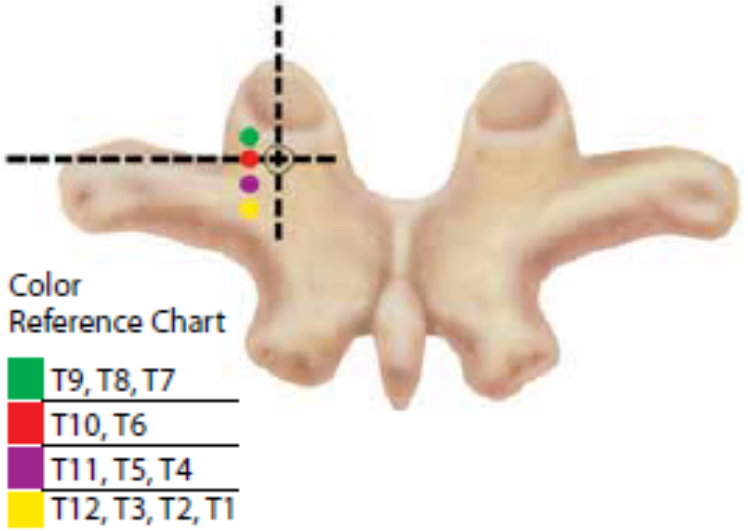
Junction of the bisected transverse process and lamina at or just medial to the lateral aspect of the pars

Pedicle Starting Points: Thoracic

Superior Facet Rule (A)



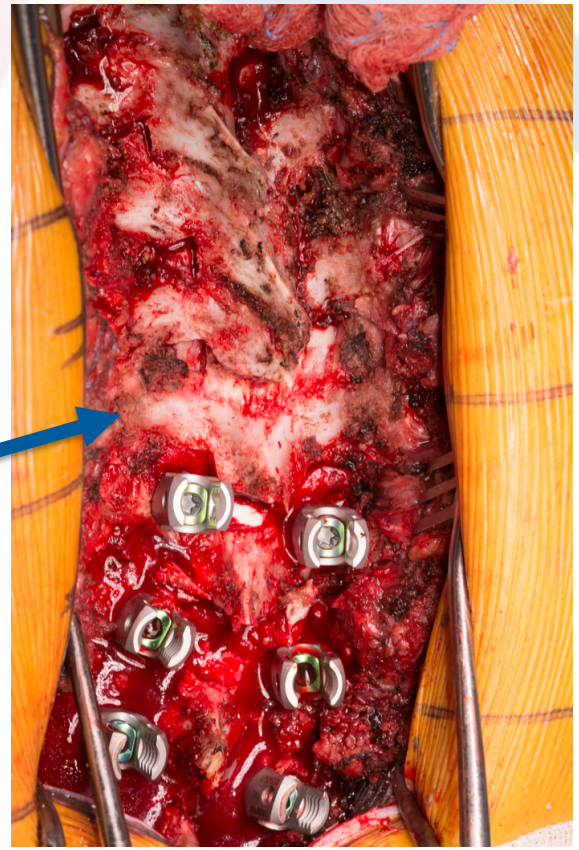
Cephalocaudal Starting Points (B)



Tip

To find right starting point

- See lateral superior facet
- See medial superior facet
- See ligamentum



You need to remove part of SP

Pedicle Screw Starting Point Lumbar

Intersection of two lines

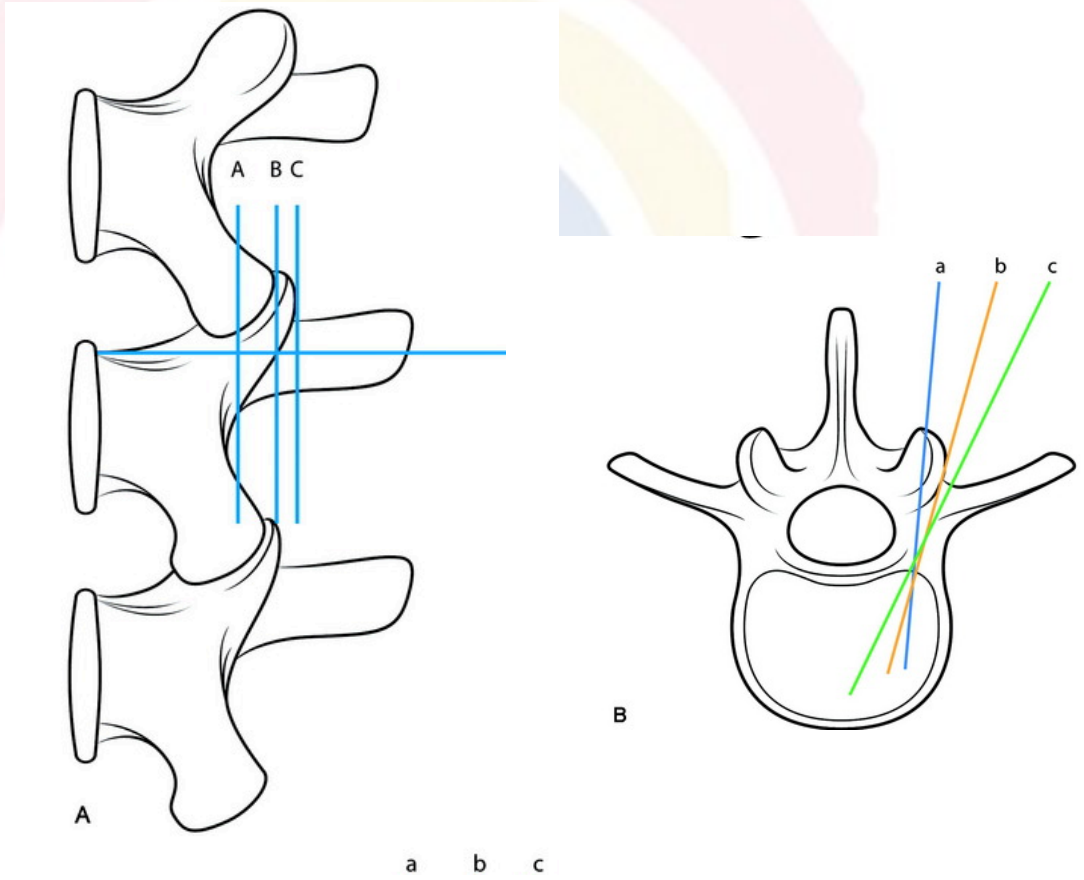
Midpoint TP (horizontal)

Vertical

A: Roy Camille (1mm under facet joint

B: Magerl (lateral border of superior articular process)

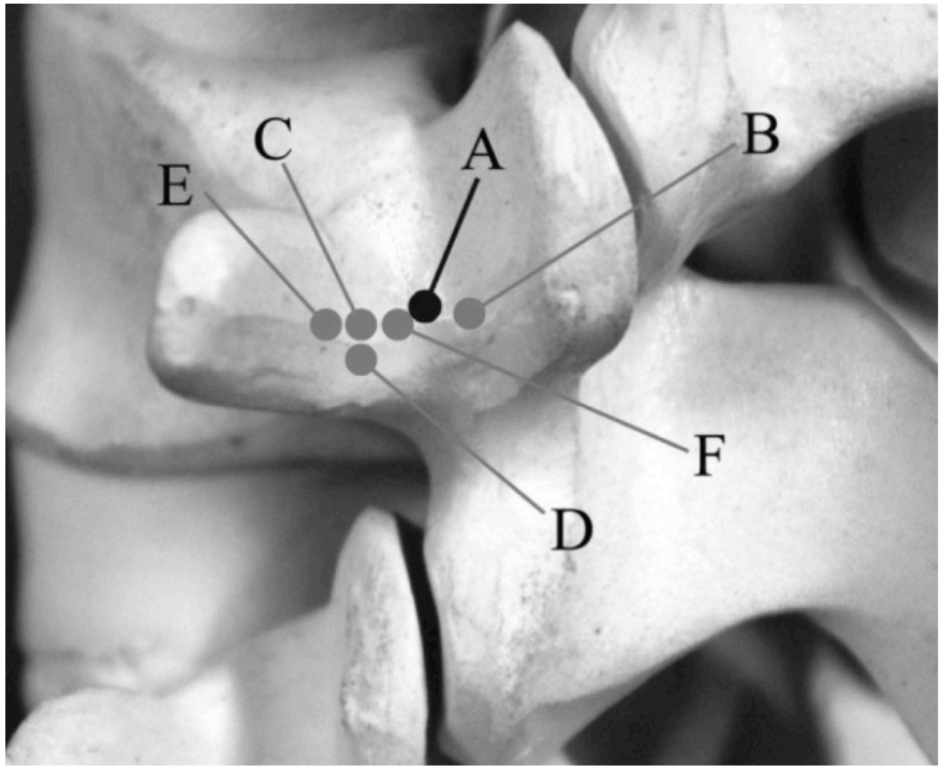
C: More lateral to avoid damage to joint

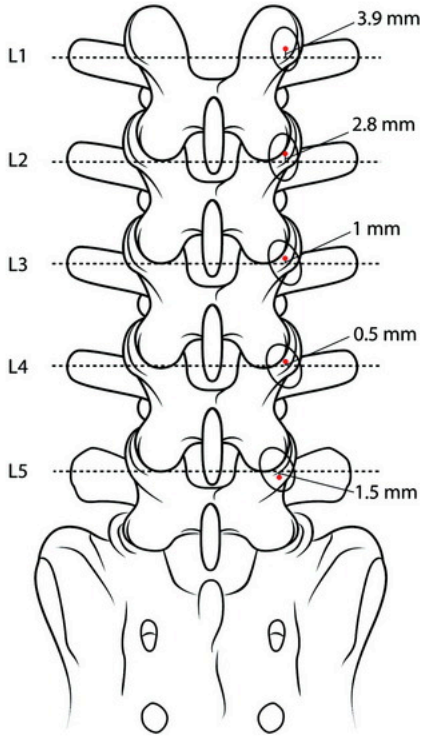


Lumbar entry point

Common description:

- Junction of pars, midpoint of TP, and inferior point of superior articular facet

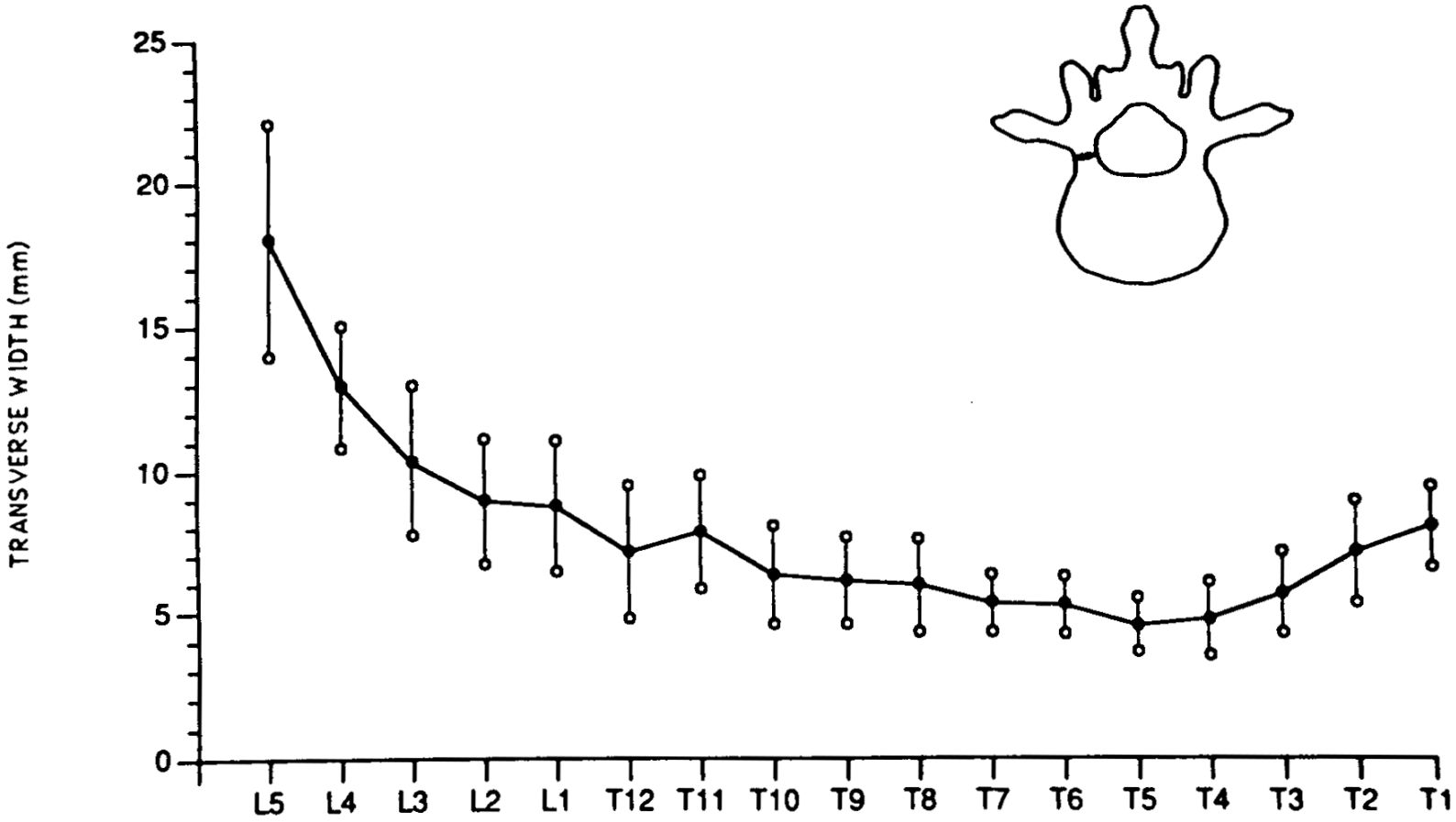




The optimal point of pedicle screw entry is at the junction of the pars interarticularis, the midpoint of the transverse process and the inferior point of the superior articular facet: the point A indicates the entry point of current study with the junction of the proximal edge of the transverse process and lamina; the point B indicates Roy-Camille's screw entry point; the point C indicates Magerl's method; the point D indicates Levin and Edwards method; the point E indicates Weinstein's method; and the point F indicates the D and Zhao method.

Oh et al 2013

Pedicle *Transverse Width*



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Zindrick, Spine, 12 (2):160-166, 1987

Pedicle Dimensions: Age Considerations

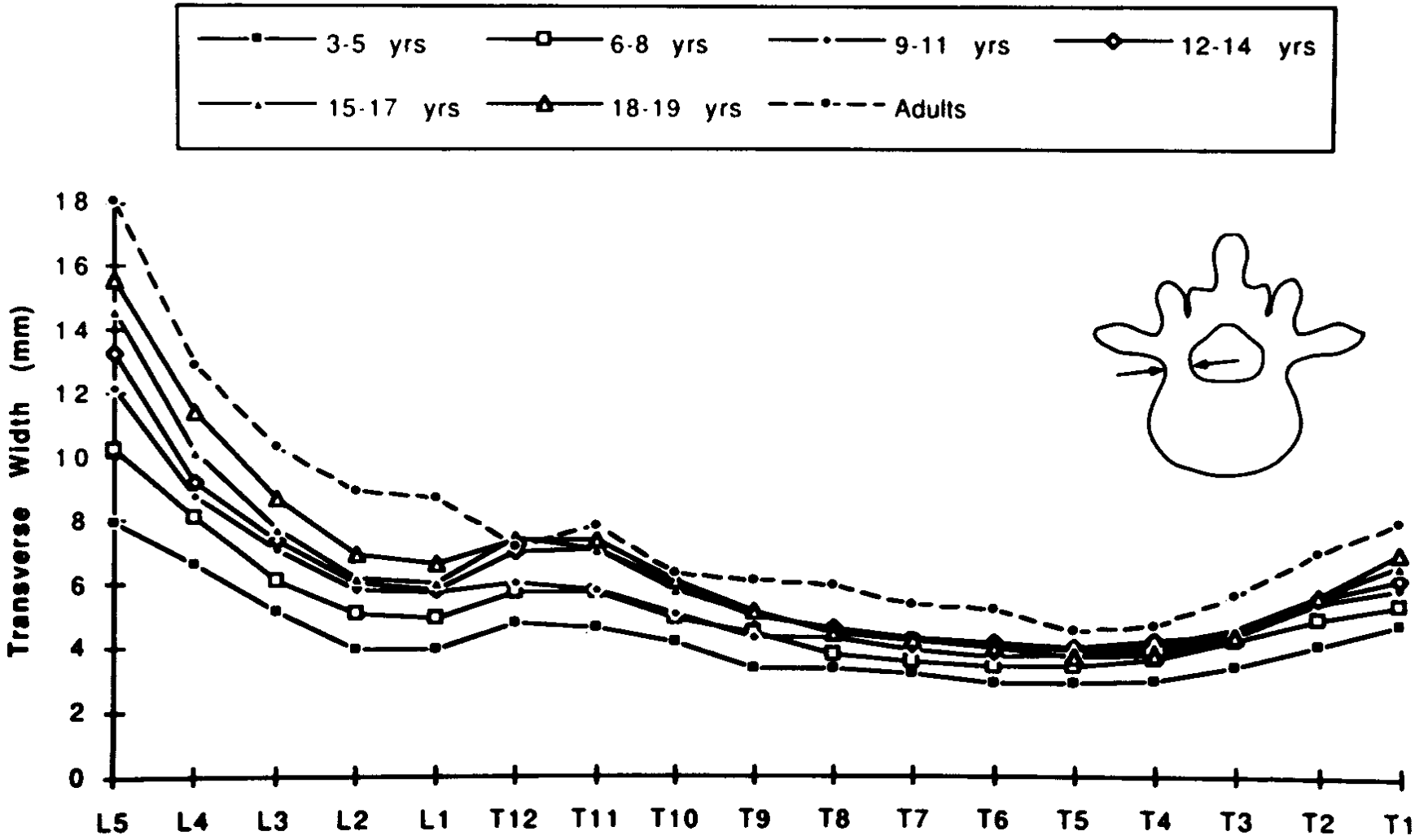

FIGURE 1. Mean adult and pediatric transverse pedicle isthmus width as a function of spinal level.

