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Title:

Lumbar Spine Osteotomy

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Introduction

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Failure to restore normal sagittal alignment in patients primarily operated for reasons other than deformity results in unacceptably high rates of poor results and revision surgery

surgical planning should consider sagittal alignment in every patient and anticipate the impact of any planned surgery on sagittal balance.

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According to Schwab et al., corrective osteotomy for adult spinal deformity (ASD) leads to good sagittal spinal balance if the range of correction is within *lumbar lordosis (LL)=PI±9°, pelvic tilt (PT)<20°, and sagittal vertical axis (SVA)<5 cm.*

However, patients with post-fusion lumbar flatback are generally **osteoporotic, elderly females** who have **poor paraspinal muscle condition due to fatty degenerative changes**, **atrophy of the back muscles**, and **thinning of the paraspinal and psoas muscles**

Therefore, restoration of lumbar lordosis below the PI value might result in another (or secondary) postoperative or delayed sagittal imbalance due to the lack of the compensatory roles from these paraspinal muscles.

Schwab FJ, et. Al. (2013). Radiographical spinopelvic parameters and disability in the setting of adult spinal deformity: a prospective multicenter analysis. Spine (Phila Pa 1976). 2013 Jun 1; 38(13):E803-12.

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Moreover, postoperative pain is related to alterations of characteristic parameters of sagittal balance and spinopelvic angulation

With advances in new techniques/instrumentation and neuro-monitoring supported with improved anaesthetic care, osteotomy techniques have evolved.

Spinal osteotomies are generally needed when the deformity is not correctable with the use of instrumentation alone or when facet or ligament releases are insufficient to gain enough flexibility.

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Osteotomies

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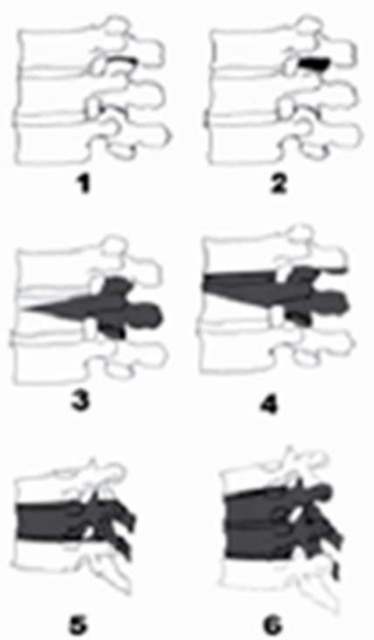
Although osteotomies **originally began as anteroposterior procedures**, posterior-only procedures have gained wider acceptance in recent years



• Grades of vertebral resection (Schwab, 2014)

1: Partial facet joint

2: Complete facet joint

3: Pedicle/partial body

4: Pedicle/disc/partial body

5: Complete vertebra and discs

6: Multiple vertebrae and discs

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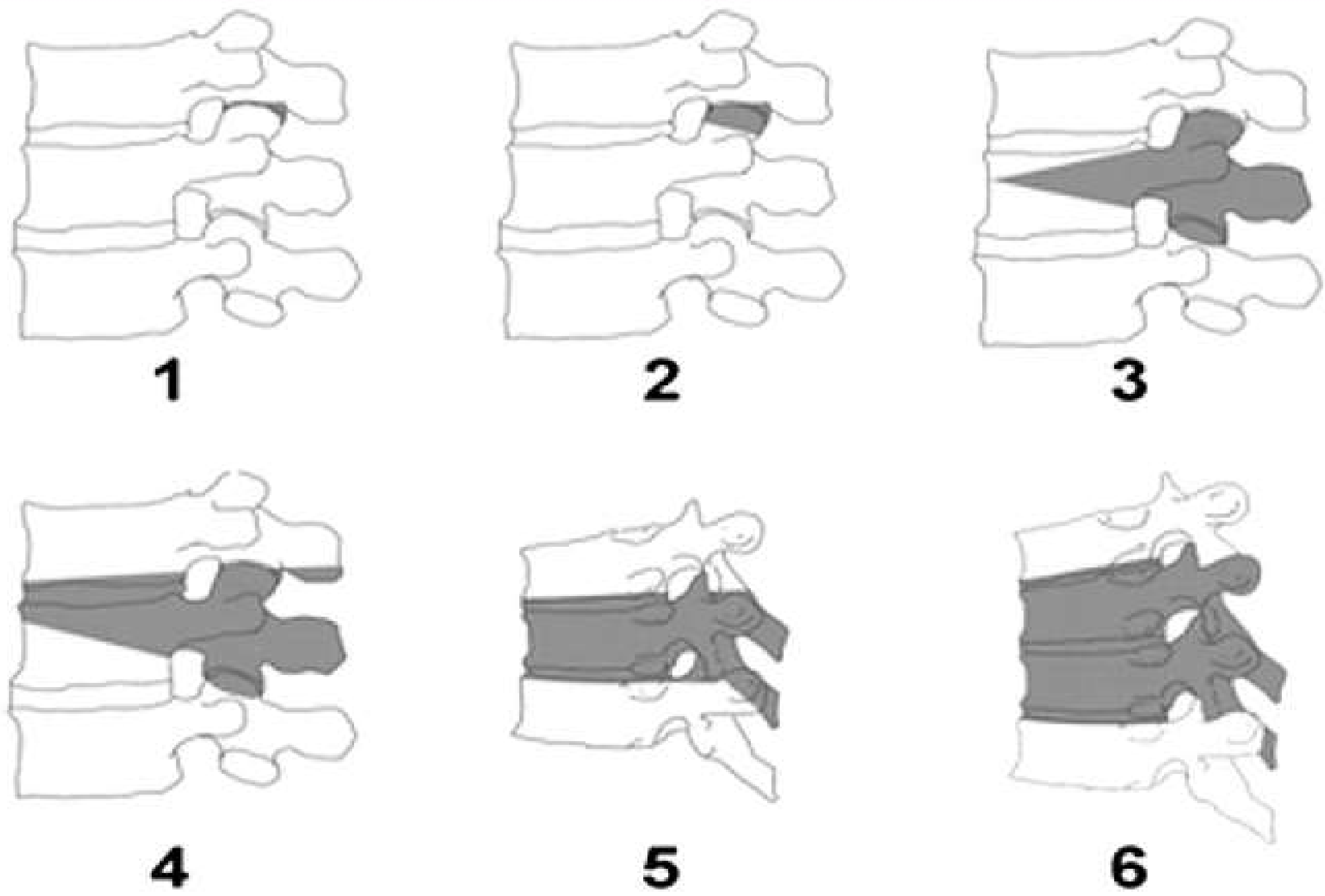

FIGURE 1. *Osteotomy classification: grades 1 to 6 according to the anatomic resection.*