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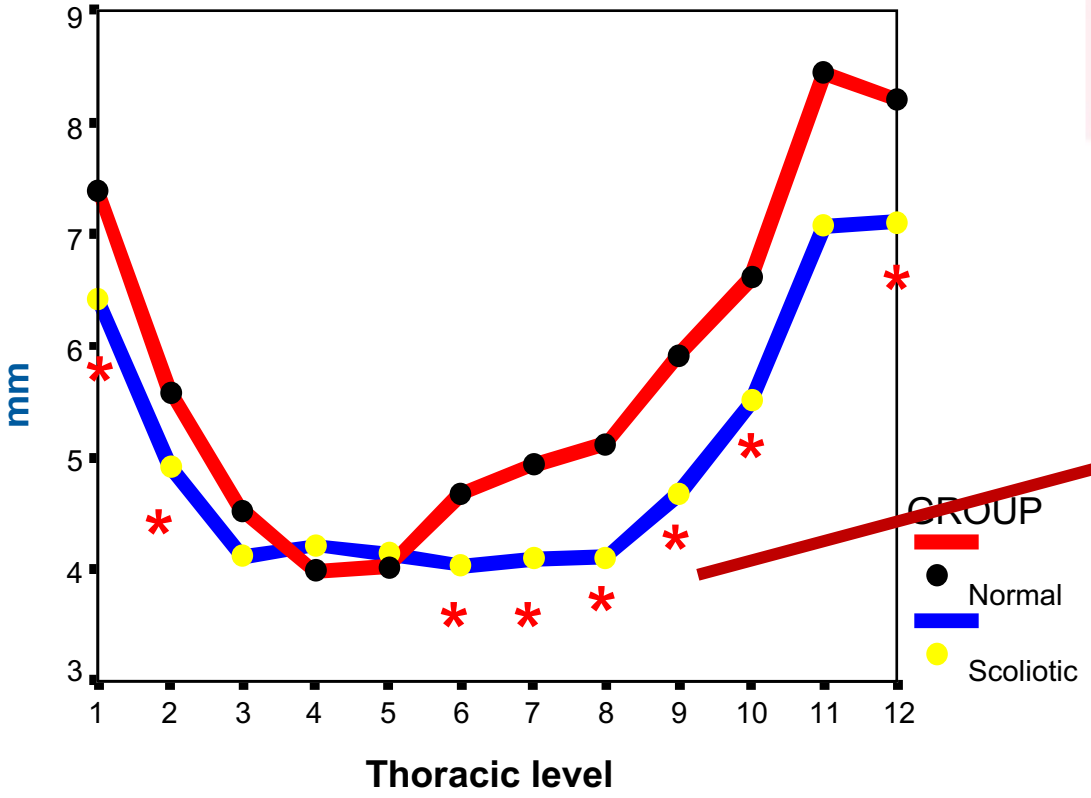
Morphology Changes With Scoliosis

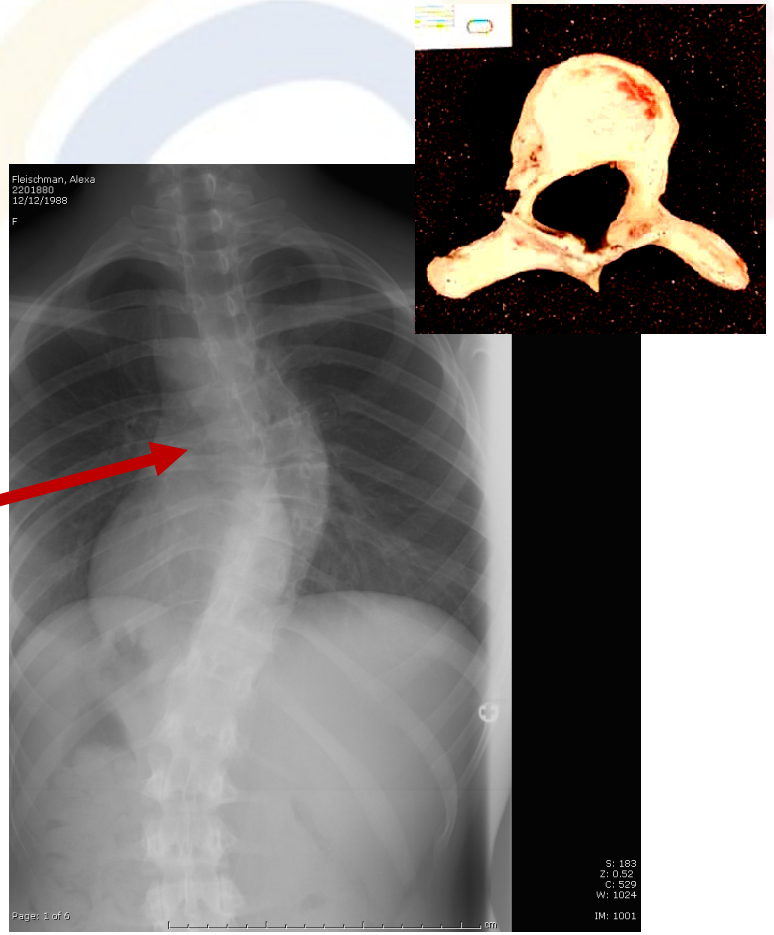
Smaller concave side?

What is the rotation?

What is the sagittal orientation?

Average L Pedicle Width Right Scoliosis vs Normal



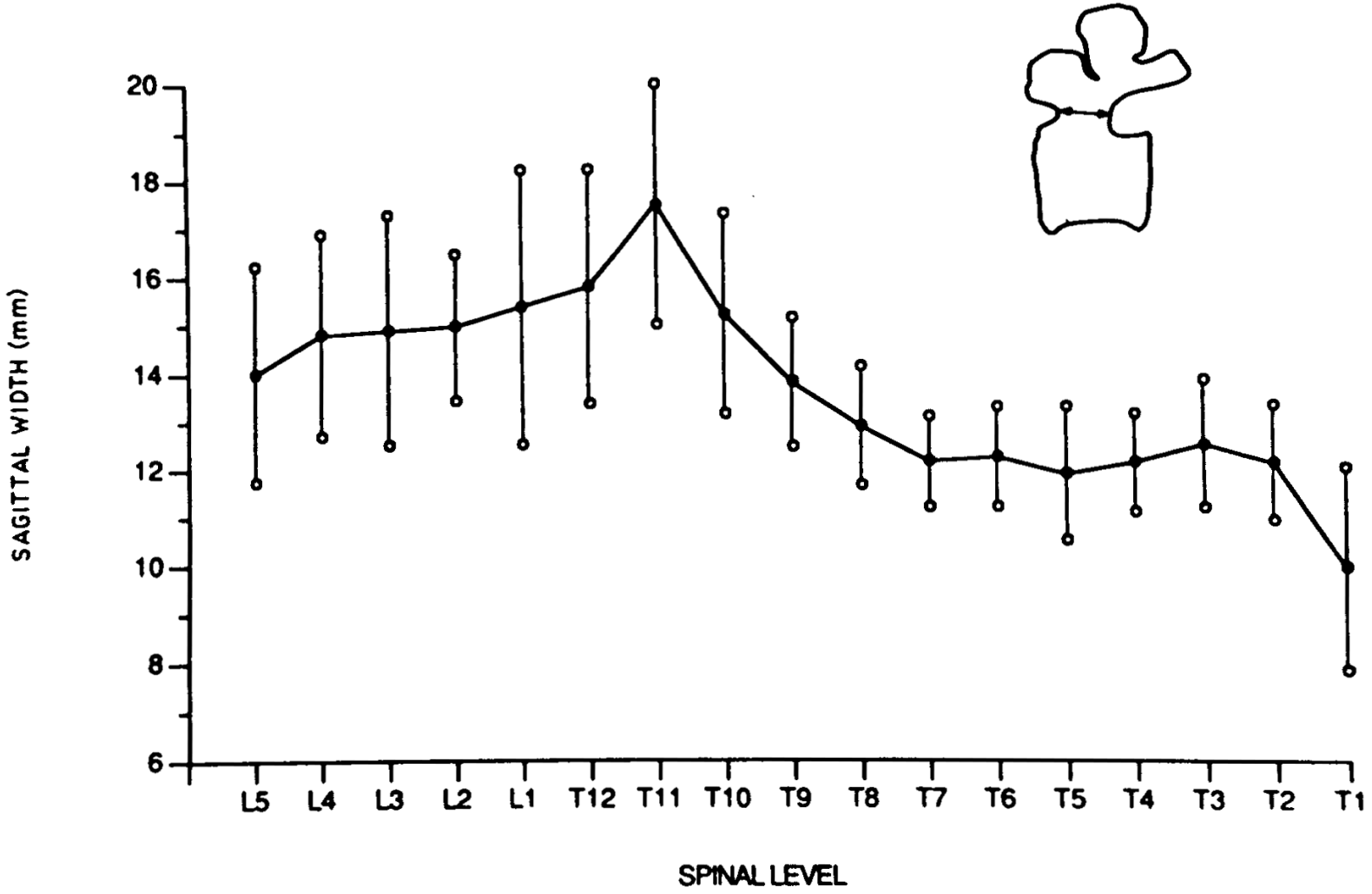


* = Significant

c/o J Emans

	Normal	Scoliotic concave
Upper thoracic area (T1-T3):	width 6-8 mm height 10 mm ***transverse 25-15°*** sagittal 15°	***2-4 mm***
-Middle thoracic area (T4-T9):	***width 5-6 mm*** height 12 mm transverse 10° sagittal 15°	***4-5 mm***
-Lower thoracic area (T10-T12):	width 8 mm height 15 mm ***transverse 0°*** sagittal 10°	***6-7 mm***

Pedicle *Sagittal Width*



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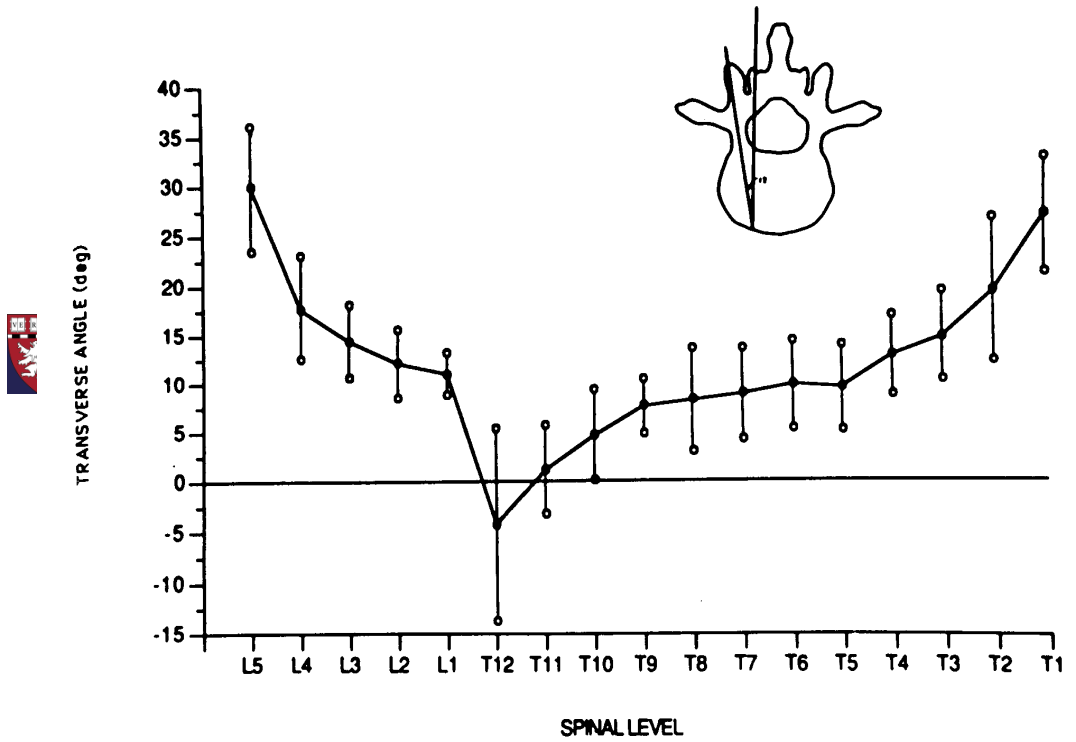
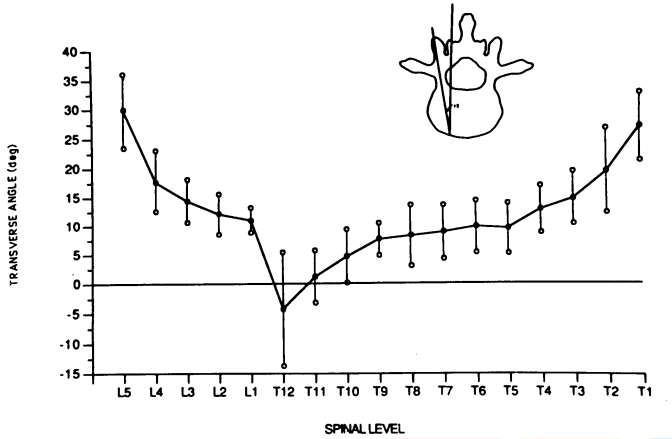
Pedicle Trajectory: Transverse Angle

Transverse pedicle angle decreases until lumbar region, then increases through lumbar spine




TRANSVERSE ANGLE (deg)
40
35
30
25
20
15
10
5
0
-5
-10
-15
L5 L4 L3 L2 L1 T12 T11 T10 T9 T8 T7 T6 T5 T4 T3 T2 T1
SPINAL LEVEL

T1 T2 T3


Sensation 64 SYS#CT54468
A
CHILDREN'S HOSPITAL BOSTON
Ex: CTTS
SE: 4
; 59.1
IM: 130
Req Num: 10301263
Marte, Brandon
12 YEAR M 4090712
DOB: 12/30/1993
Study 12/22/2006
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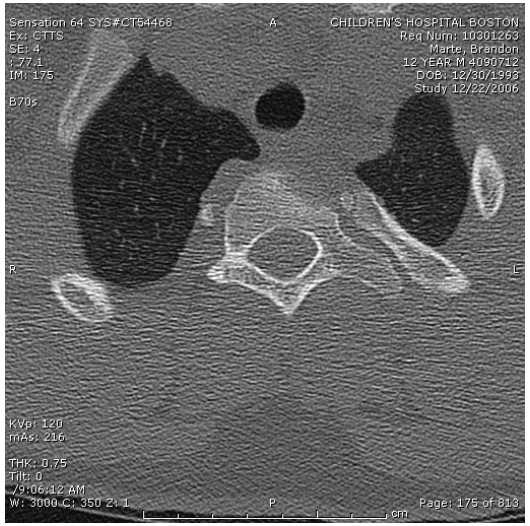
Sensation 64 SYS#CT54468
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CHILDREN'S HOSPITAL BOSTON
Ex: CTTS
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12 YEAR M 4090712
DOB: 12/30/1993
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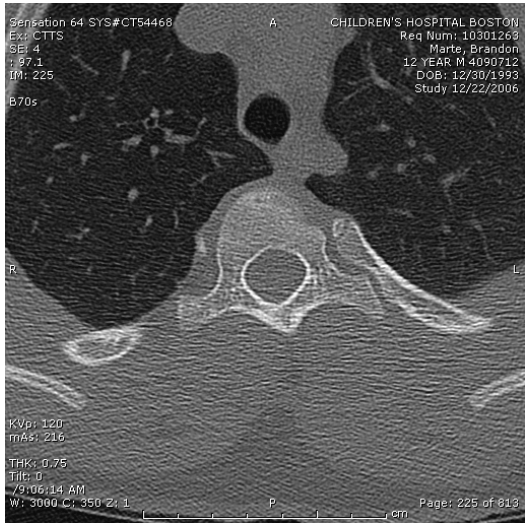
Sensation 64 SYS#CT54468
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CHILDREN'S HOSPITAL BOSTON
Ex: CTTS
SE: 4
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Req Num: 10301263
Marte, Brandon
12 YEAR M 4090712
DOB: 12/30/1993
Study 12/22/2006
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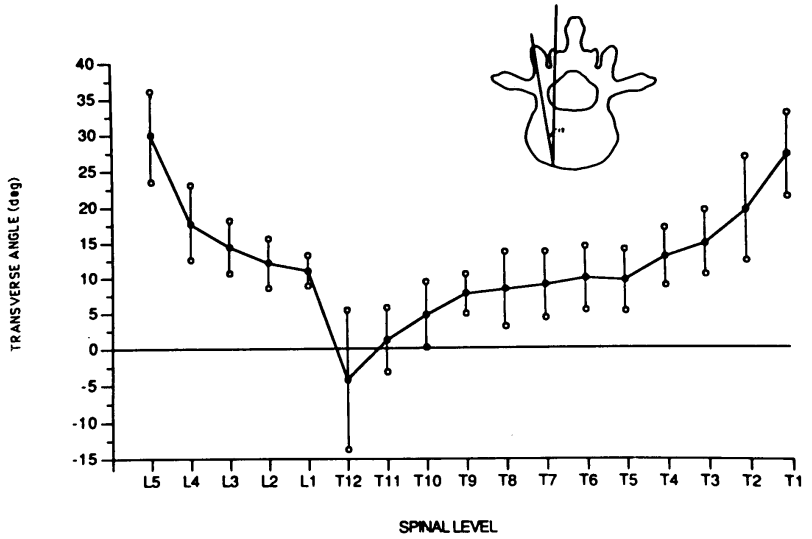
Page: 225 of 813


TRANSVERSE ANGLE (deg)
40
35
30
25
20
15
10
5
0
-5
-10
-15
L5 L4 L3 L2 L1 T12 T11 T10 T9 T8 T7 T6 T5 T4 T3 T2 T1
SPINAL LEVEL