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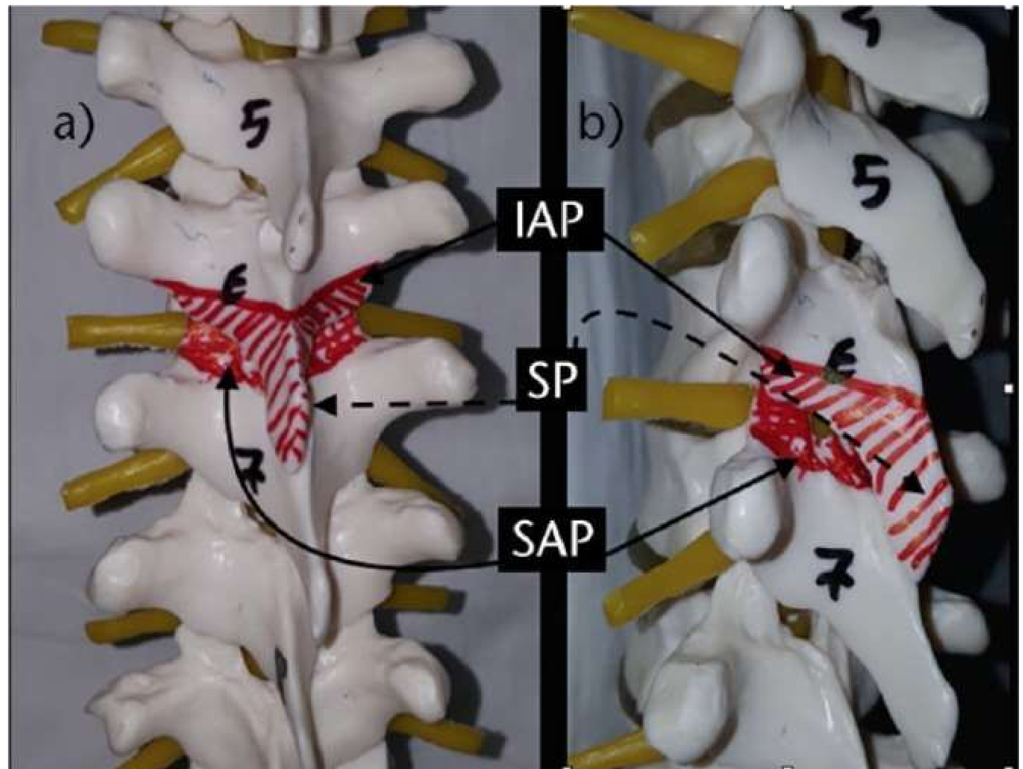
SPO

The SPO is a posterior column osteotomy in which the posterior ligaments **(supraspinous, intra-spinous ligaments and ligamentum flavum) and the facet joints** are removed and correction is performed through the disc space.

A mobile anterior disc is essential to benefit from this procedure. Both coronal and sagittal correction can be achieved. This procedure was first described by Smith- Petersen in 1945



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SPO

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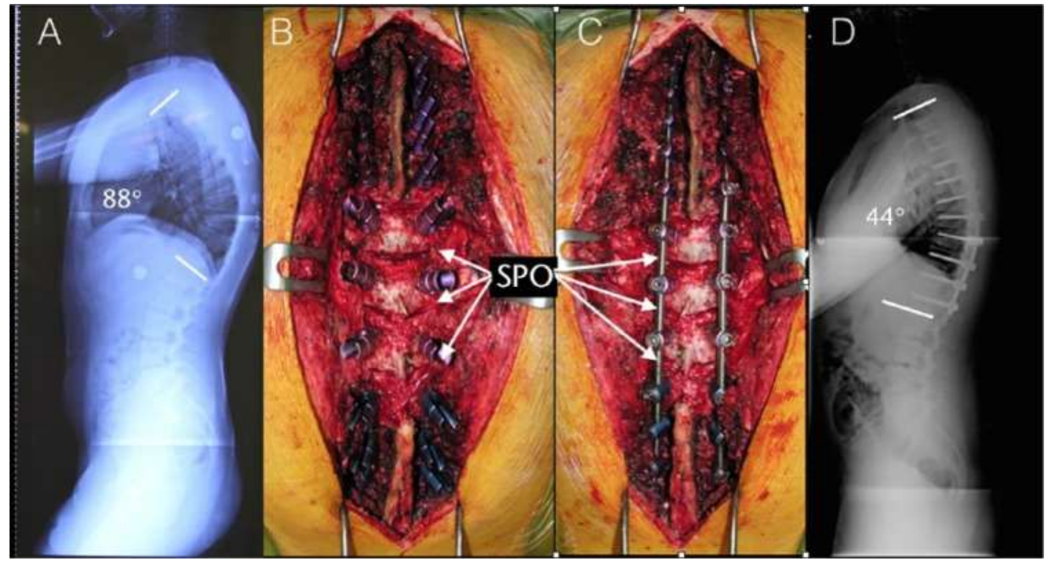
When the surgeon is not familiar with the more extensile surgical procedures such as PSO, Corner Osteotomy or VCR, the **SPO is the least complicated procedure which can be applied by a surgeon.**



SPO should be considered for patients with a C7 plumbline that is in the range of 6 cm to 8 cm positive.

The amount of correction provided by SPO is in the range of **9.3° to 10.7° per level**. ***One degree of correction is achieved per millimetre of bone resected (1°/mm bone).***

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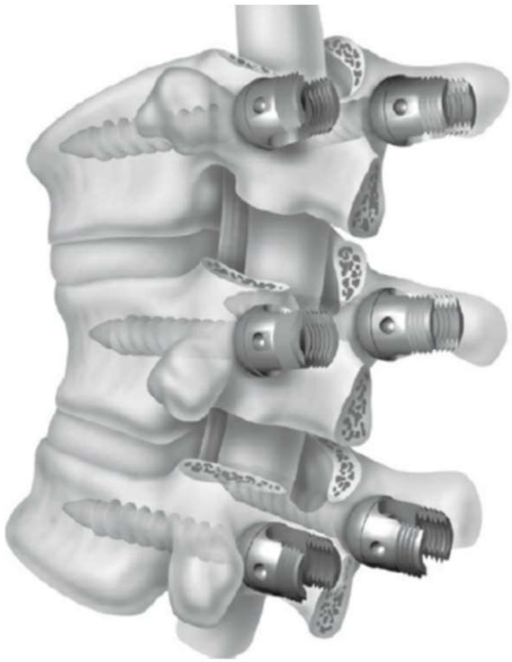
profuse bleeding from the epidural space can occur during either ligamentectomy or facetectomy (*especially during removal of the superior facet of the inferior vertebra*).

Packing with gelatin sponges usually solves this problem if bipolar cautery does not.



Removal of facets and compression to correct kyphosis leads to a decrease in foraminal height. This may lead to nerve root impingement.

A wide facetectomy can solve this problem if neurological abnormalities are seen on the neuromonitor

In some cases, an extensive SPO might lead to opening anterior disc level (greater than 10 mm in height)

It may be necessary to graft the disc space anteriorly.