T4


Sensation 64 SYS#CT54468
A
CHILDREN'S HOSPITAL BOSTON
Ex: CTTS
Req Num: 10301263
SE: 4
Marte, Brandon
: 117.9
12 YEAR M 4090712
IM: 277
DOB: 12/30/1993
Study 12/22/2006
B70s
R
L
KVp: 120
mAs: 216
THK: 0.75
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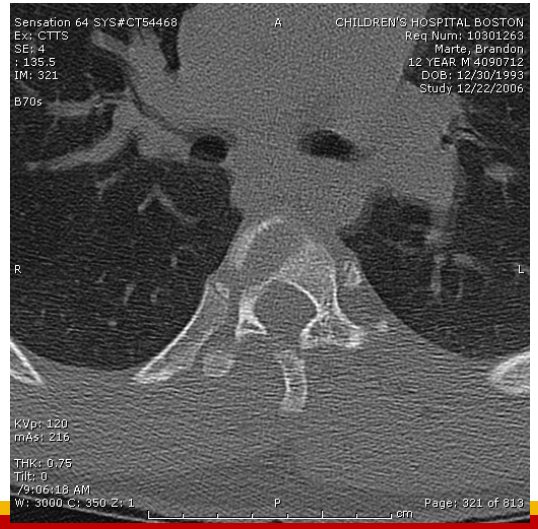
P
Page: 277 of 813

T5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: 135.5
12 YEAR M 4090712
IM: 321
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R
L
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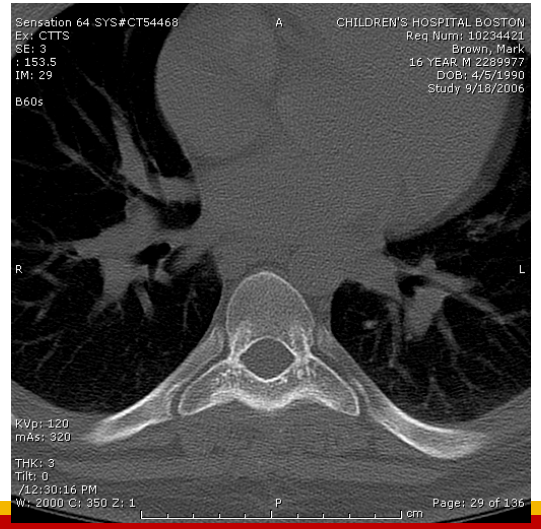
T6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A
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Brown, Mark
: 153.5
16 YEAR M 2289977
IM: 29
DOB: 4/5/1990
Study 9/18/2006
B60s
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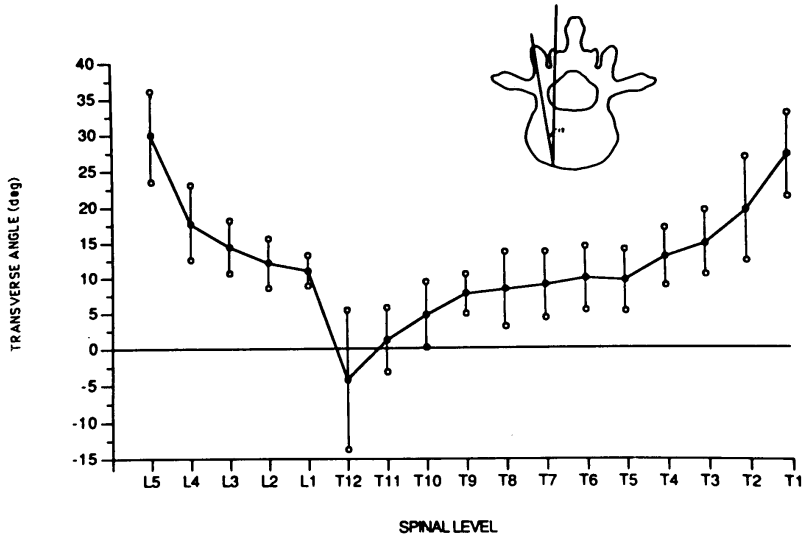
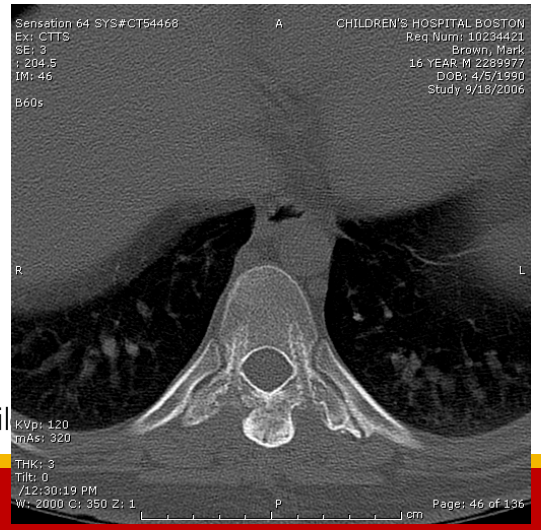
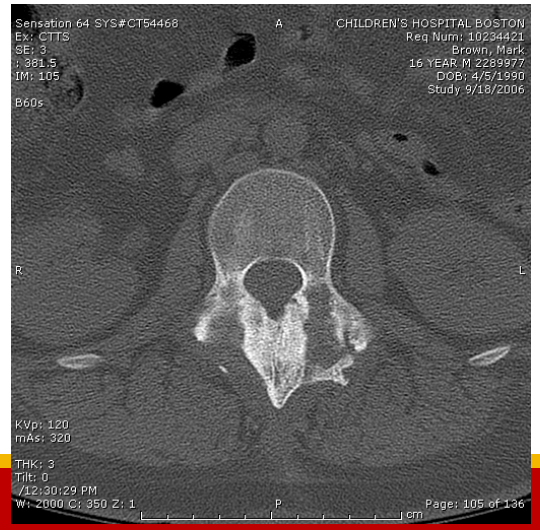


T8 T10 T12





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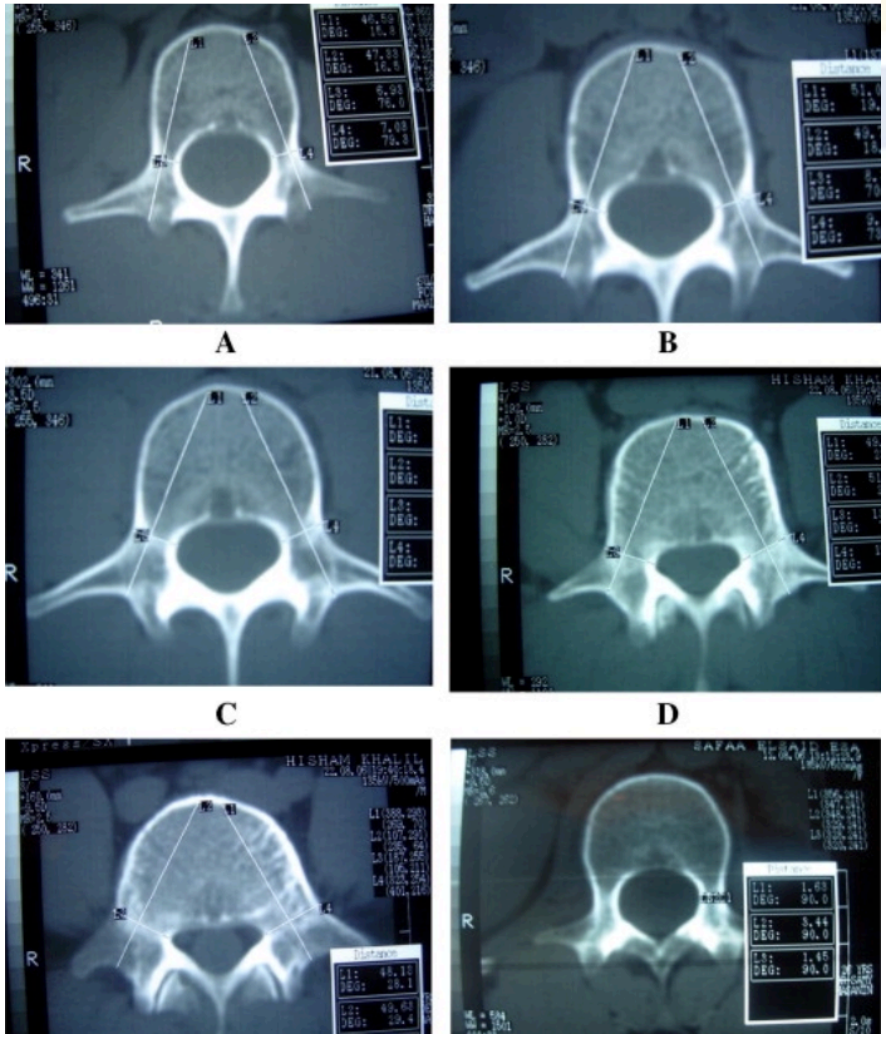
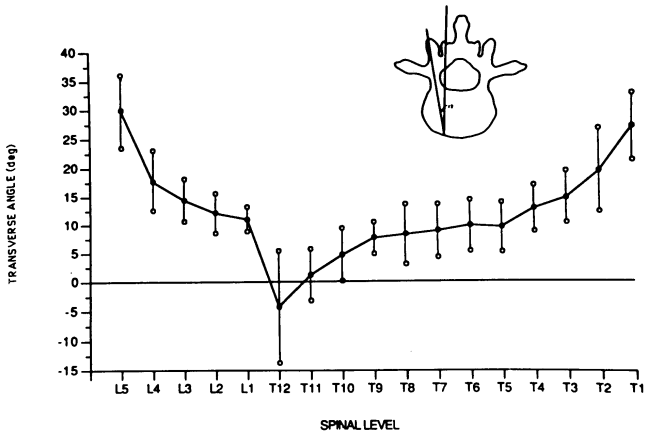
Lumbar Pedicle Angles

A→E

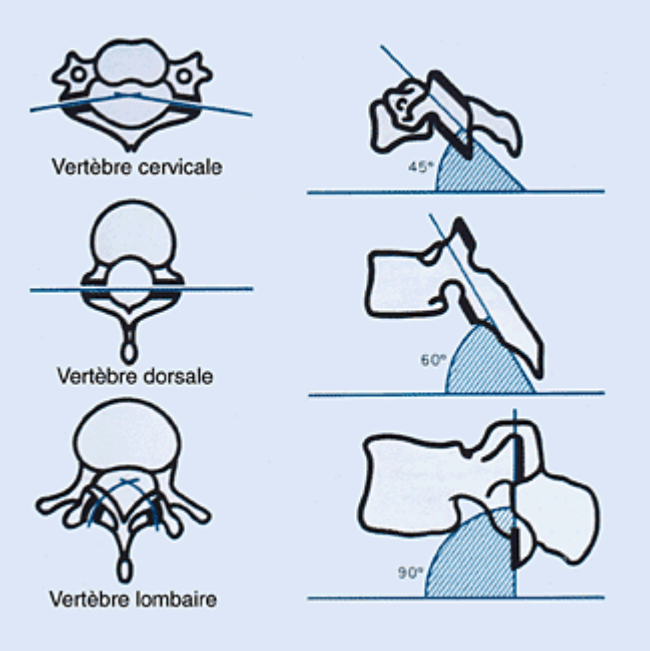
L1→L5

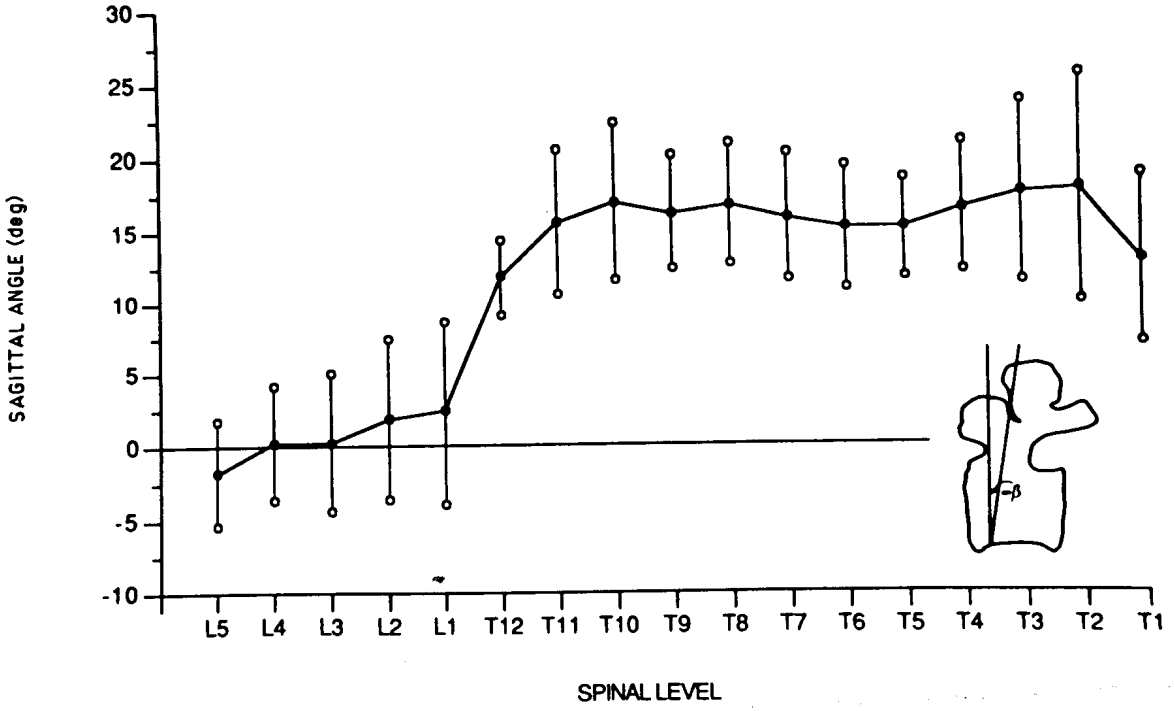




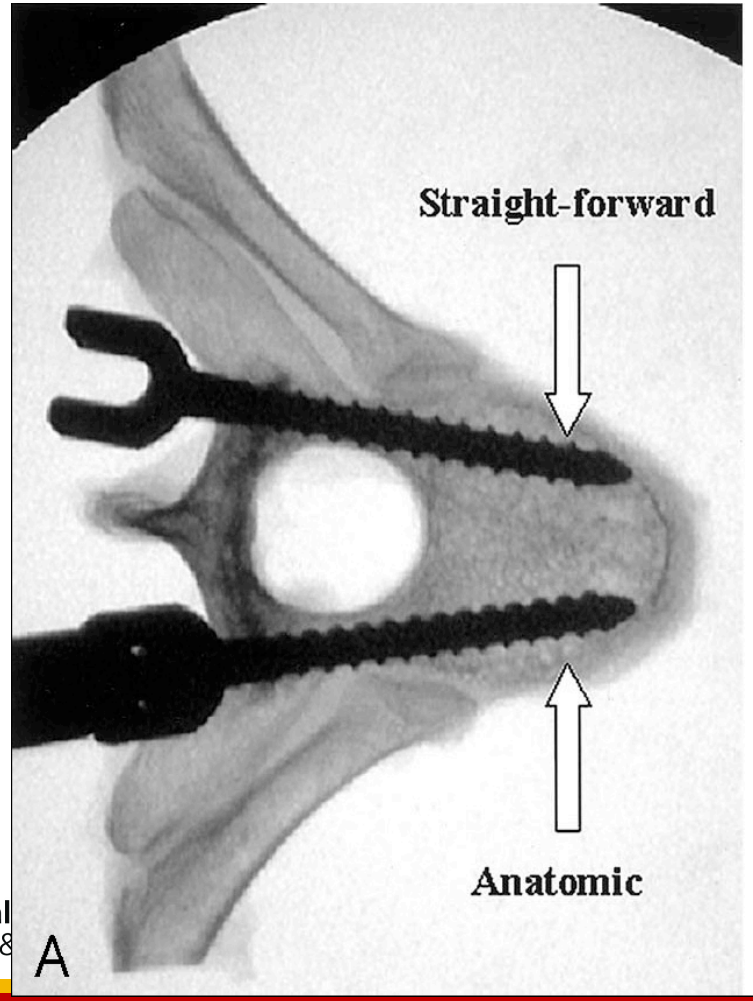
Maaly et al 2010

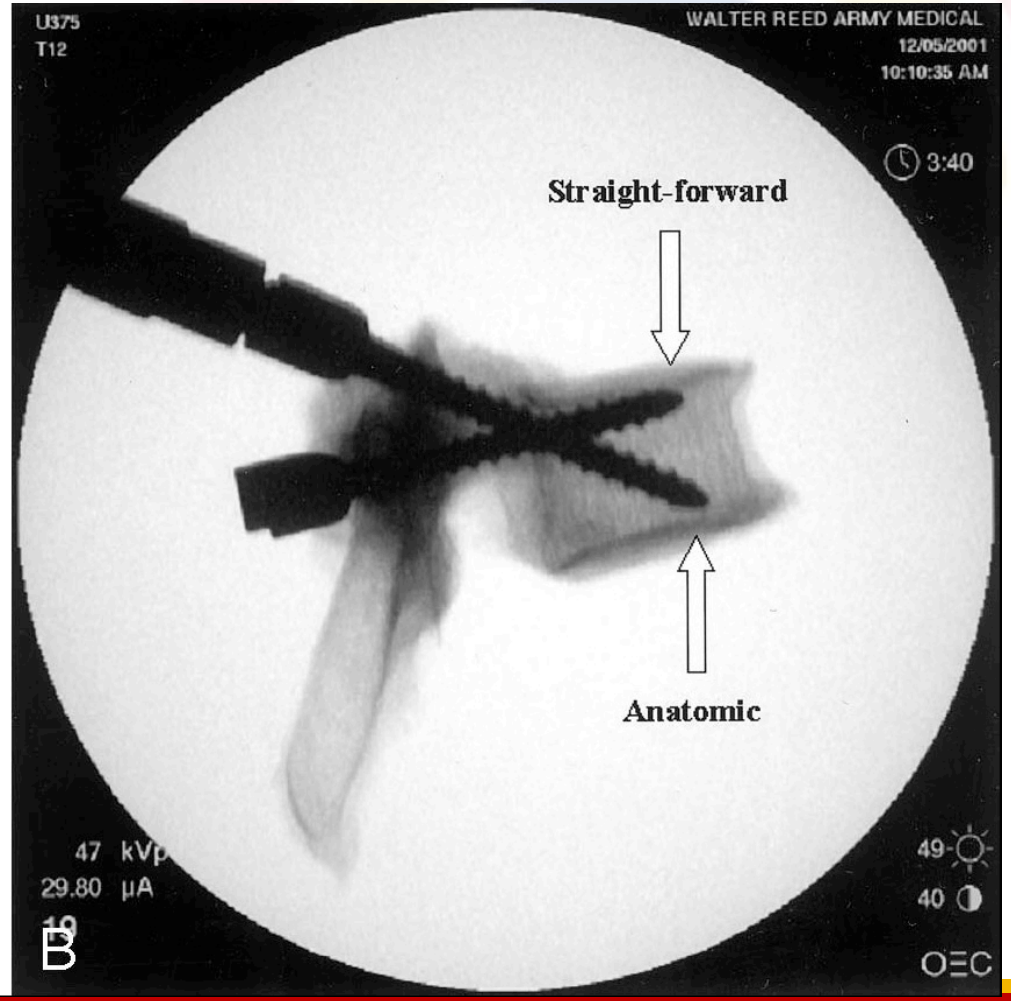
Pedicle Trajectory: Sagittal Angle





Straight Forward vs Anatomic





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Pedicle Screw Placement

University Hospitals
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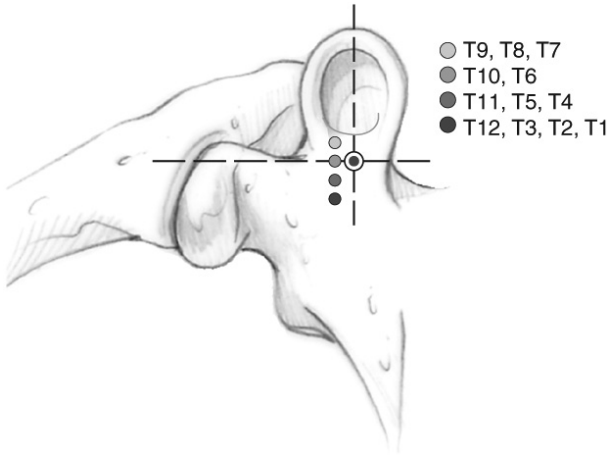
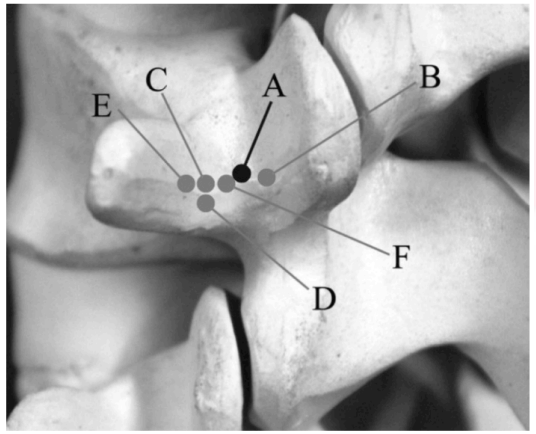
Review Article

Thoracic pedicle screw placement: Free-hand technique

Yongjung J. Kim, Lawrence G. Lenke
One Barnes-Jewish Hospital Plaza, 11300 West Pavilion, St. Louis, Missouri - 63110, USA

Pedicle Screw Placement





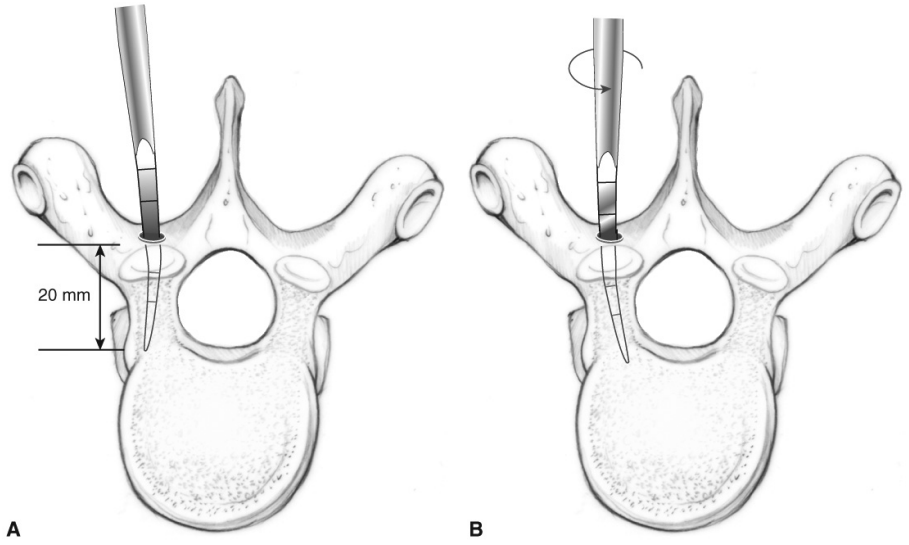
The optimal point of pedicle screw entry is at the junction of the pars interarticularis, the midpoint of the transverse process and the inferior point of the superior articular facet: the point A indicates the entry point of current study with the junction of the proximal edge of the transverse process and lamina; the point B indicates Roy-Camille's screw entry point; the point C indicates Magerl's method; the point D indicates Levin and Edwards method; the point E indicates Weinstein's method; and the point F indicates the D and Zhao method.

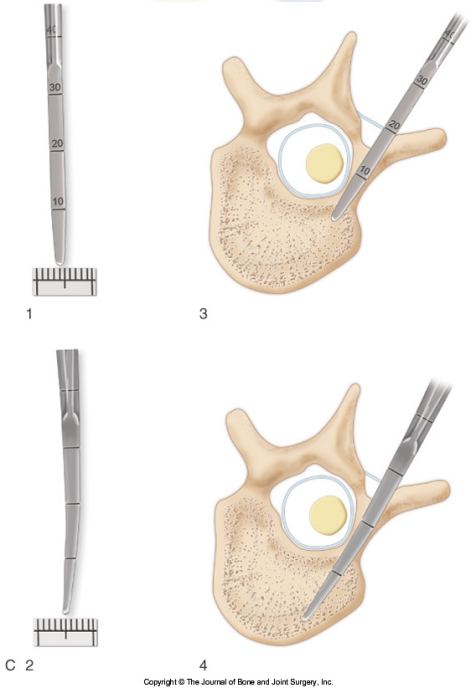
Step 1: Starting point with burr

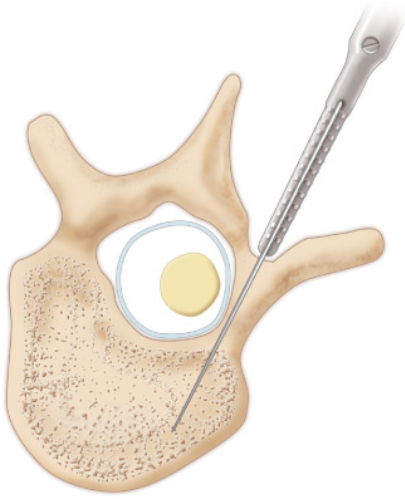
Pedicle Screw Placement

2. Insert Awl 20 mm into body (curve faced laterally)
3. Check with ball tip for integrity
4. Turn awl medially and advance remaining way into body

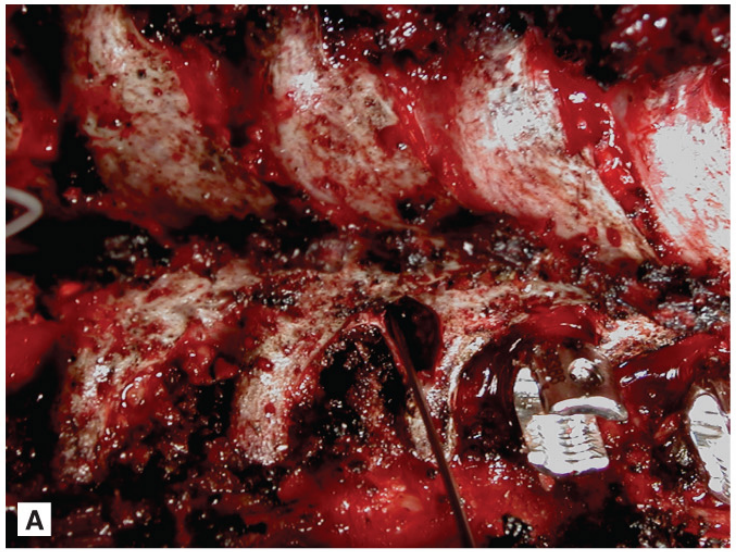
***Drill another option

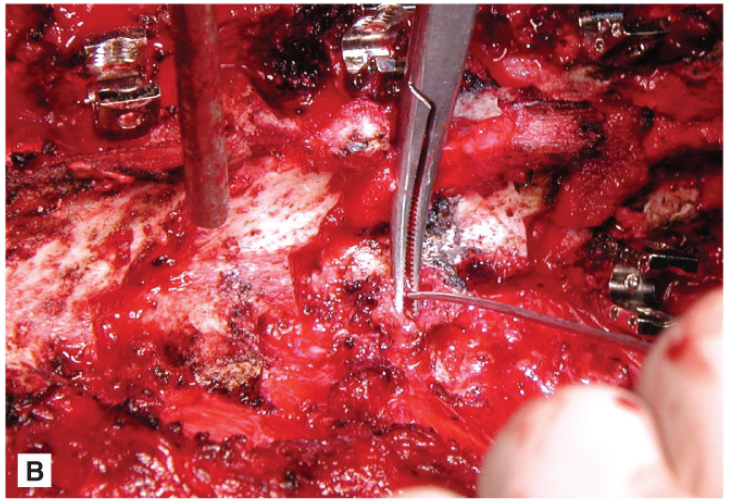


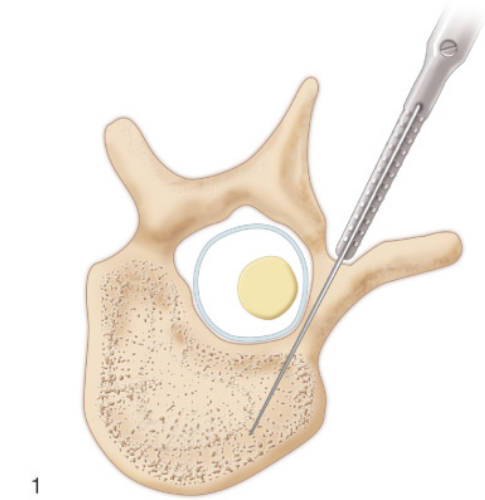


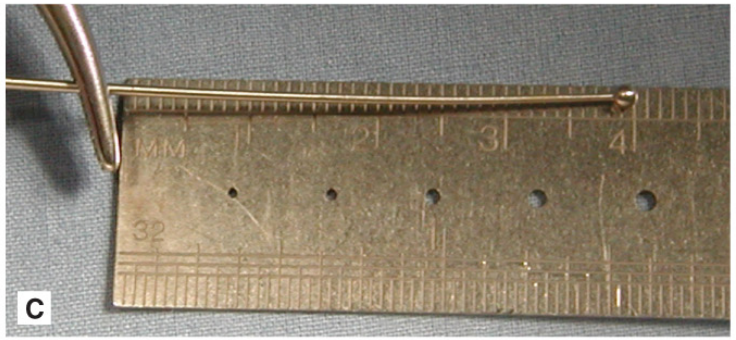


Pedicle Screw Placement









-Check track for integrity
    -Feel all walls and floor with ball tipped probe
-Measure for appropriate sized screw

Pedicle Screw Placement

Place Screw

Make sure stays in same trajectory as probe

Watch for medial/lateral deviation

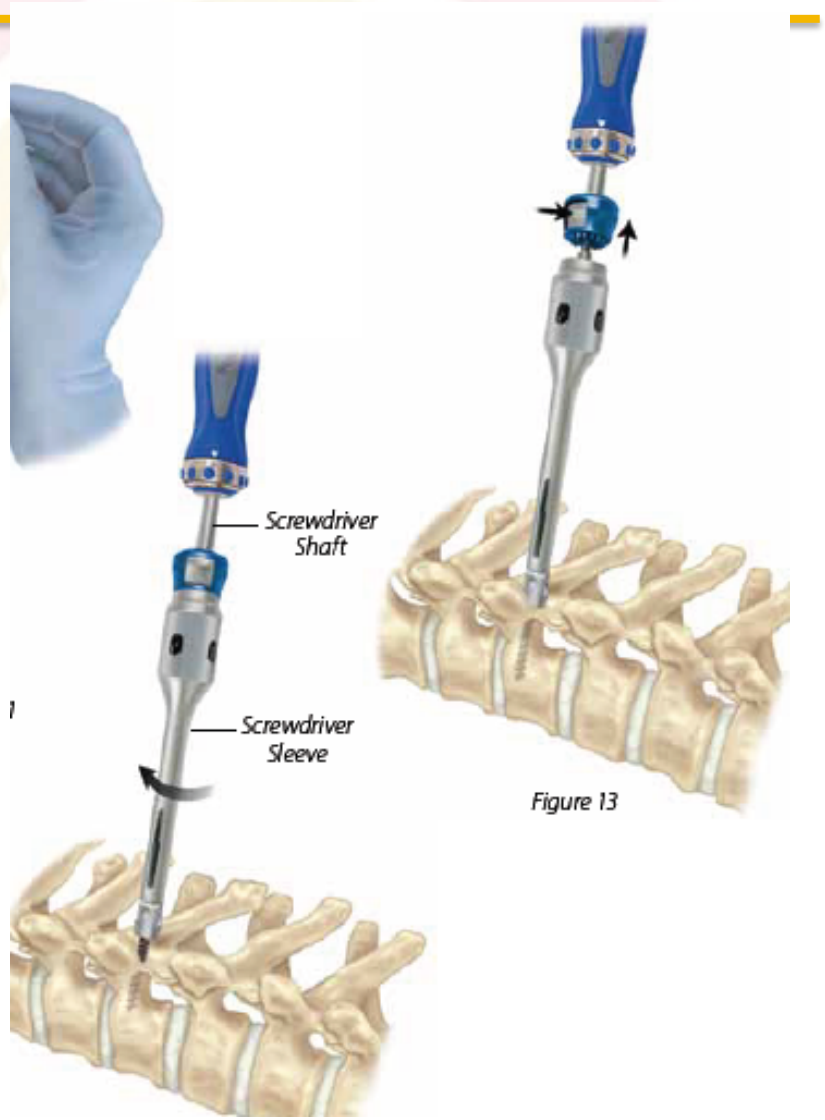
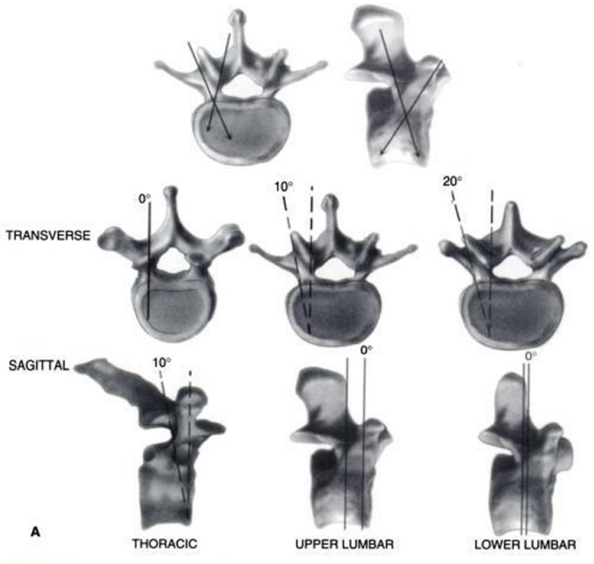


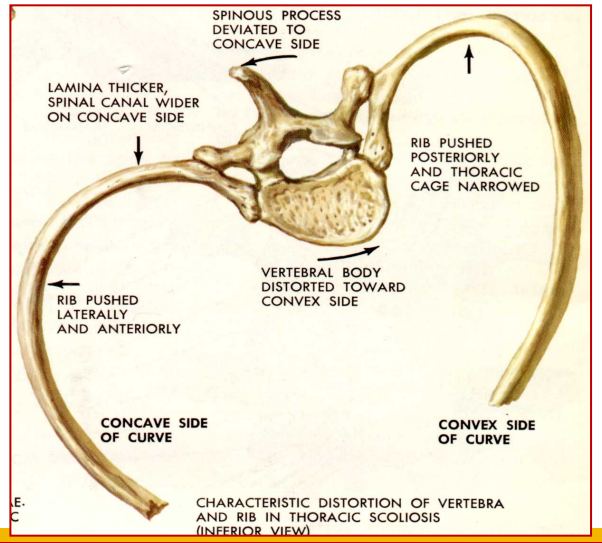
Figure 13

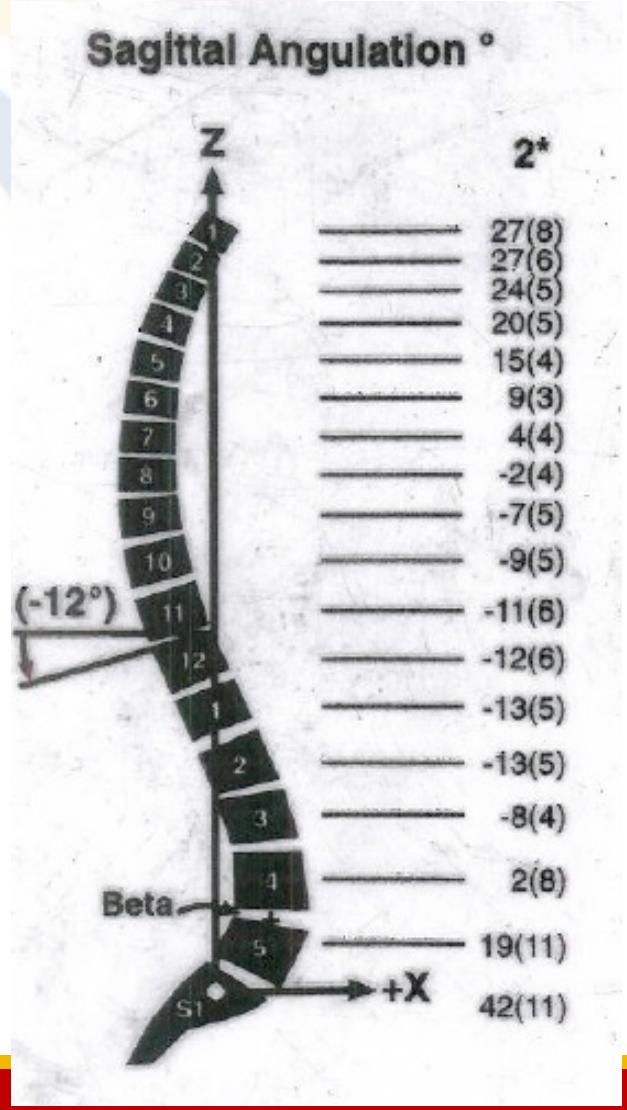
Pedicle Screw Placement

When placing a screw consider:

- Normal pedicle track (angle, size, length)
- Rotation
- Sagittal alignment at instrumented level (kyphosis/lordosis)







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Risks:

No epidural space between the pedicle and the dura

Avg. Dist between pedicle and adjacent nerve root

- 1.5 to 3.9 mm superiorly
- 1.7 to 2.8 mm inferiorly

Ebraheim, M.A. et al., Spine, 22(14):1553-1556, 1997

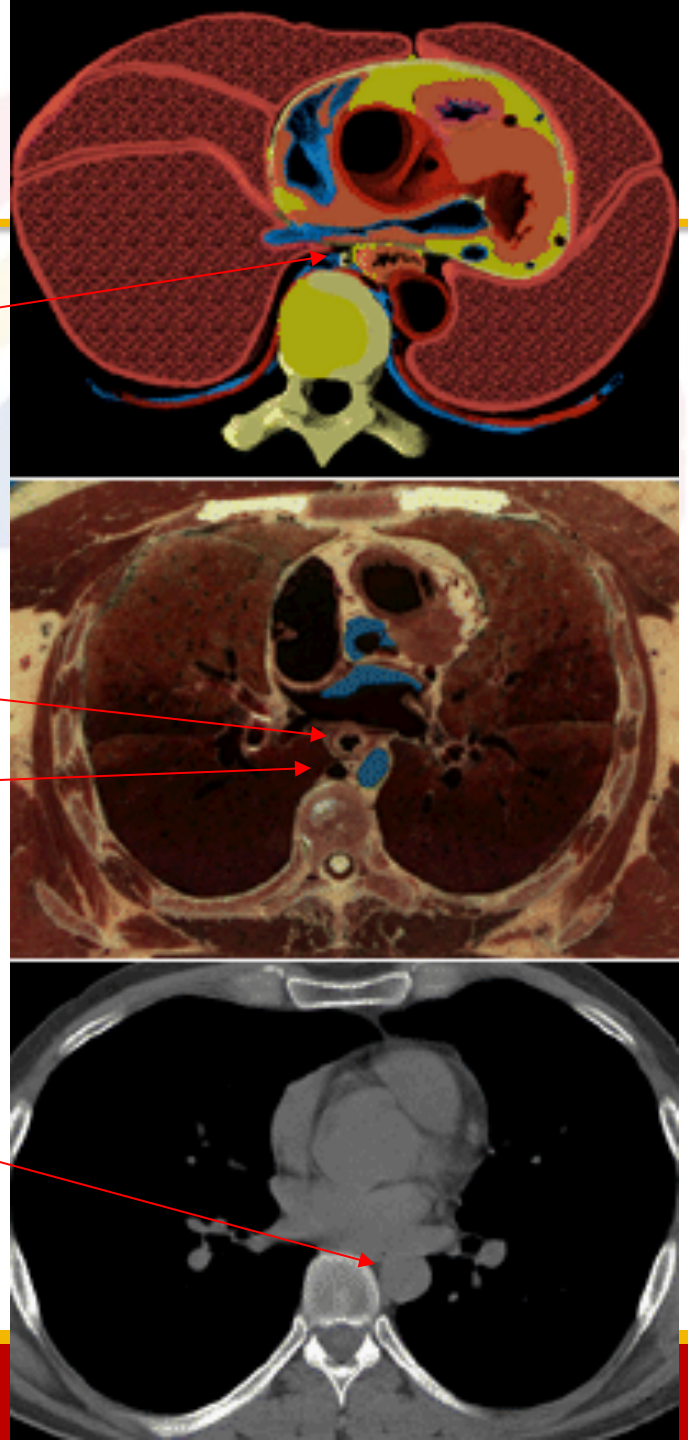
T7 Level: Risks

Thoracic duct

Esophagus

Azygos vein

Descending Aorta



Hooks

University Hospitals
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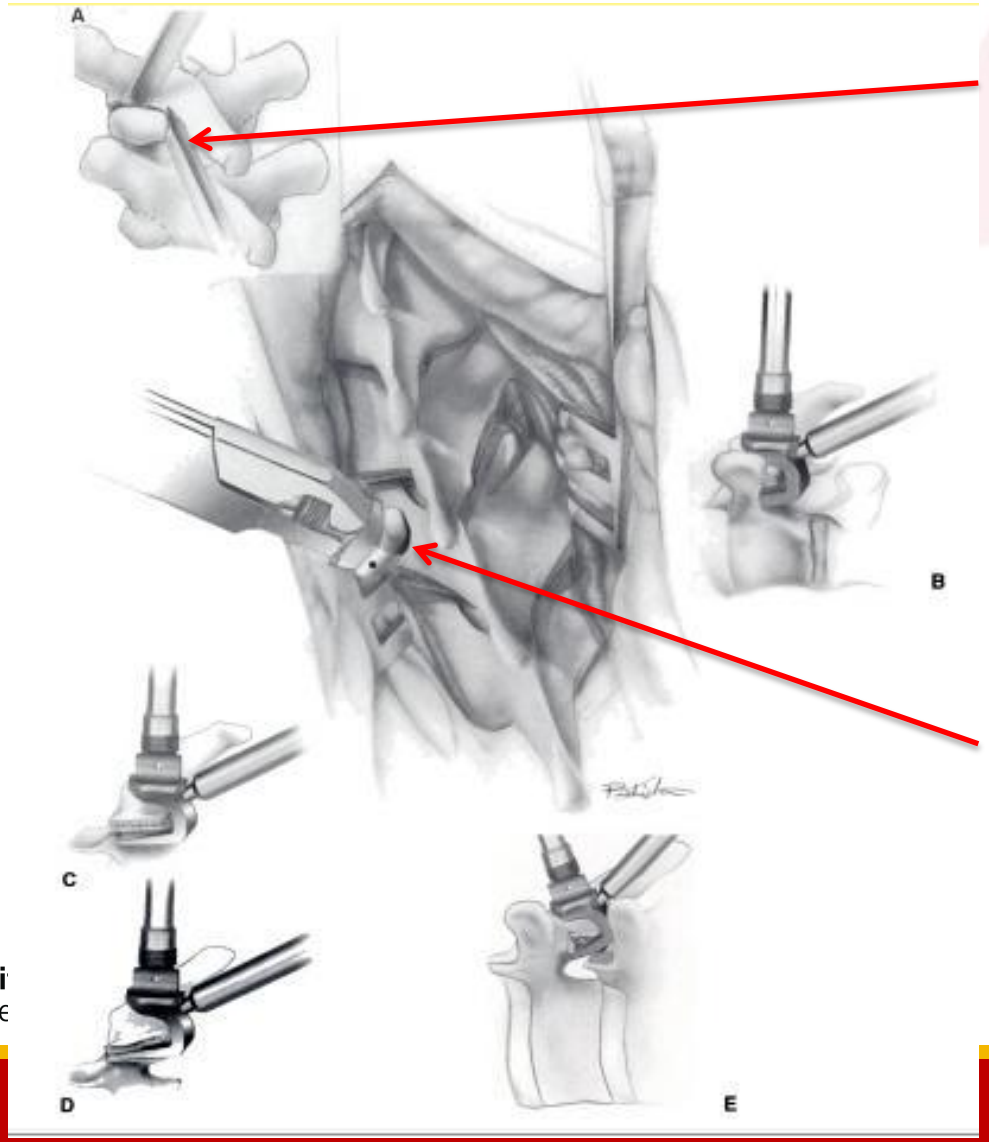
Review Article

Thoracic pedicle screw placement: Free-hand technique

Yongjung J. Kim, Lawrence G. Lenke
One Barnes-Jewish Hospital Plaza, 11300 West Pavilion, St. Louis, Missouri - 63110, USA

Hook Placement

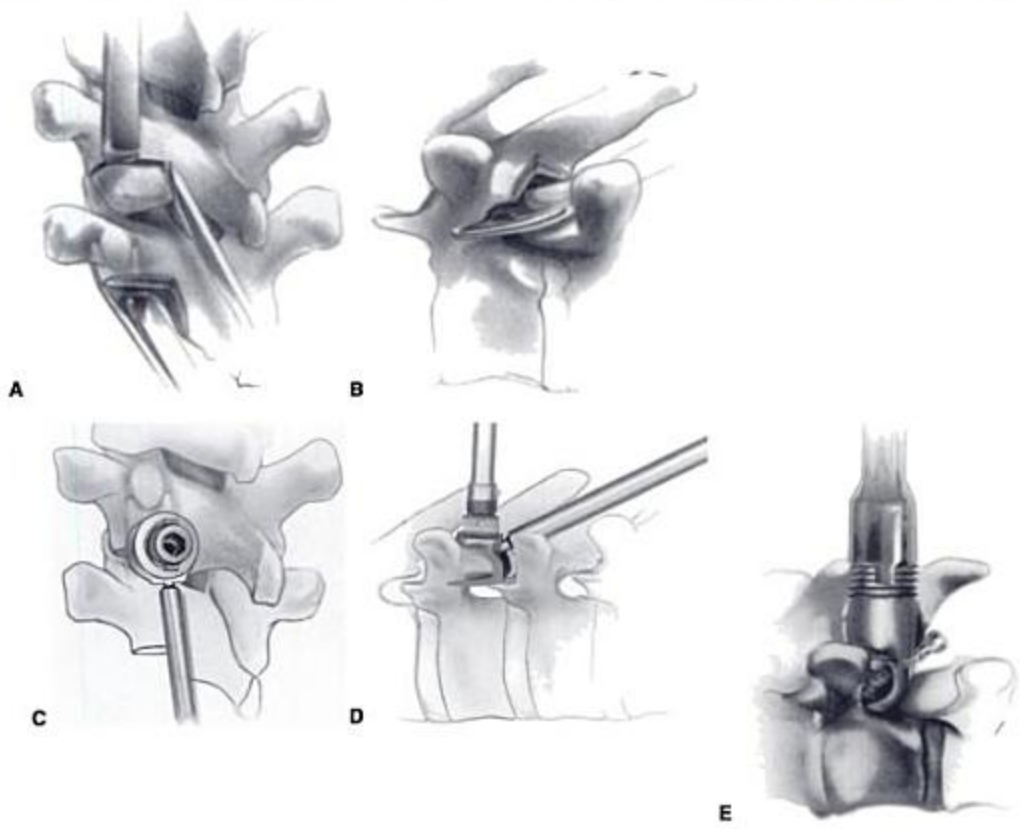


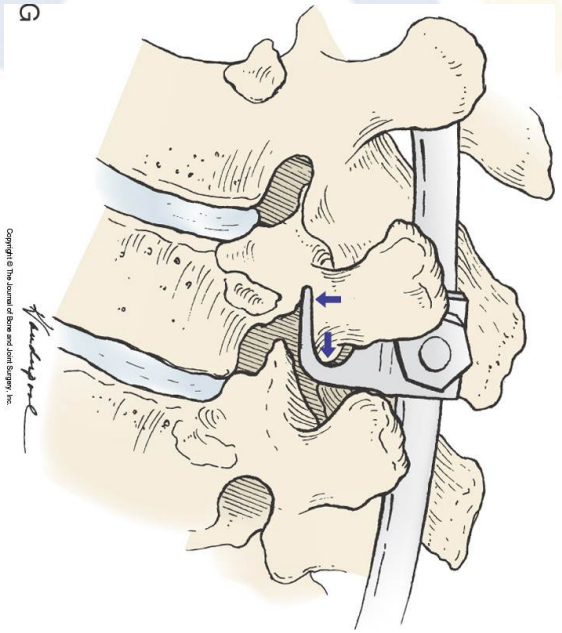
Straight osteotome (or bone scalpel) used to square off facet joint

Cartilage cleaned w/ curette or burr

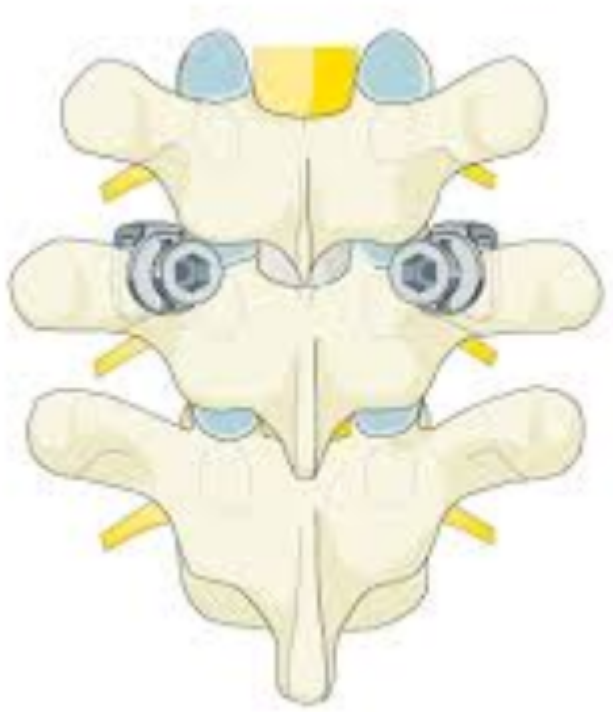
Pedicle hook placed between remaining inferior facet and exposed superior facet

Pedicle Hook (upgoing)



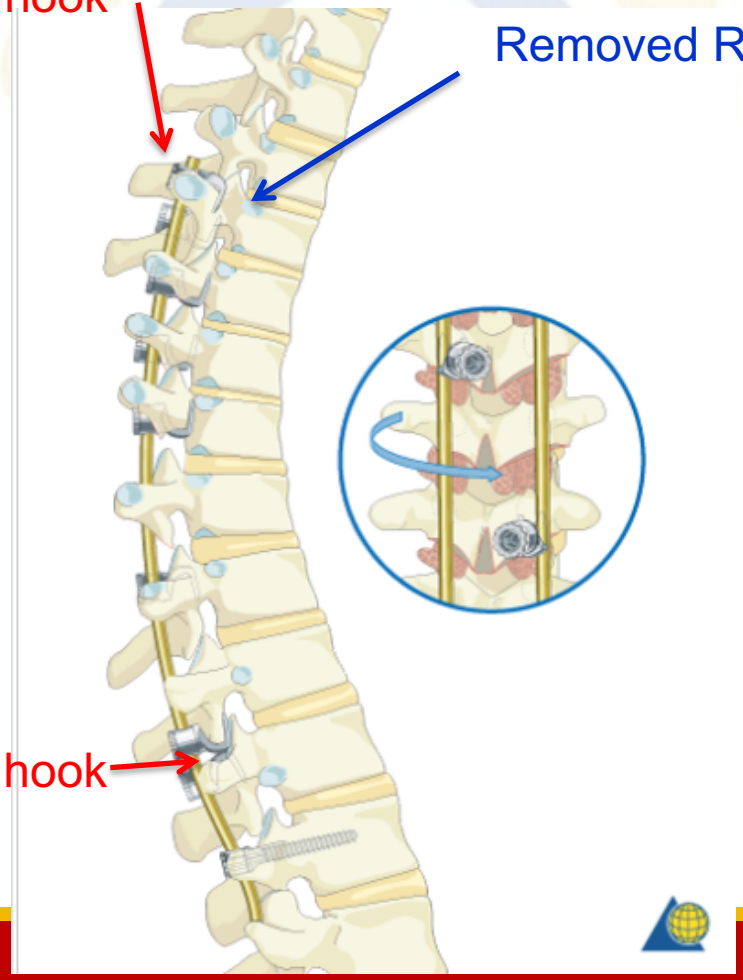


Downgoing TP Hook



TP inserted over the top of TP and sits between TP and underlying rib

Hook Placement



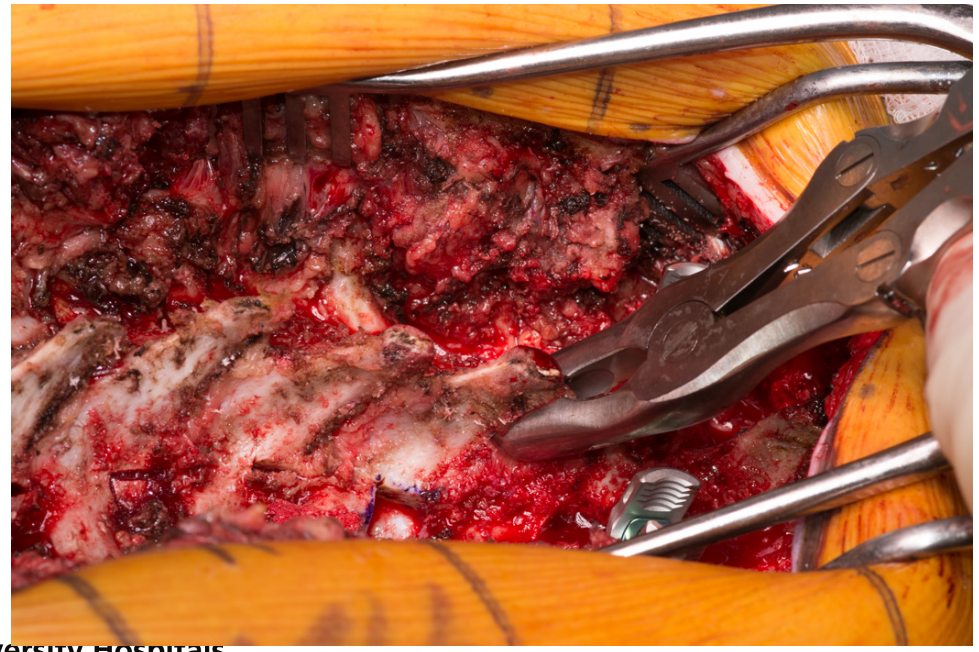
Loosening Spine (Ponte)