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History

In 1920, **Holger Werfel Scheuermann**, a Danish orthopedic surgeon and radiologist, described a clinical finding hallmarked by rigid developmental thoracic kyphosis

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History

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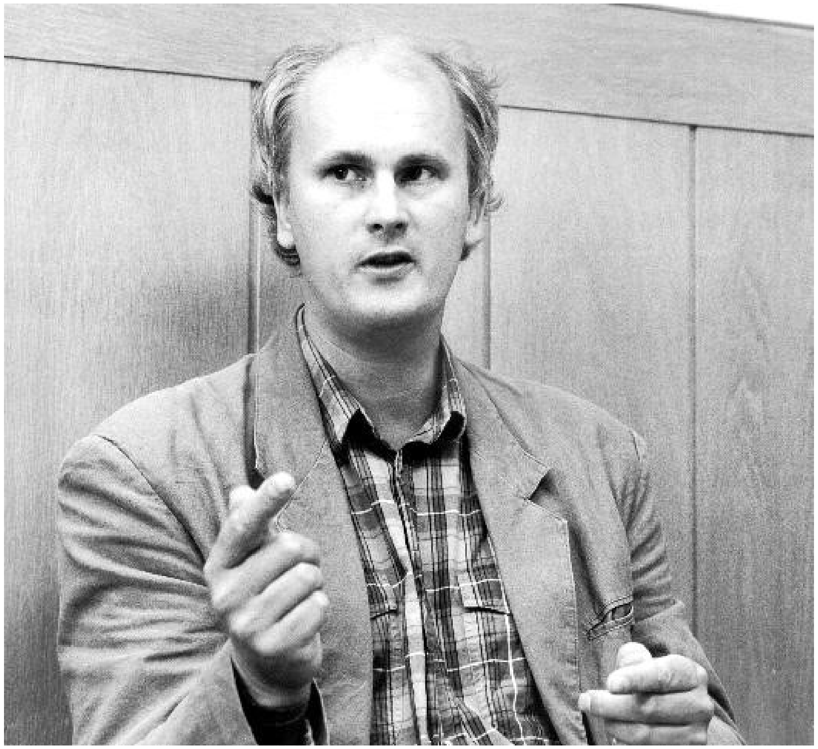
In 1964, Knut H. Sorensen further defined the condition quantitatively by highlighting that **the apical vertebral bodies are wedged at least 5 degrees per level, over three contiguous levels on lateral radiographs**



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History

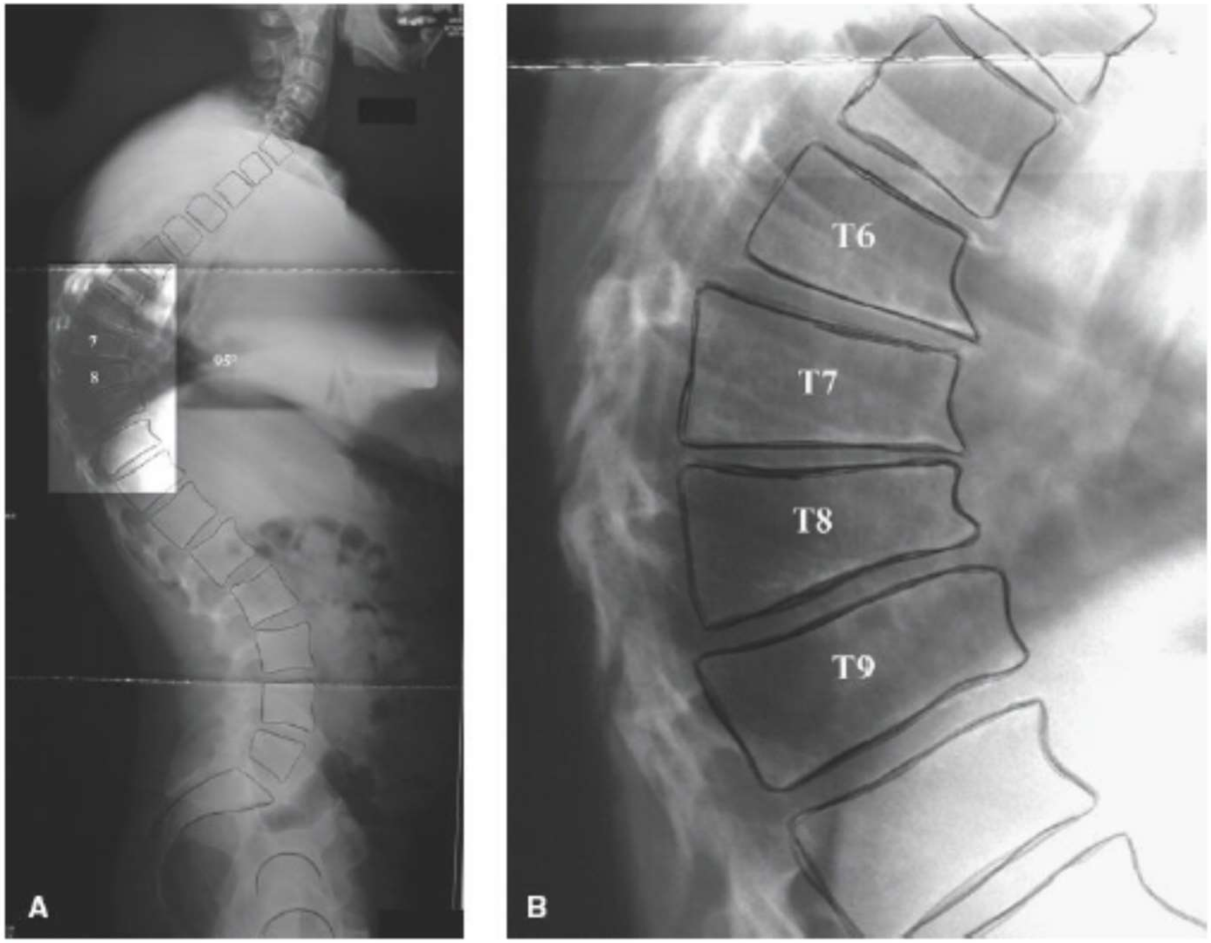

Figure 121.1 **A:** AB is a 45-year-old man showing a classic large Scheuermann kyphosis with apex at disc T7–T8. The curve is 95 degrees across the Cobb angle measurements from T4 to T11. The apical four vertebras are wedged. **B:** Close-up view shows the elongated anterior to posterior dimension of the apical vertebral bodies, the wedging, and the anterior osteophytic deformations typical of Scheuermann deformity.

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The prevalence of Scheuermann kyphosis is between 0.4% and 8.3% of the general population. **Scheuermann reported that the condition was found predominantly in males.** Nonetheless, Bradford et al. suggested a higher prevalence in women than what was originally postulated. Others have suggested an equal distribution between males and females

Normative values for thoracic kyphosis range between 10 and 45 degrees. However, standard age-related sagittal alignment changes, increases this range to approximately 50 degrees in the adult population.

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Etiology

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The etiology of Scheuermann kyphosis ***remains unclear.***

1. **avascular necrosis** of the ring apophysis
2. Inhibition of **enchondral ossification**
3. Intervertebral **disc herniation** with endplate perforations, and persistent anterior vascular grooves.
4. **Reduction in collagen and increase in mucopolysaccharide** in the vertebral end plates have also been identified.
5. **Hamstring tightness** has also been implicated in possibly contributing to the progression of the deformity by causing difficulty with pelvic anteversion, leading to increased compensatory flexion stress in the thoracic spine, resulting in kyphosis.

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Pre OP

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A preoperative magnetic resonance imaging **(MRI) study should be considered in operative candidates**. This allows for assessment of possible spinal cord abnormalities, epidural lipomatosis, disc herniation, spondylolysis, and the health of the disc distal to the planned lowest instrumented vertebra.

A recent prospective multicenter study found that **4.7% of patients had an operative plan change as a result of preoperative MRI findings**

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NONOPERATIVE TREATMENT

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A practical guideline for dividing operative from nonoperative treatments would suggest that **curves less than 70 degrees in the growing adolescent** could be considered for **bracing**. When bracing is the treatment of choice, **it should be accompanied with an exercise program**. As with scoliosis brace wear, braces should be used **at least 18 hours per day.** Patients may be out of the brace at night for sleep if necessary.

Although **Milwaukee** braces have been favored in the past, a **thoracolumbar sacral orthosis (TLSO)** brace is usually sufficient in most curve patterns except those with a high thoracic apex.

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Nonoperative treatment

Indications:

1. Painless deformity
2. Kyphosis <70 degrees
3. Stable asymptomatic kyphosis of any size in adult
4. Acceptable cosmetic appearance
5. No neurologic deficit

Operative treatment

Indications:

1.Progressive curve

2.Painful curve

3.Unacceptable appearance

4.Restrictive pulmonary disease

5.Neurologic deficit

The main goals in surgical treatment are to relieve pain at the affected site, improve overall sagittal alignment, cosmesis, and to improve health related quality-of-life issues

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Operative treatment

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Lonner et al. found a ***3.9-fold increase in major complications rates in operatively managed Scheuermann kyphosis patient compared to adolescent idiopathic scoliosis patients.*** Scheuermann kyphosis patients demonstrated significantly higher rates of infection and reoperation.

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Surgical Technique

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Both anterior and posterior techniques have found favor at various times. However, **recent studies have found that the posterior-based techniques are associated with lower complication rates and shorter hospitalization**.

The key to achieving correction, however, is performing adequate osseous–ligamentous releases. These releases are performed using various osteotomy techniques. Posterior column osteotomies in the form of **Smith-Peterson or Ponte osteotomies** in the **thoracic** spine and **wide posterior releases as described by Shufflebarger** in the **lumbar** spine are the most useful and standard release technique for Scheuermann disease

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Surgical Technique

Ponte osteotomies in the thoracic spine are usually sufficient for posterior release; however, intraoperative evaluation of spinal flexibility will be the determinant as to whether or not more aggressive techniques such as a pedicle subtraction osteotomy (PSO) are required

In curves that are stiff, have many levels with **significant vertebral wedging**, or in **curves greater than 100 degrees**, the treating surgeon should embark on the surgery, willing and ready to add a **PSO** at one or two levels to achieve the final correction

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Surgical Technique

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For high and midthoracic apex deformities, the upper instrumented vertebra should ideally be adjacent to a lordotic disc, and is usually T2 or T3.

The distal fusion level will be decided by two criteria. First, the sagittal sacral vertical plumb line should bisect or nearly bisect the vertebra that is anticipated to be the distal instrumented vertebra. Second, that vertebra should also be positioned distal to the first lordotic disc and rostral to a lordotic disc.

Care should be taken to ensure that the first uninstrumented disc is not degenerative

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Stopping instrumentation short will often result in deformity progression or a distal junctional kyphosis (DJK). DJK may or may not be symptomatic. DJK does not always require revision surgery. Proximal junctional kyphosis (PJK) is also a potential problem with an unclear etiology. Avoiding spinopelvic imbalance may be protective against PJK

care must be taken not to overcorrect the deformity. In general, 50% correction of the deformity is sufficient. Correction greater than 50% may result in either PJK or DJK

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Surgical Technique

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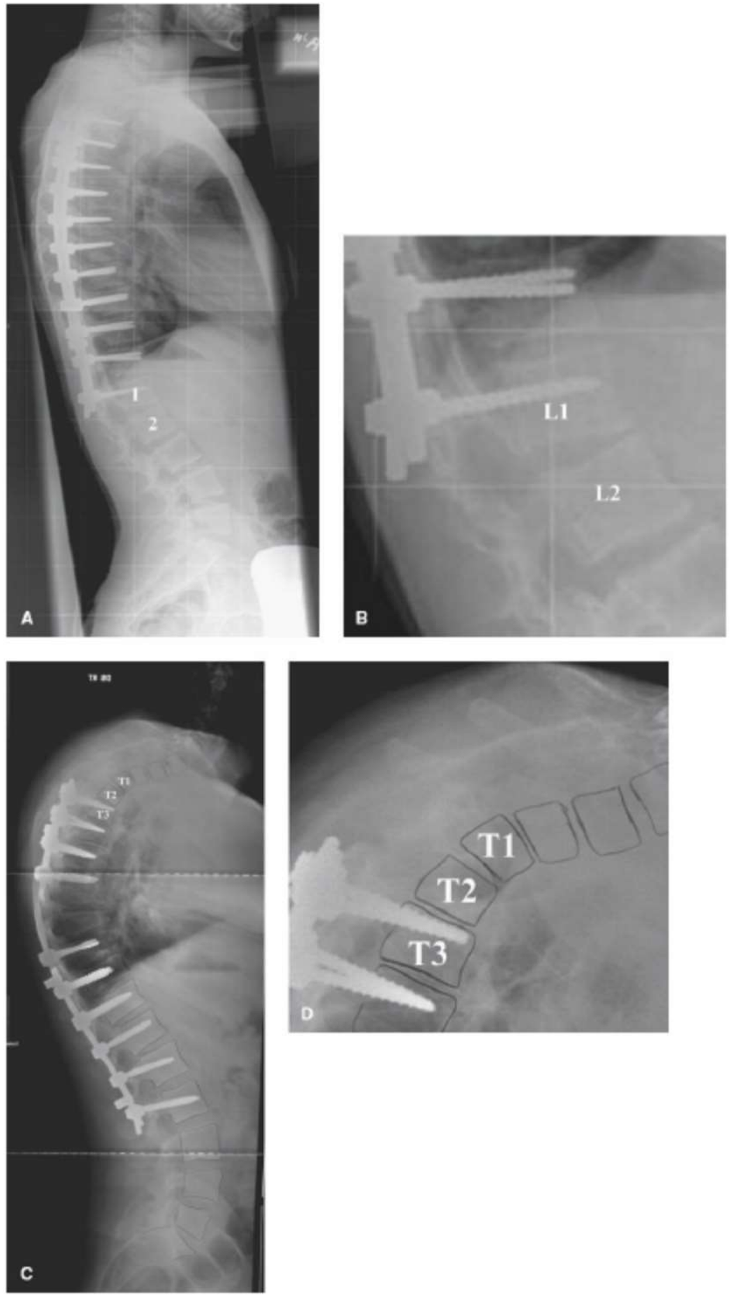

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Although correction of Scheuermann kyphosis is typically uncomplicated, it is not without risk. Neurologic deficits can be provoked by **disc herniation, osseous compressive pathologies, and vascular insults**. During these surgical procedures, particularly at the time of deformity correction, vascular physiology should be optimized to protect against neurologic deficit.

Steps should be taken to increase the mean arterial blood pressure greater than or equal to 90 mm Hg. If osteotomies are performed that might be accompanied by large angular corrections such as PSOs or vertebral column resections, care must be taken to ensure that the neural canal remains patent.