Ponte Osteotomy

Step 1: Inferior facetectomy

Ponte Osteotomy

Step 2: Remove interspinous ligament inferior lamina, expose ligamentum

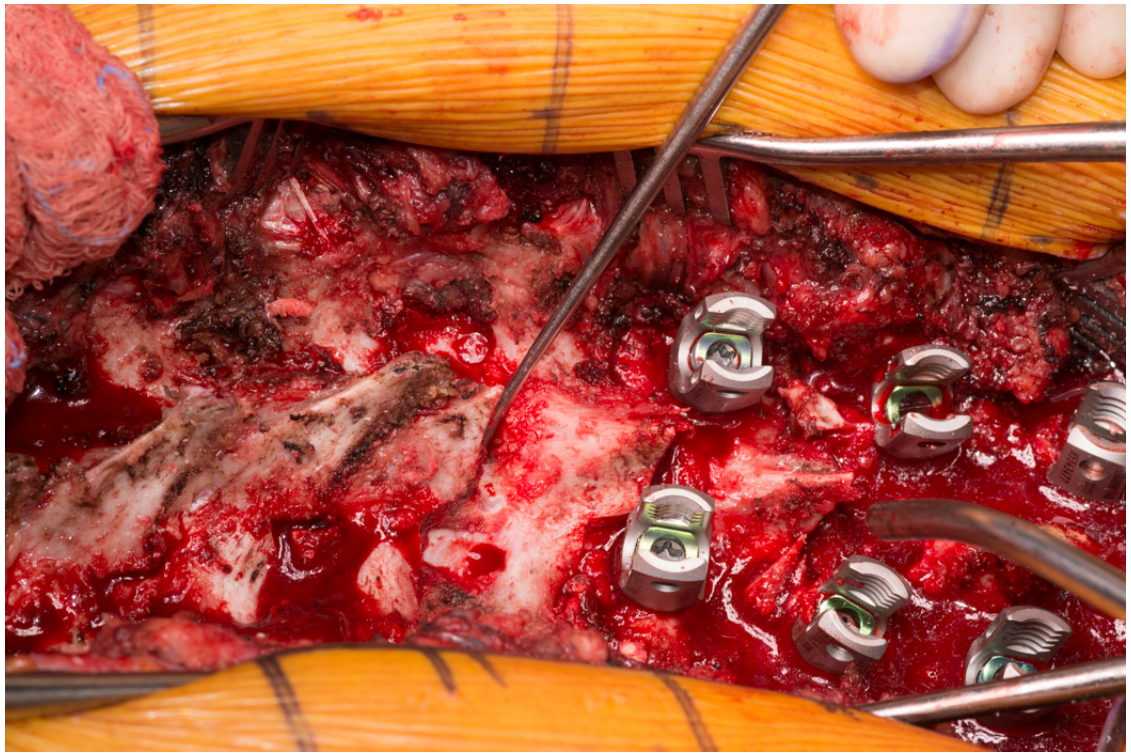


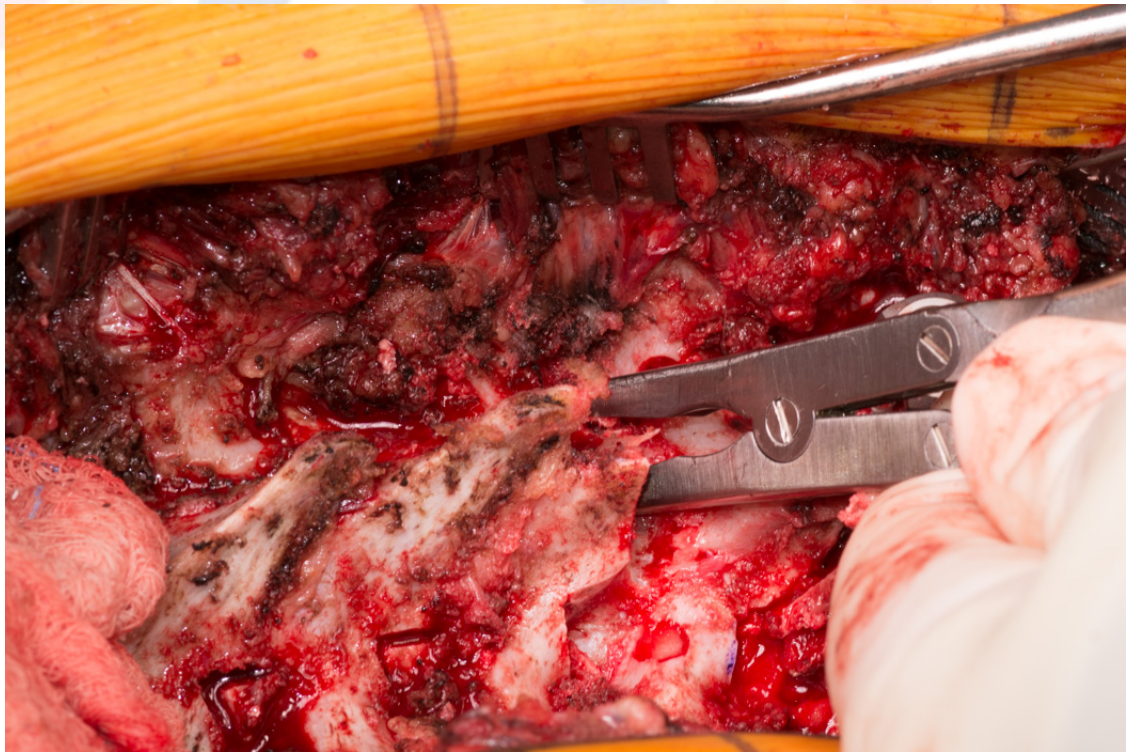
Ponte Osteotomy

Step 3: Remove ligamentum flavum

Ponte Osteotomy

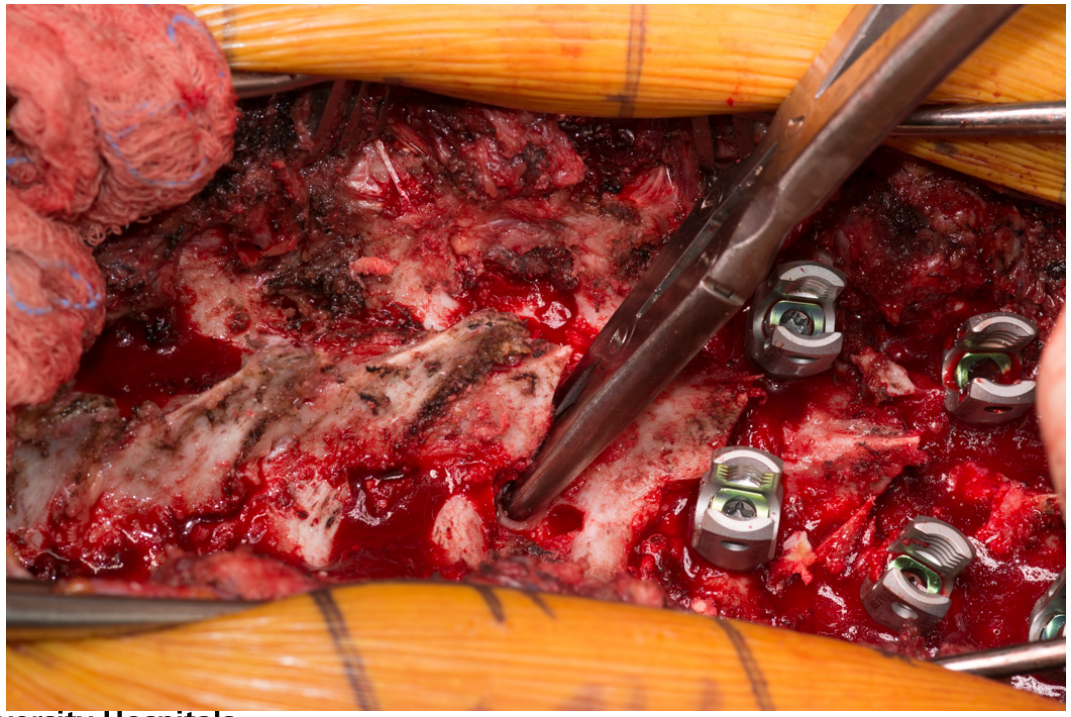
Step 4: Work toward superior articular facet





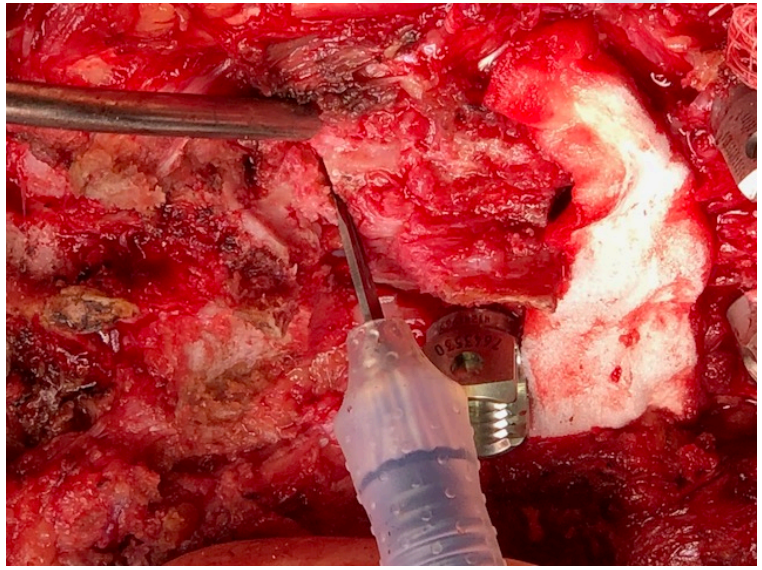
Ponte Osteotomy

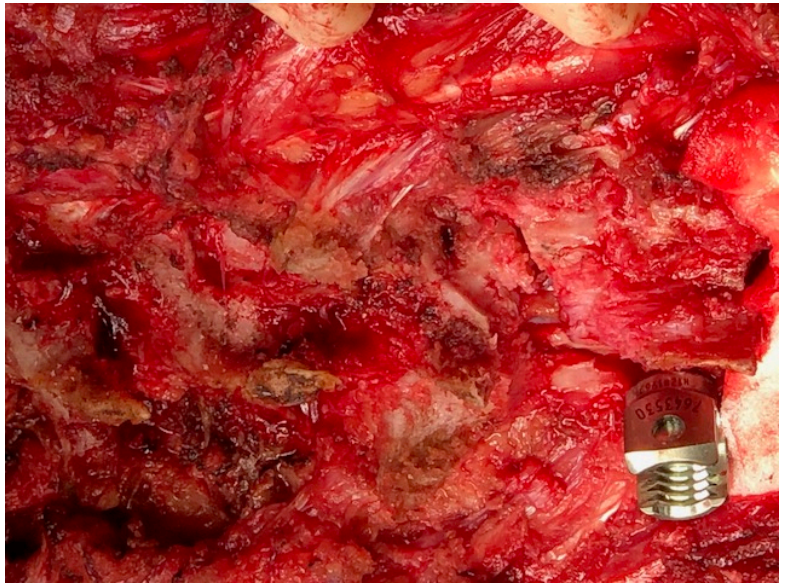
Step 5: Remove superior articular facet (rongeur, Kerrison)



Ponte Osteotomy

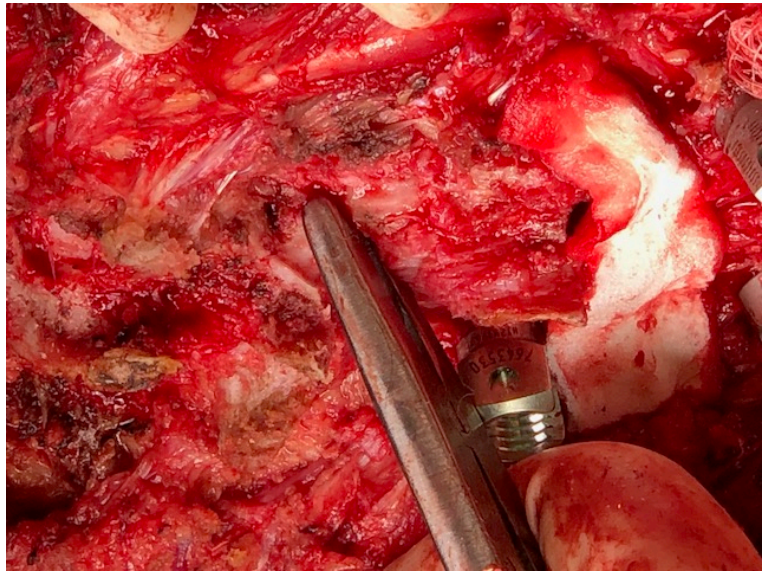
Step 5: Remove superior articular facet—Bone Scalpel