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Surgical Technique

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To assist with postural reduction, the **chest pads and the pelvis pads are separated a bit more than usual** to allow gradual reduction of the kyphosis via gravity during the exposure.

After complete exposure of the spine the thoracic and lumbar facets are excised. The facets should be excised prior to placing pedicle screws to facilitate their complete removal. The presence of pedicles screws will make removal of the facet joints difficult.

The interspinous ligaments are removed at each level, except for the first two rostral levels, where all midline structures should be preserved. The spinous processes are then shortened or excised as necessary to gain access to the interlaminar space

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The ligamentum flavum is exposed and partially resected in the midline with a wide double action Leksell rongeur.

Kerrison rongeurs are then used to excise the remaining ligamentum flavum proceeding laterally through the facet joints. **The Kerrison rongeur is continued laterally through the superior articular process of the inferior vertebrae at that level.**

The result is a series of **chevron-shaped osteotomies**. Rostral and caudal widening of the osteotomy is performed as dictated by the requirements of the reduction

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Surgical Technique

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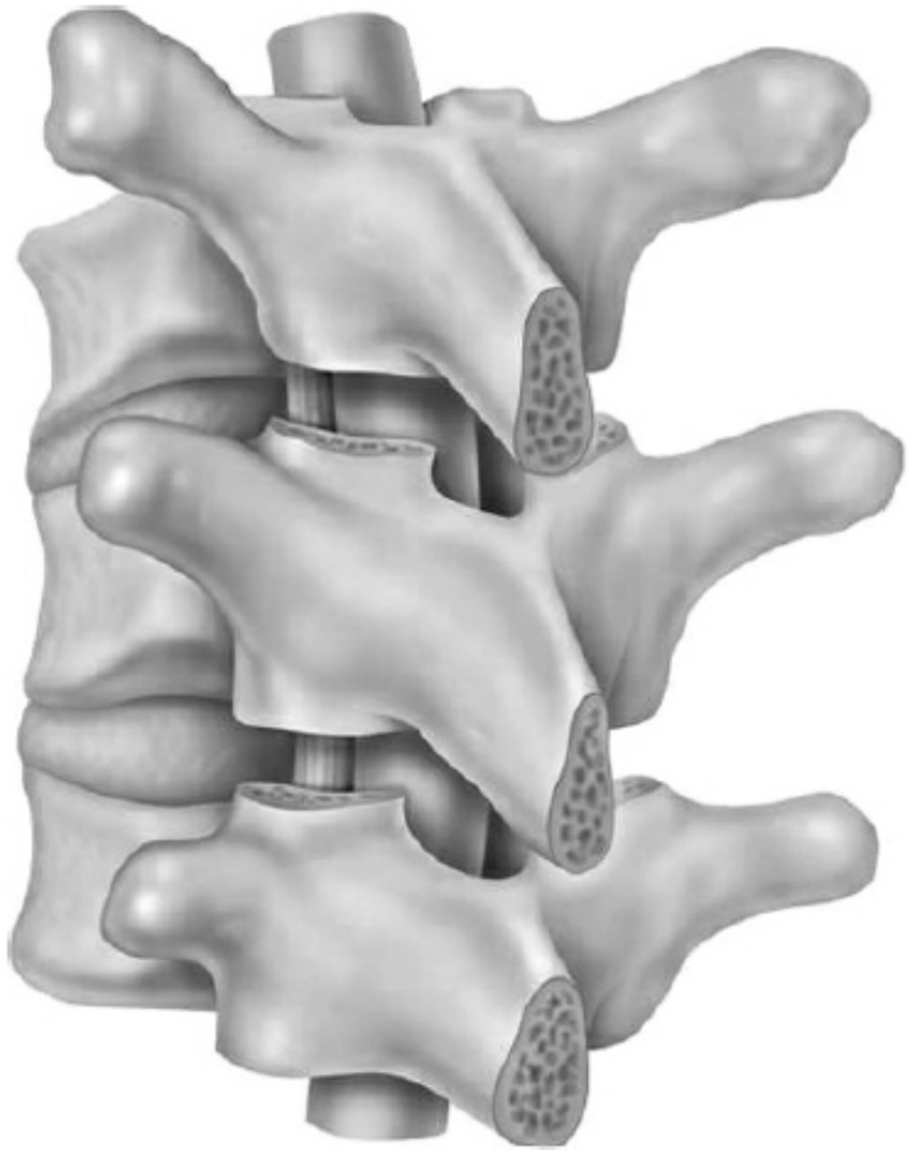

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Surgical Technique

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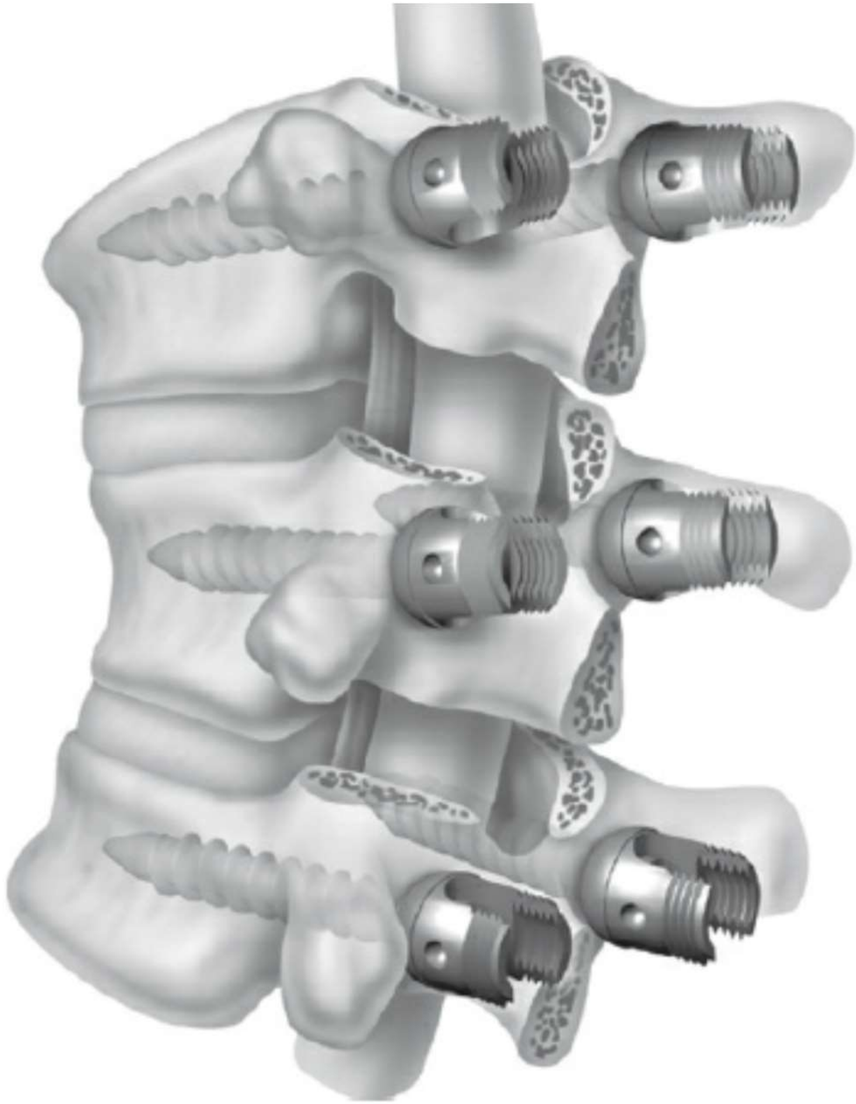

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The rods are placed in the proximal anchors, and these anchors are compressed. The rest of the reduction is achieved by using cantilever maneuvers with the rod while inserting it into the distal anchors.

Engaging and reducing the rods in a sequential and bilateral manner is facilitated by the use of **reduction screws below the apex of the deformity**. After rod placement, additional correction can be achieved by segmental compression

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Surgical Technique

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The final step -in construct assembly is torque tightening all the connections.

Posterior fusion is completed with decortication of the posterior elements, followed by placement of local autograft and allograft bone.

Ambulation without a brace is accomplished on the first day after surgery. Patient is typically discharged home on postoperative day **2 or 3.**

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Surgical Technique

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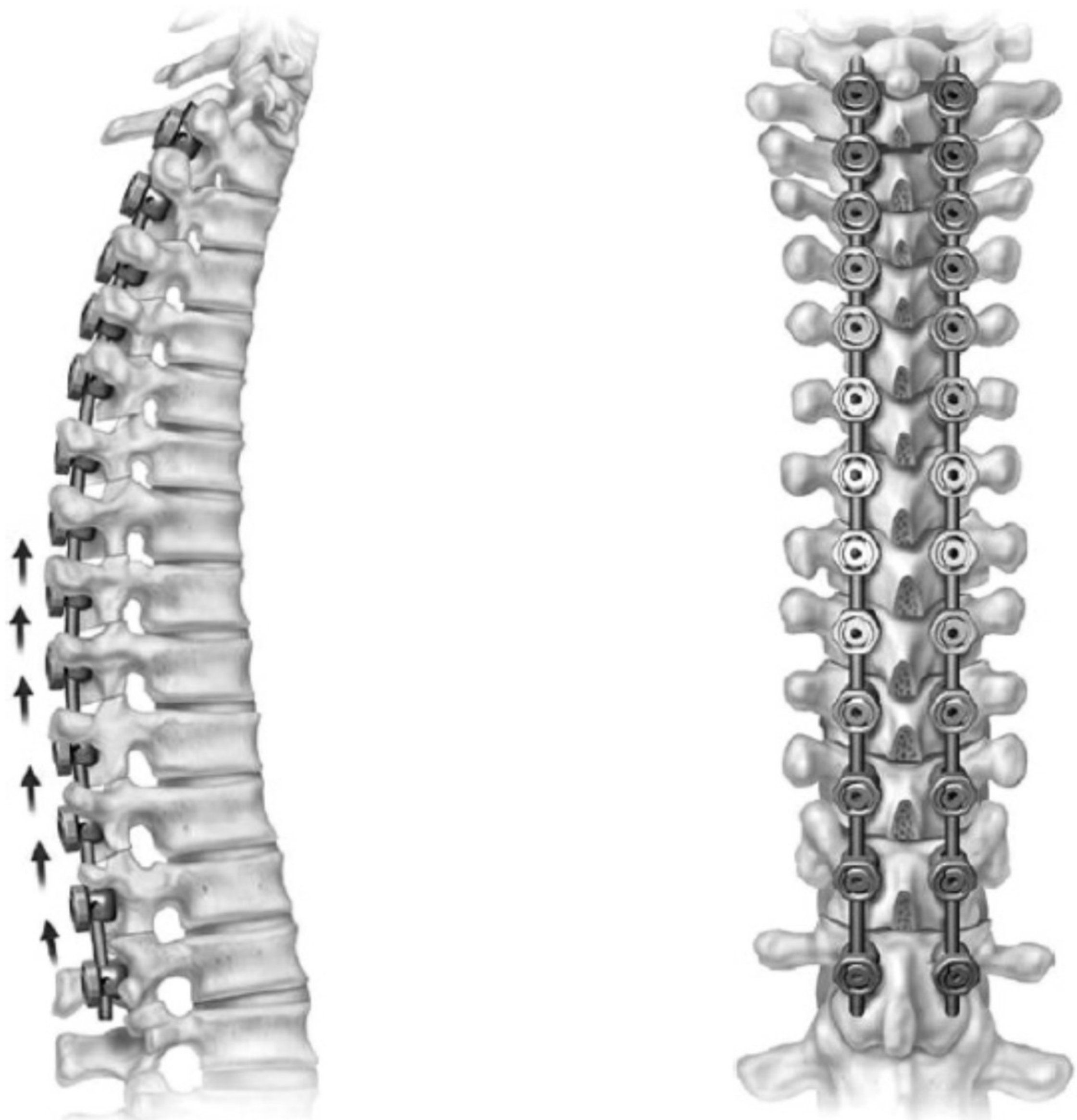

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Grade 2 Osteotomy

TK:83

TK:50

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Grade 2 Osteotomy

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TK:95

TK:47

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Grade 2 Osteotomy

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TK:71

TK:51

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Grade 2 Osteotomy

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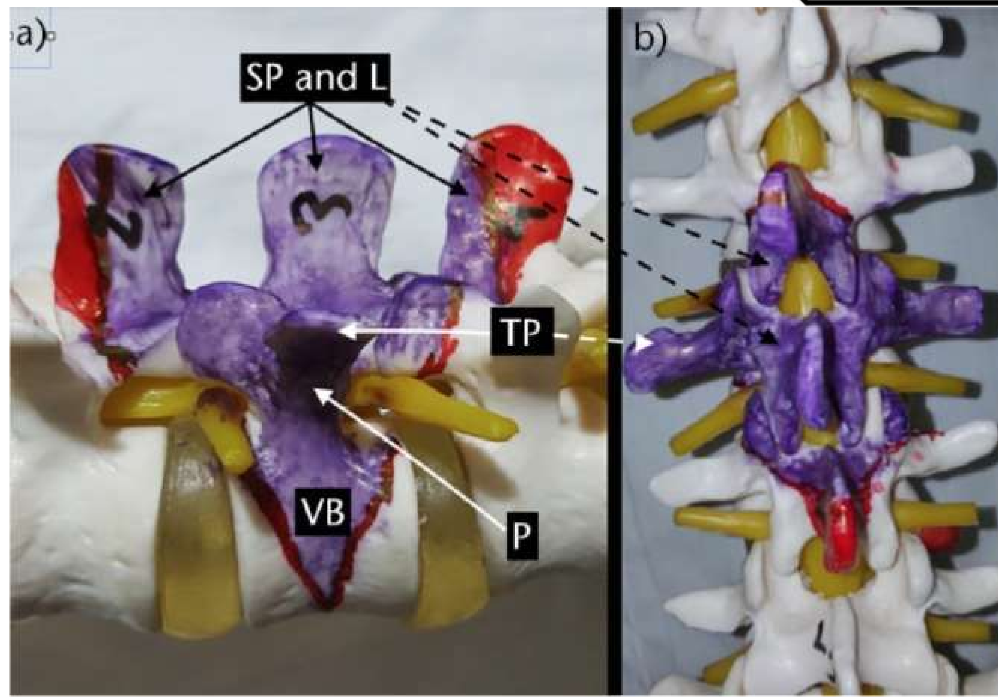
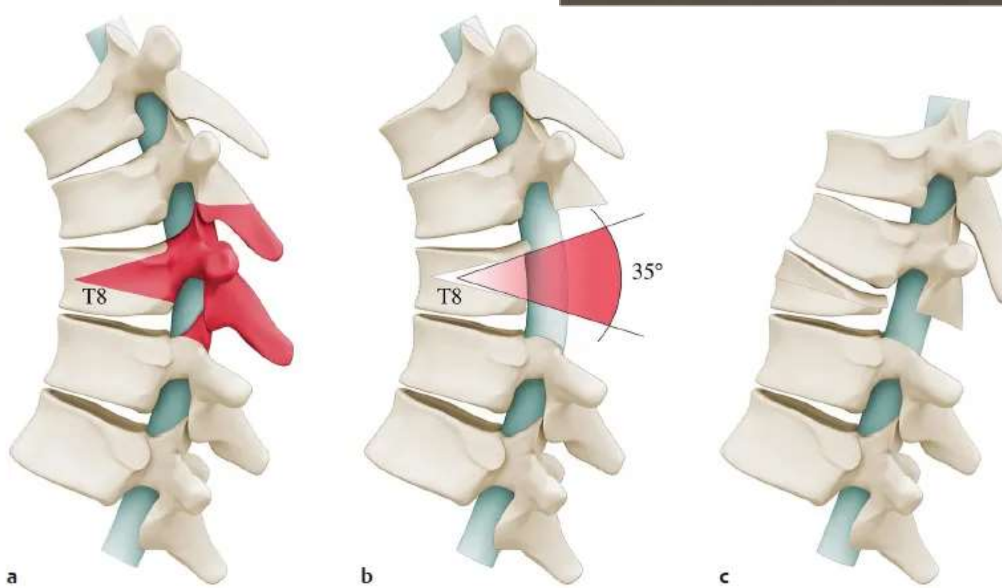
PSO