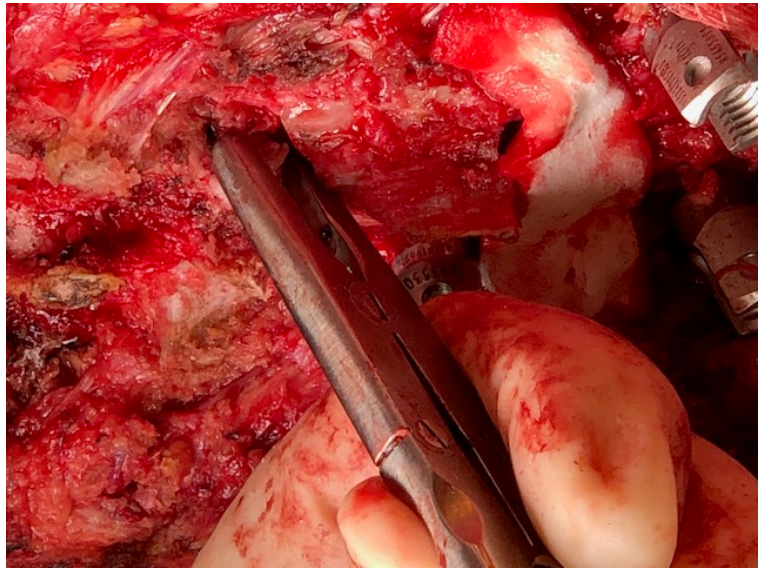


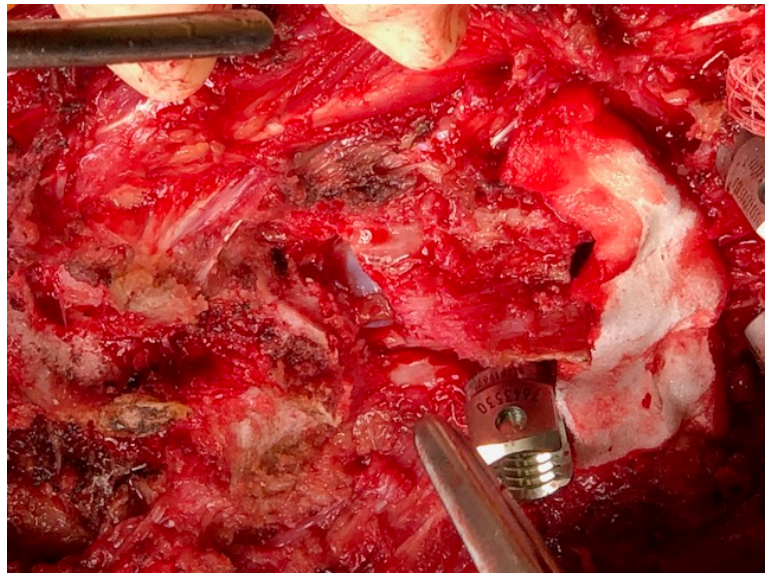


Ponte Osteotomy

Step 5: Remove superior articular facet—Rongeur

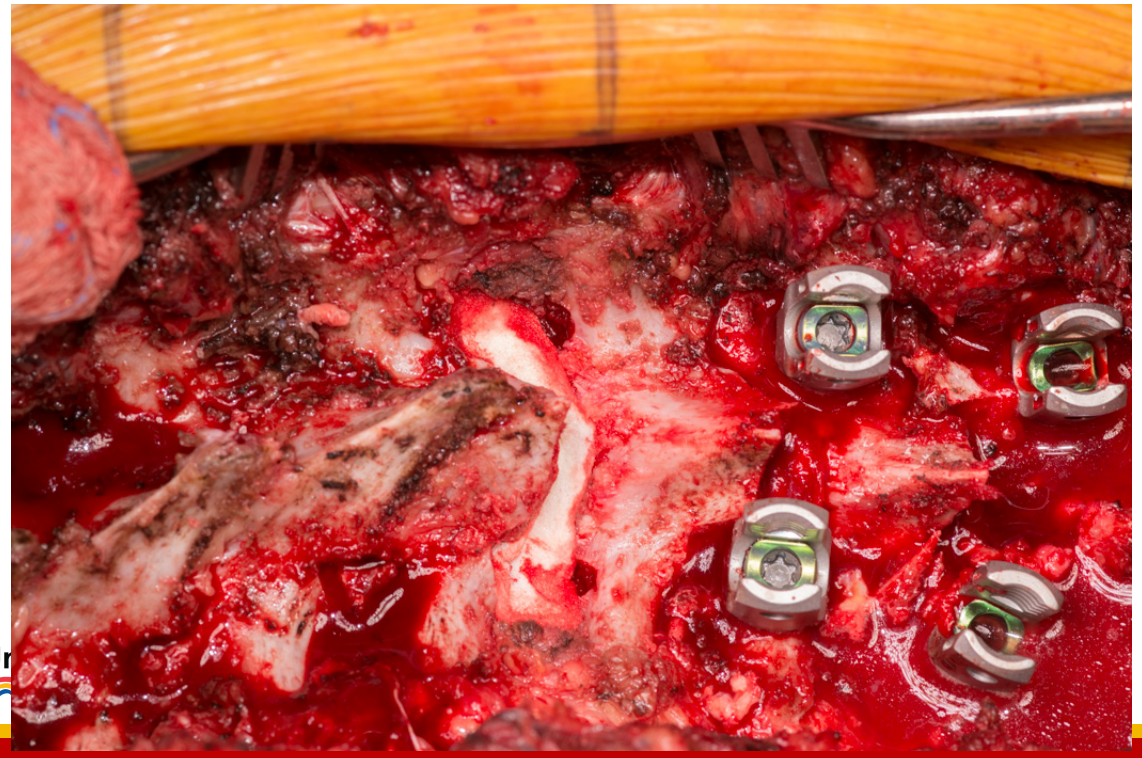




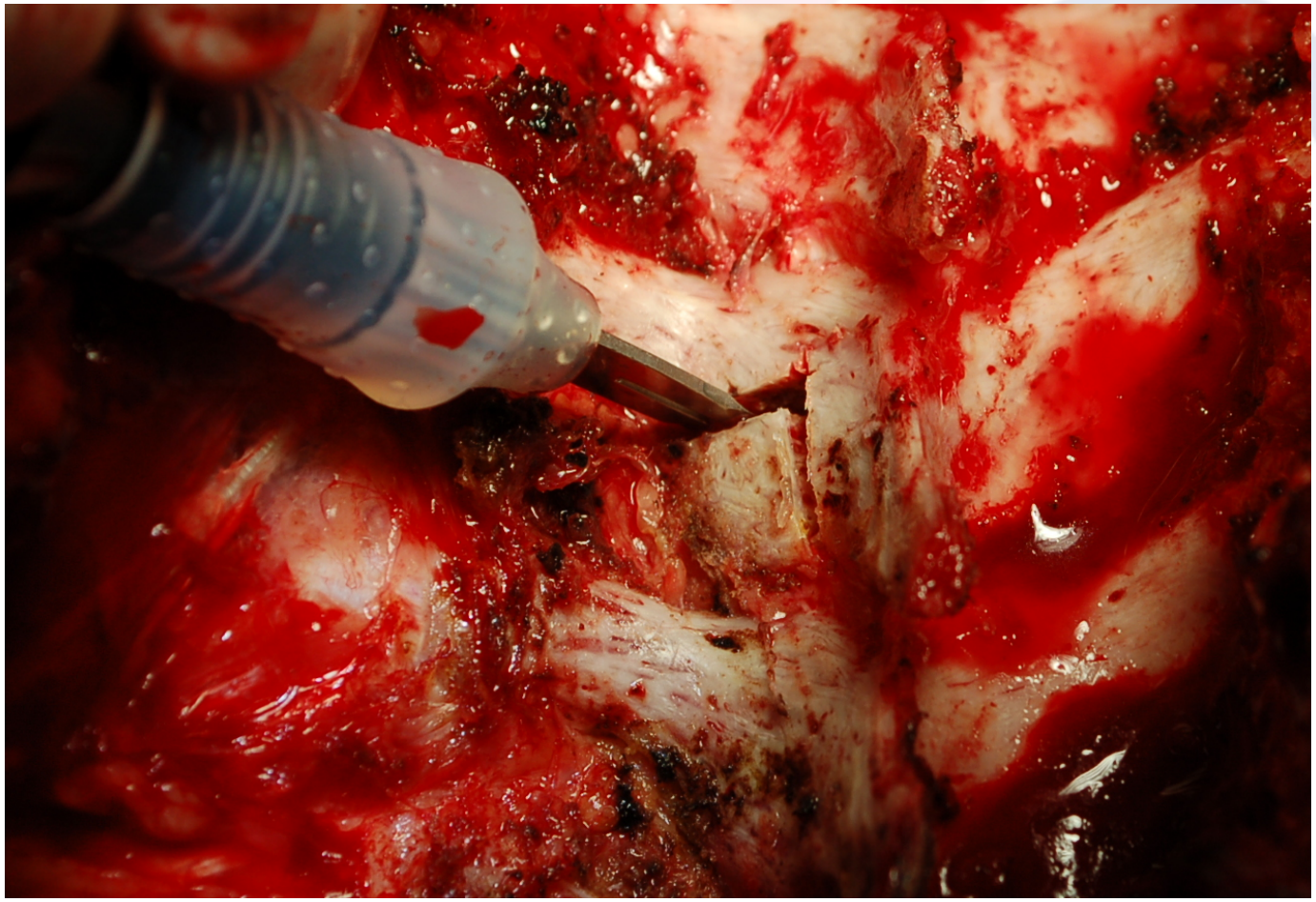


Ponte Osteotomy

Step 6: Pack with gelfoam, place screws



Alternative: Leave Facet Behind

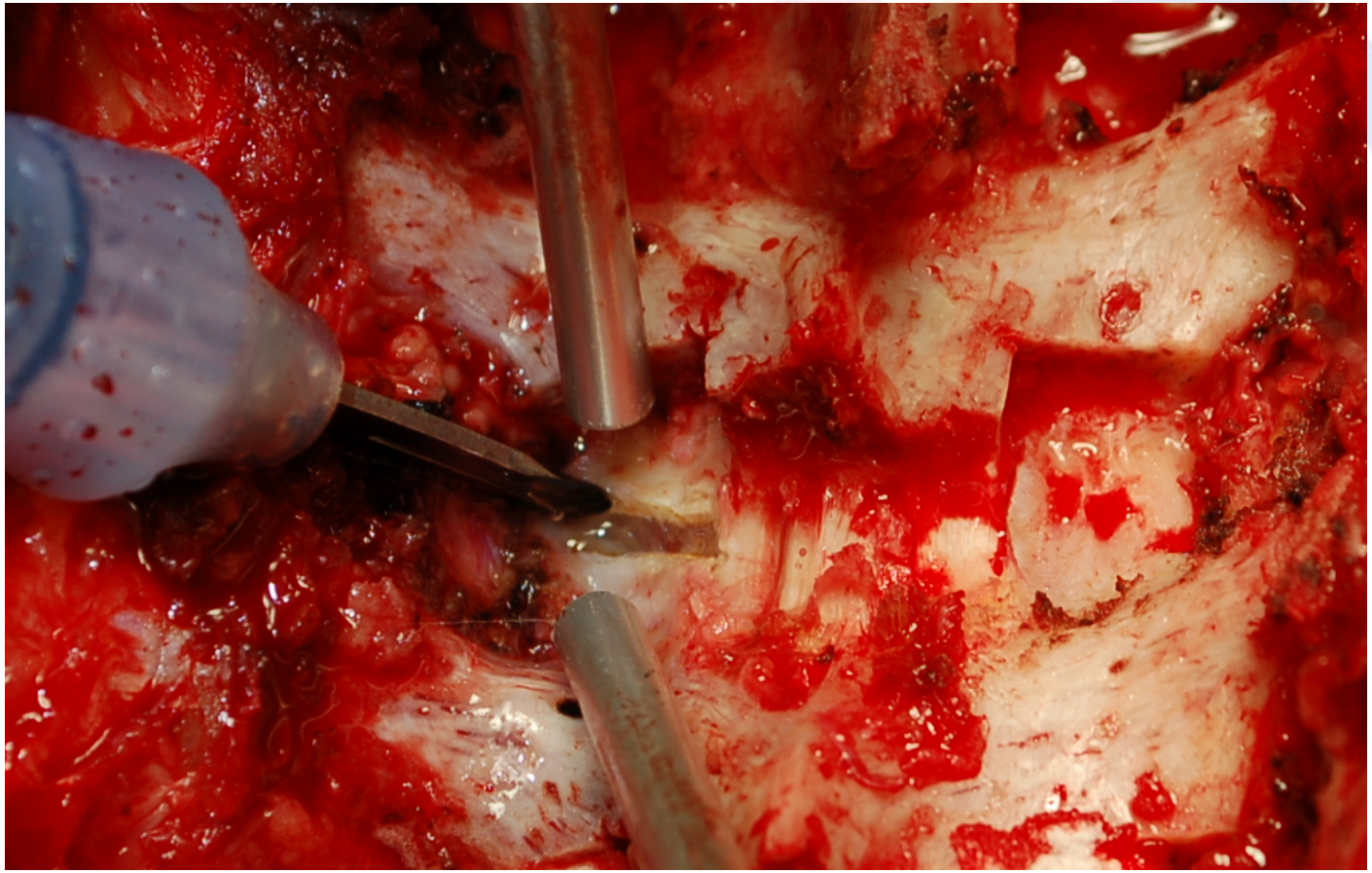


Courtesy S. Shah

Alternative: Leave Facet Behind

Courtesy S. Shah

Alternative: Leave Facet Behind



Courtesy S. Shah

Alternative: Leave Facet Behind

Courtesy S. Shah

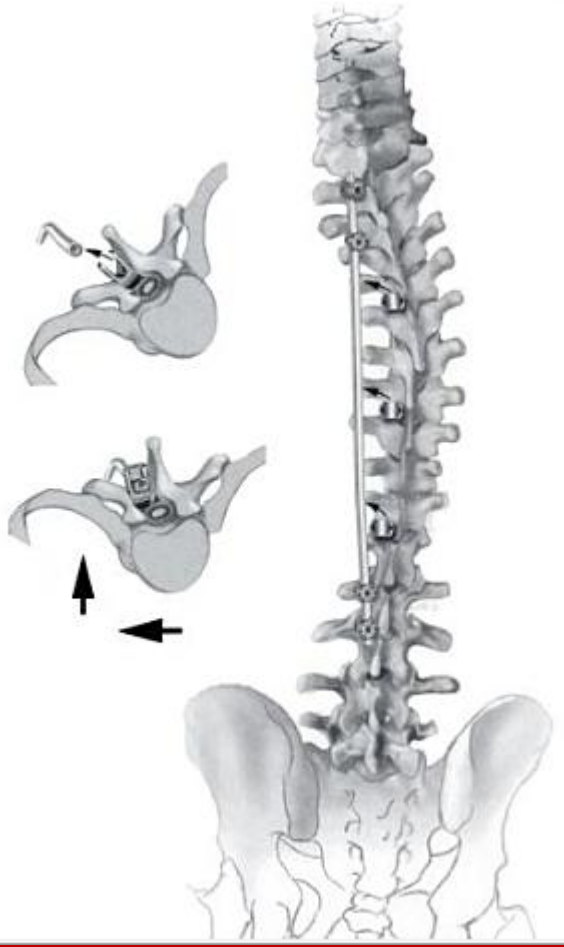
Alternative: Leave Facet Behind

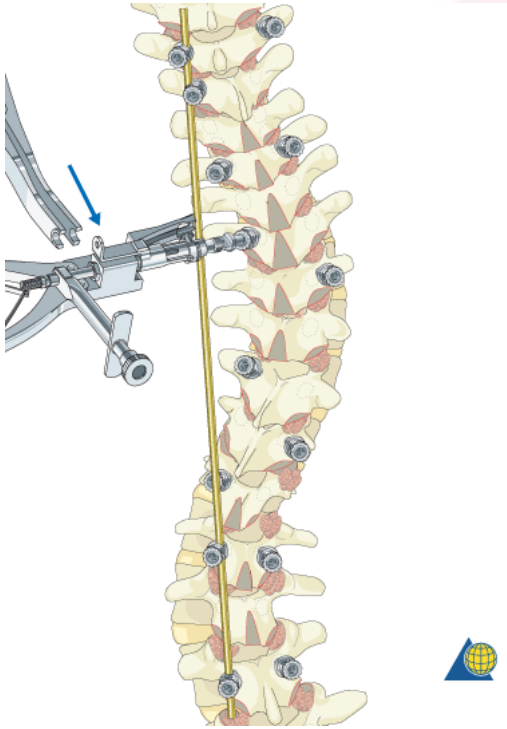
Courtesy S. Shah

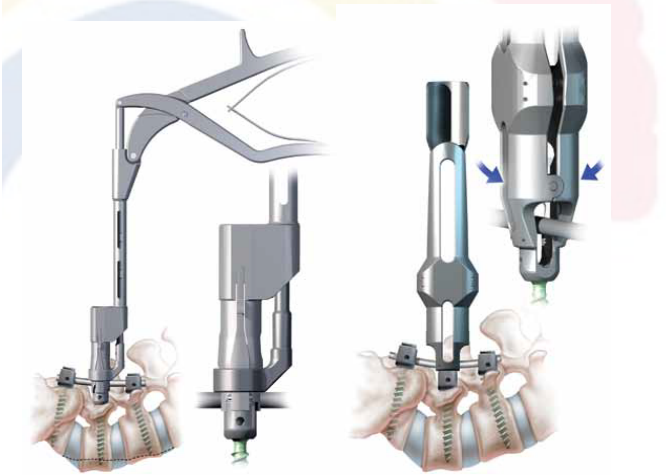
Correction Techniques

Measure and Contour Rod

Translation



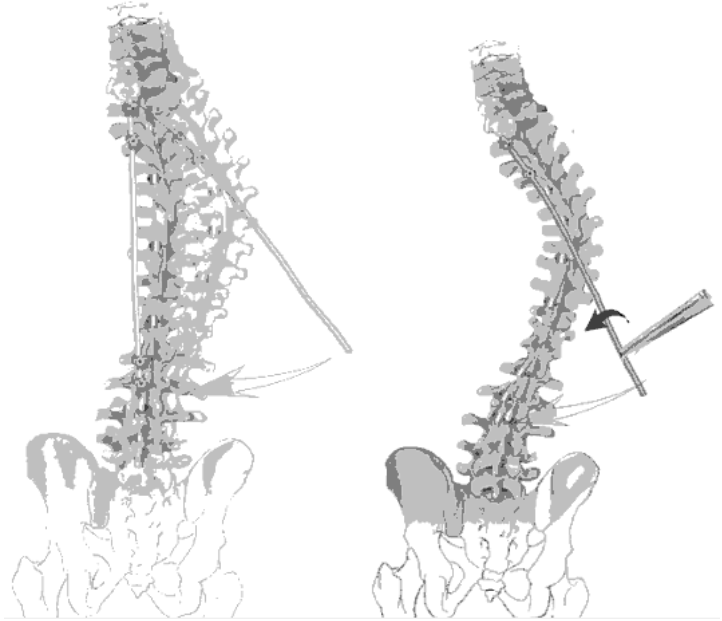


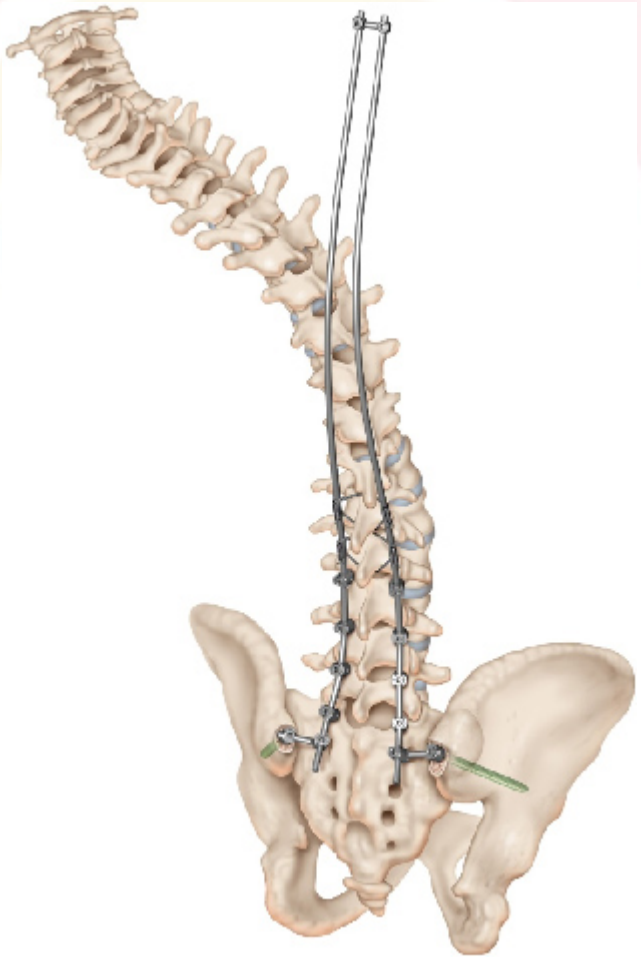


Strategies:

-Reduction screws
-Reduction tool

Cantilever





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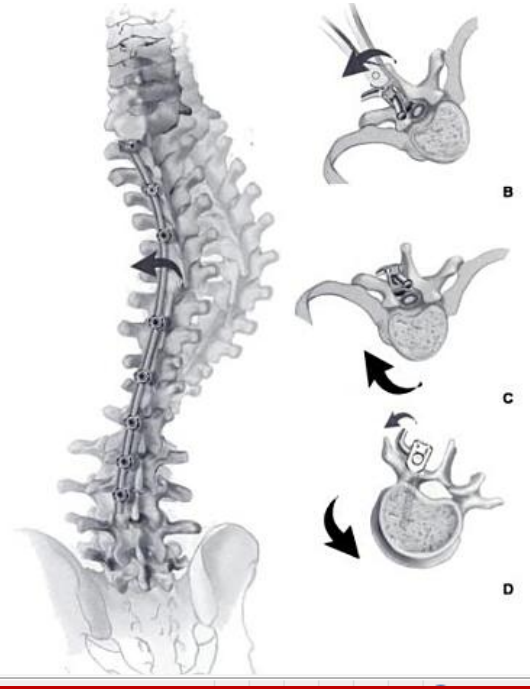
Rod Rotation

Strategies:

1) Contour into sagittal profile you want
2) Rotate 90 degrees and place in screws
   -Will usually align with appropriate scoliosis
3) Rotate back 90 degrees into sagittal plane
   -Will correct scoliosis

***Technique for Top Gun Lab



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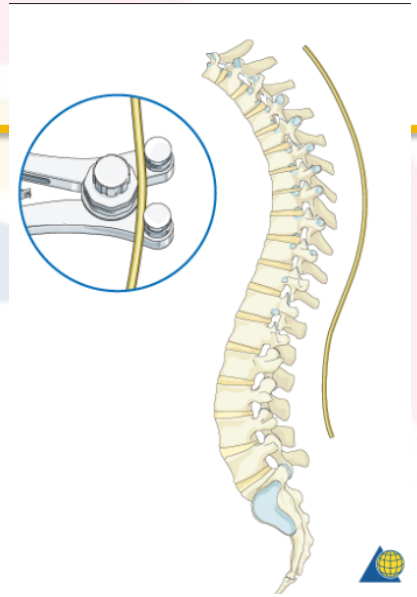