PSO is a technique where posterior elements and pedicles are removed, and a triangular wedge through the pedicles is removed either with a de-cancellation technique or an osteotome. **The posterior spine is shortened by closing the osteotomy using the anterior cortex as a hinge.**





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PSO

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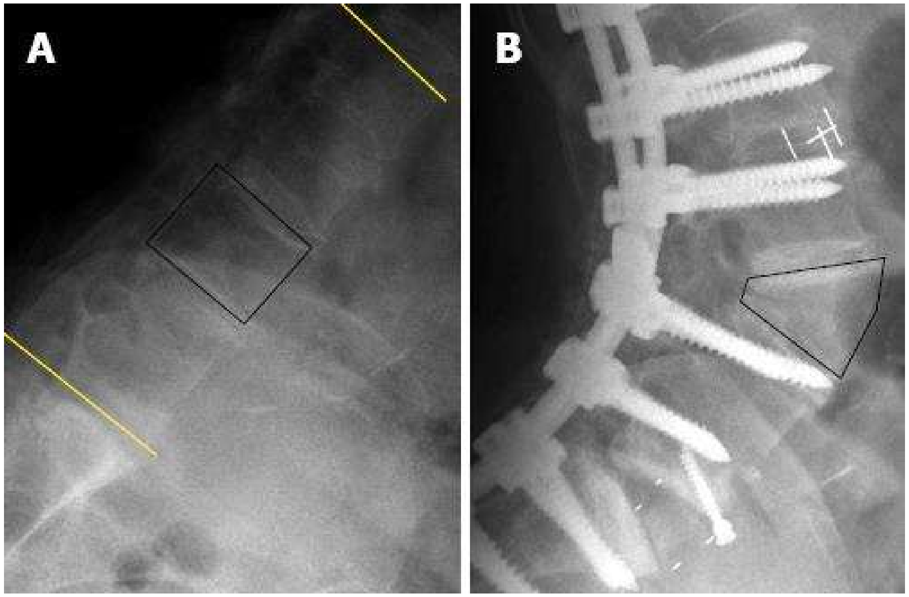
The ideal candidates for PSO are patients with a substantial sagittal imbalance more than 12 cm (SVA > 12 cm) with a sharp, angular kyphosis, and those patients who have circumferential fusion over multiple segments, which would preclude performing SPOs.



A PSO can also be done in areas of rotation and prior laminectomy, but this may lead to an increased complication rate and is technically demanding.

In case of simultaneous coronal and sagittal imbalance, PSO can be performed **asymmetrically** with a more aggressive resection on one side, which categorises the osteotomy between a standard PSO and a VCR.

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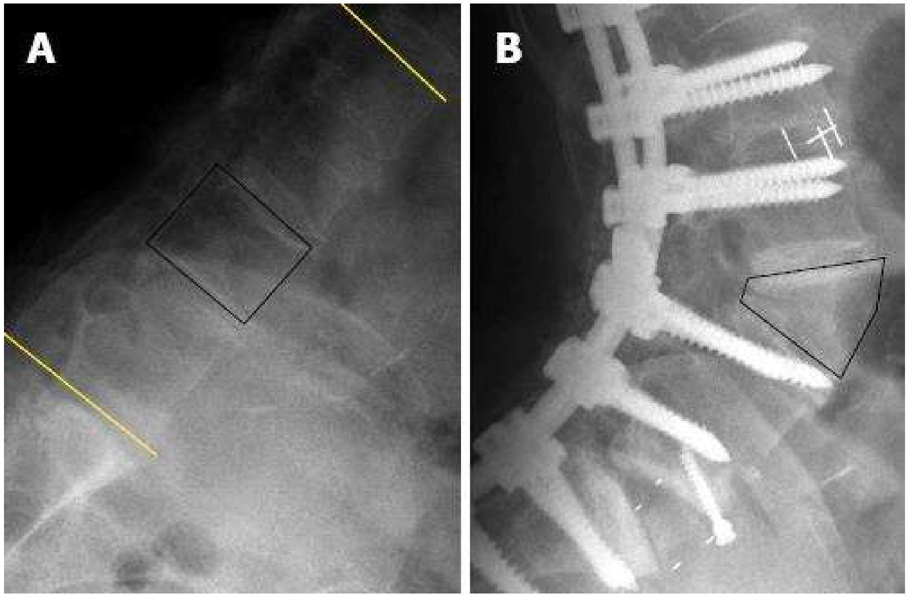
While the posterior and middle columns shorten, this osteotomy does not lengthen the anterior column, does not create an anterior bone defect and provides a more stable correction

Instrumentation should be done before any osteotomy attempt. This should be followed by laminectomy. Standard pedicle screws are used **at least three levels** above and below the level of osteotomy. If there is a thick fusion mass, and the anatomical landmarks are obscure, then screws or hooks can be placed in the fusion mass.



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PSO

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The extent of laminectomy

This should be one level above and below the previously planned osteotomy level. This is important **to prevent buckling** of the spinal cord. Normally, for a one-level resection procedure, a posterior column laminectomy will result in a 5 to 6 cm exposure of the dura and neural elements.

Buckling becomes a more severe problem, especially in cases where a previous laminectomy or laminotomy has been done and there is peridural fibrosis which prevents the gliding movement of the dura as the osteotomy gap is closed.