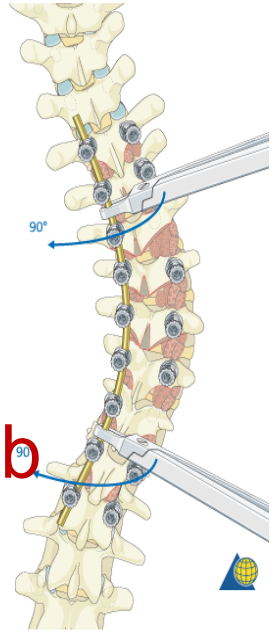

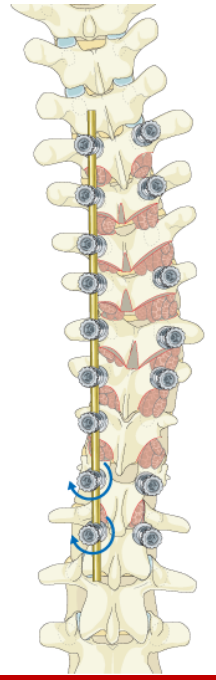

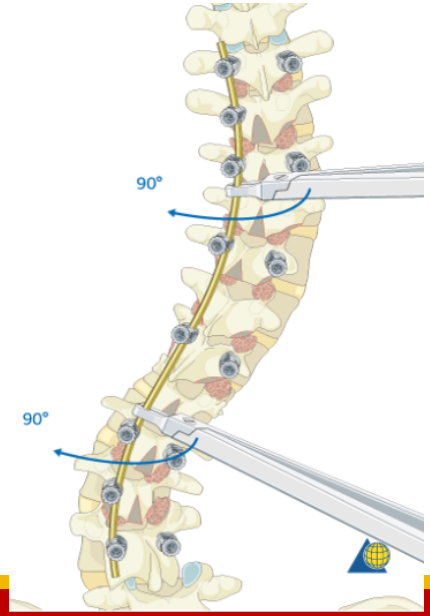

***Technique for Top Gun Lab

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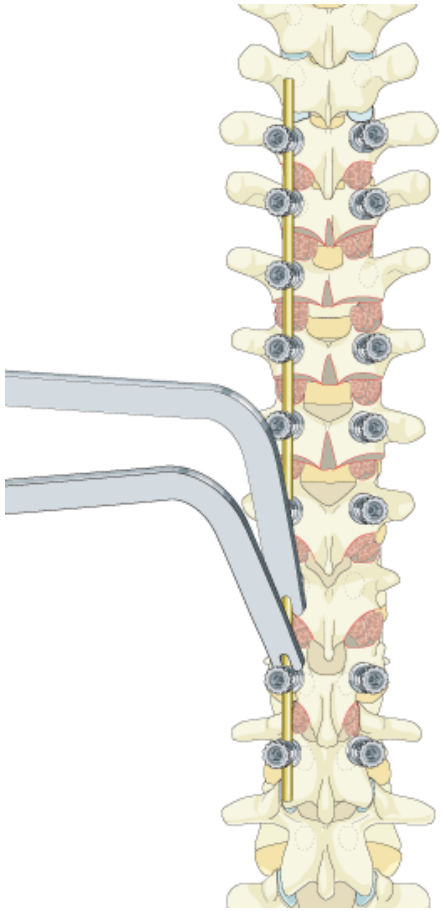
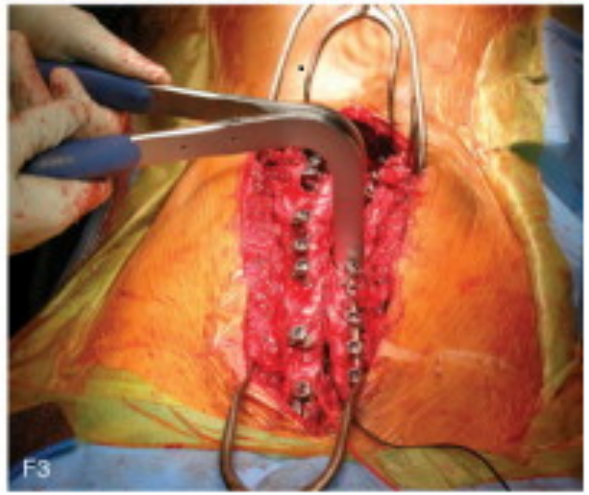
In Situ Bending

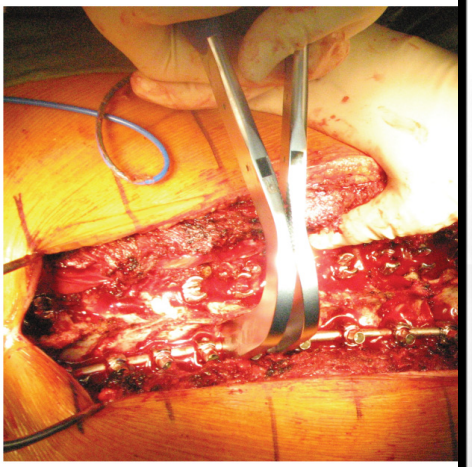


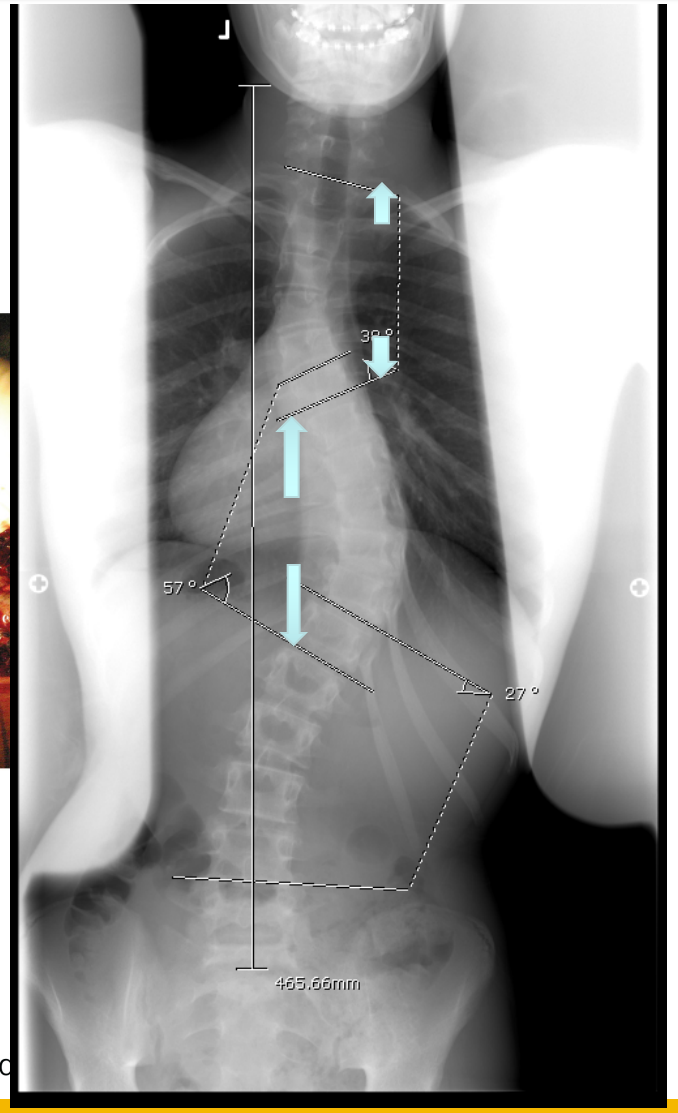
Can correct:

-Coronal and sagittal plane



Distraction/Compression





Distract Concave

Compress Convex

Remember:

- Compression is lordotic
- Distraction is kyphogenic

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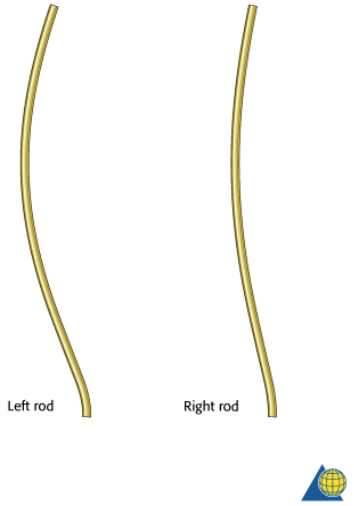
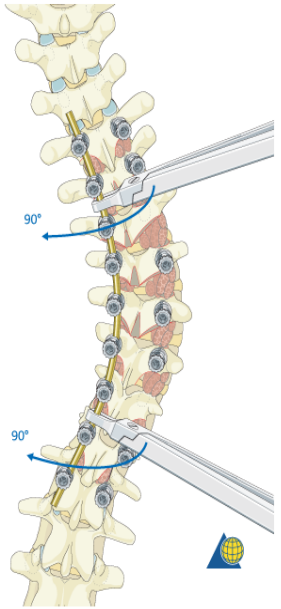
Derotation

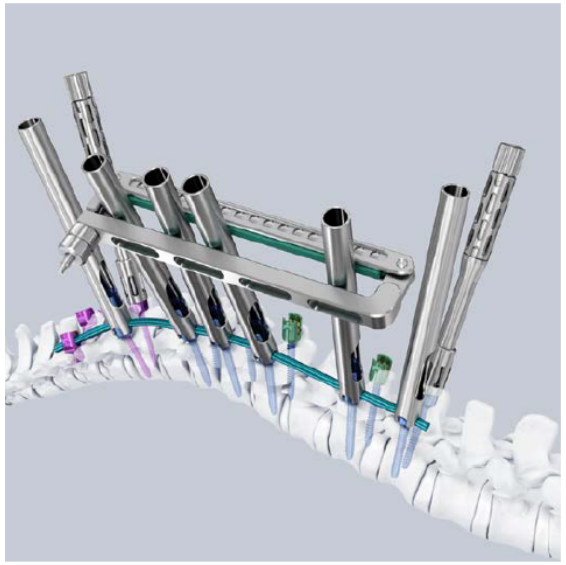
- Differential rod contouring
  - Left rod over contoured into “extra kyphosis”
    - Pulls spine “up” derotating
  - Right rod undercontoured
    - Pushes “down” on rib hump

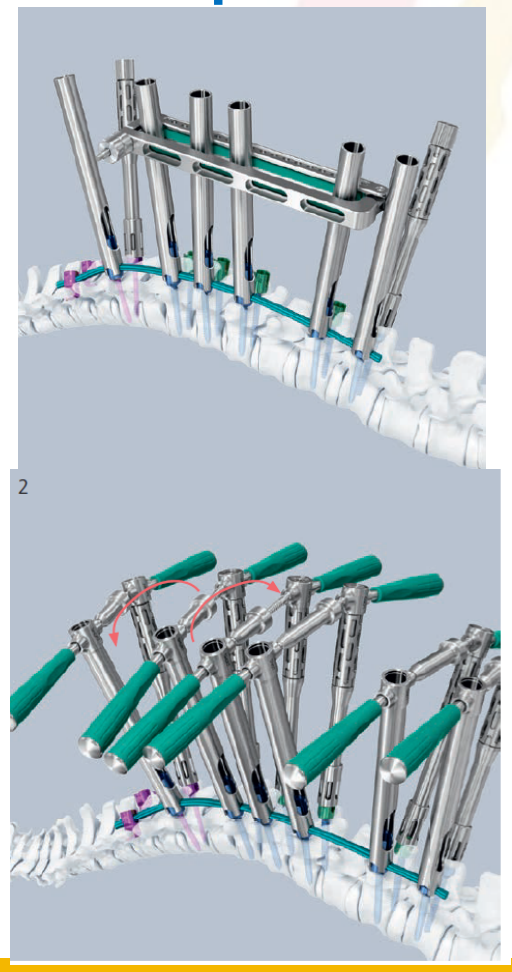


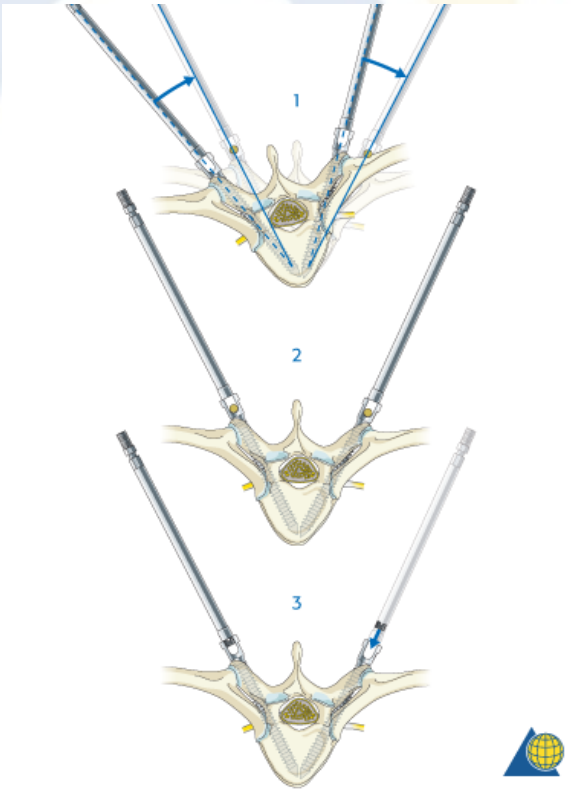


En Block or Segmental Derotation

Uniaxial or fixed angle at apex







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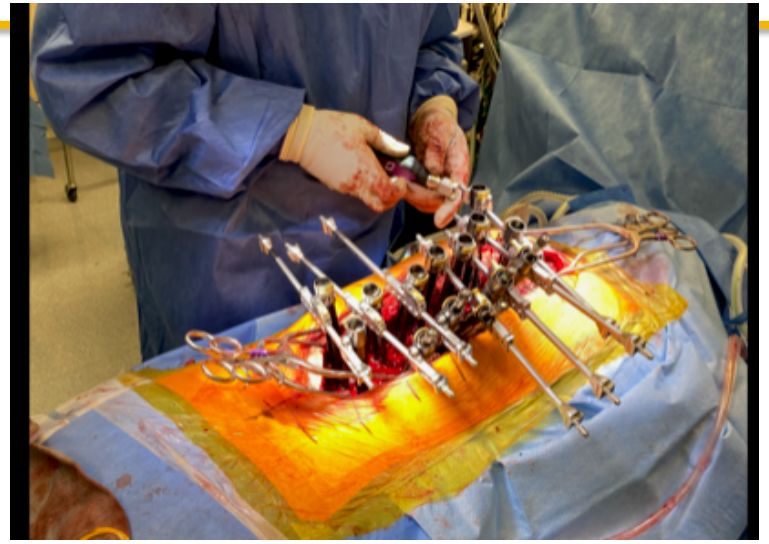
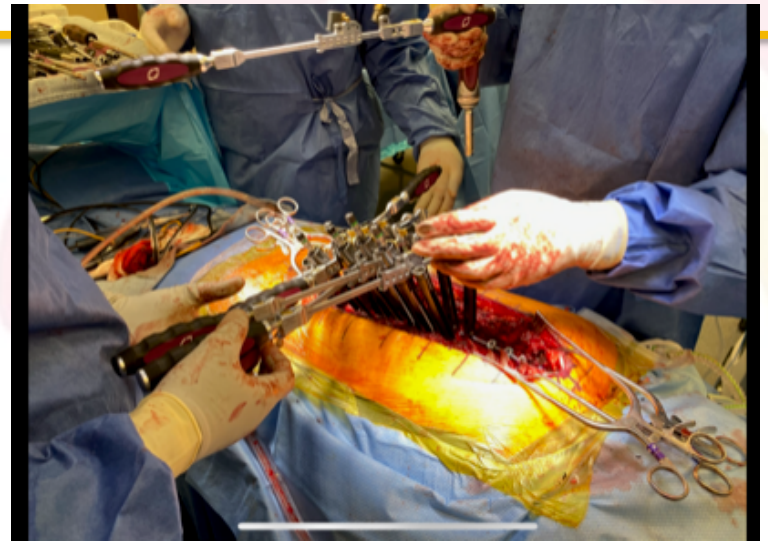
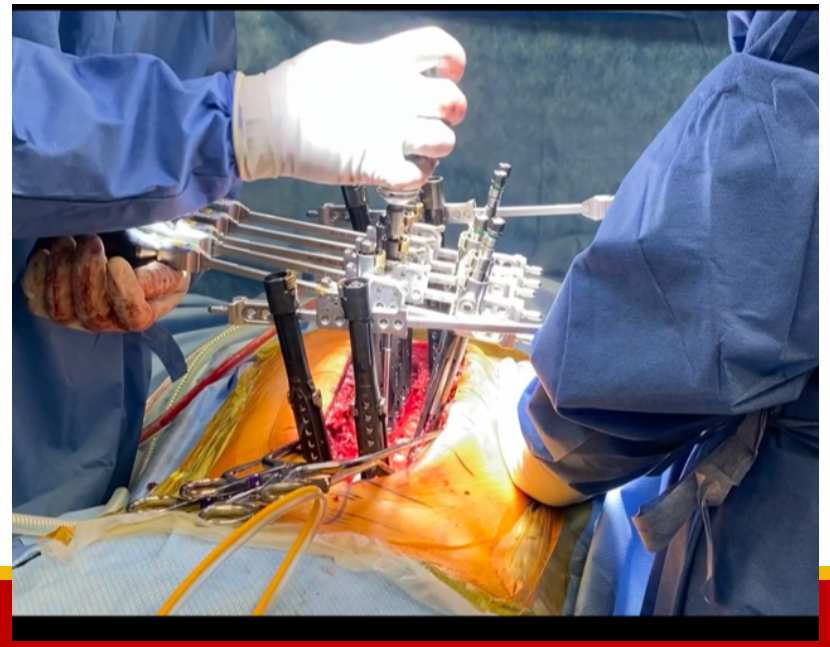
My Process: Everyone a bit different

My steps (for typical right thoracic):

-Place pedicle screws (base, top, apex)
-Apical screws uniaxial for derotation
-Distracting hooks/temporary rod in concave upper fractional curve (if present)
-Place concave rod slightly overcontoured for sagittal profile
-Lock it proximally and distally with mild distraction in correct sagittal orientation with apex of rod sitting above the uniaxial apical screws with reduction towers
-En block Derotation to bring the screws up to the rod
-Reduce screws/rod at apex with reduction towers
-Get further segmental derotation
-In situ bend
-Place slightly undercontoured rod on convex side







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