In addition to extending the laminectomy, laminar undercutting should be done to widen the spinal canal from within, again to prevent infolding of ligamentum flavum and bony surfaces.

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Up to 2 litres of blood may be lost during a PSO procedure. Cho et al compared three levels of SPO with single-level PSO in a series of 71 patients, and found that single-level **PSO caused nearly twice as much bleeding than three levels of SPO**

Transient neurological deficits have been reported up to **20% of cases with PSO**. These include radiculopathy, transient single root weakness and, rarely, cauda equina syndrome

Deficits were always unilateral and never proximal to the osteotomy, often did not correspond to the level of osteotomy and were not detected by neuro-monitoring.

Pseudoarthrosis: This is a late complication. Anterior fusion is more likely as the osteotomy is through the cancellous bone. Posterior mid-line fusion is unlikely because of laminectomies.

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Clinical Case

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SVA: 13cm
PT: 31

SVA: 1cm
PT: 12

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Clinical Case

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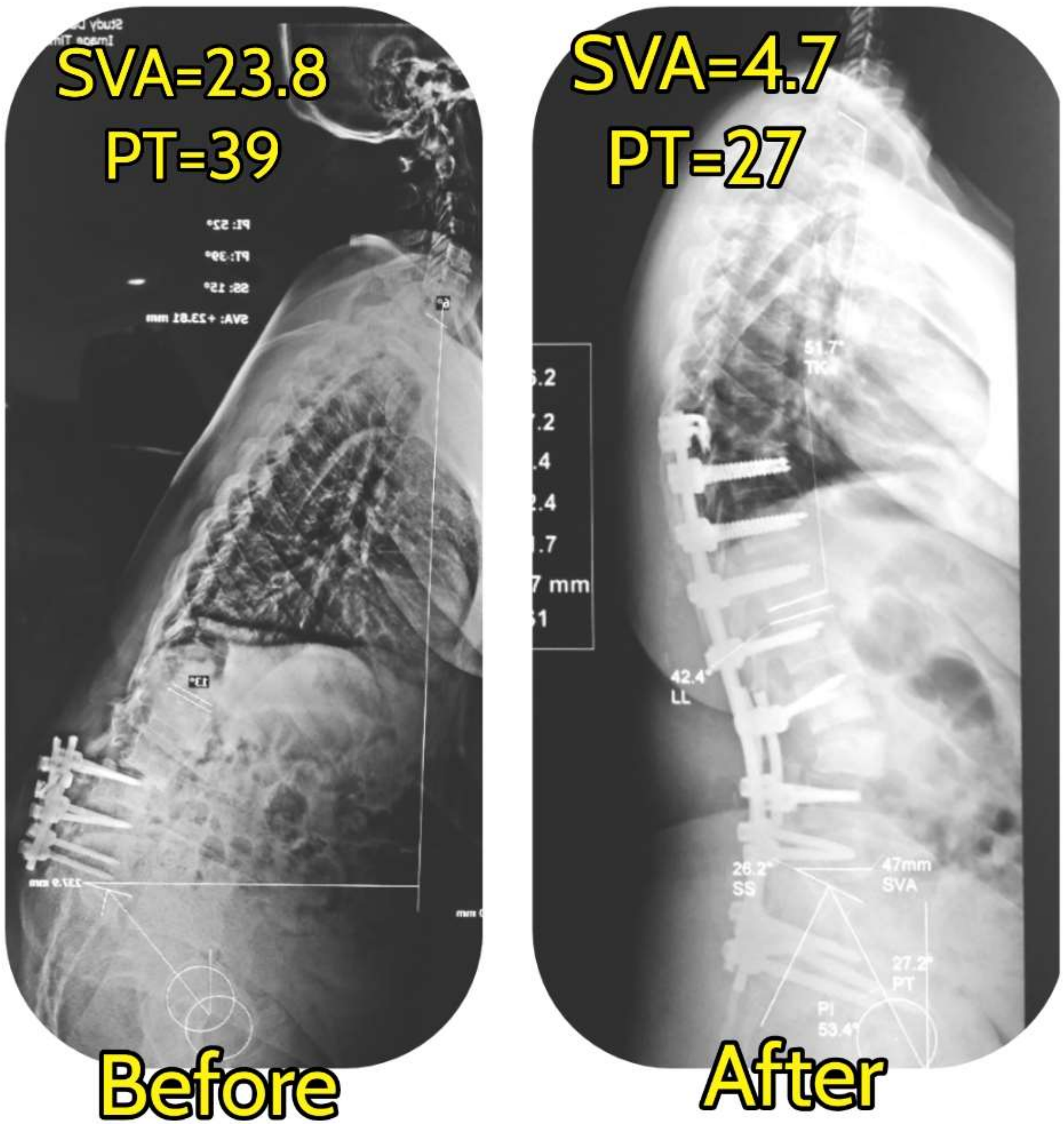

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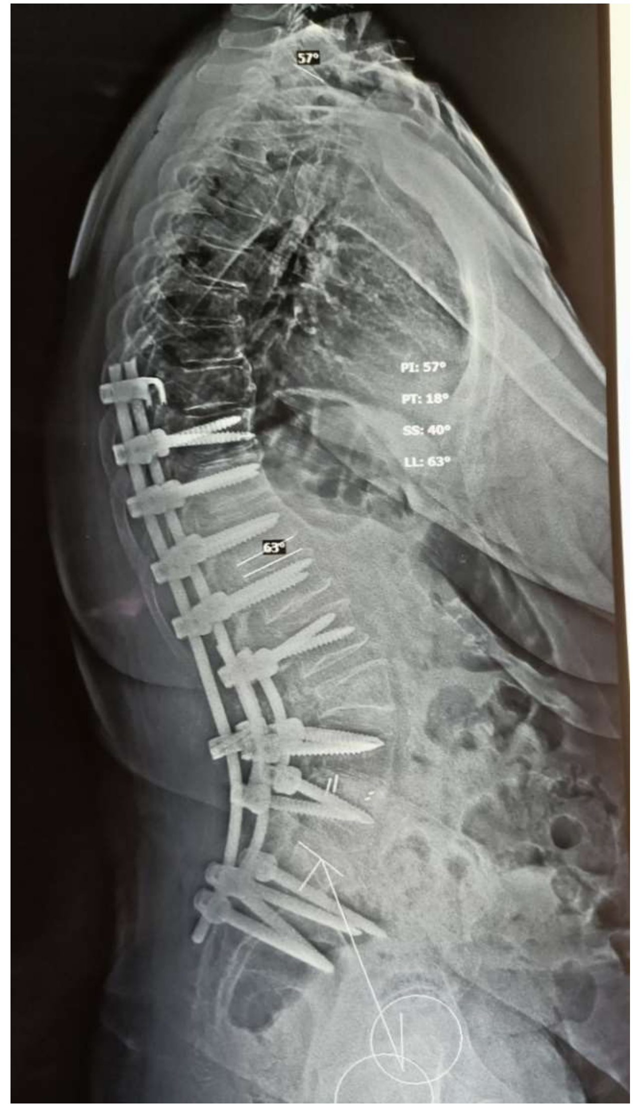
SVA: 15cm
PT: 35



SVA: 1.4 cm
PT: 18

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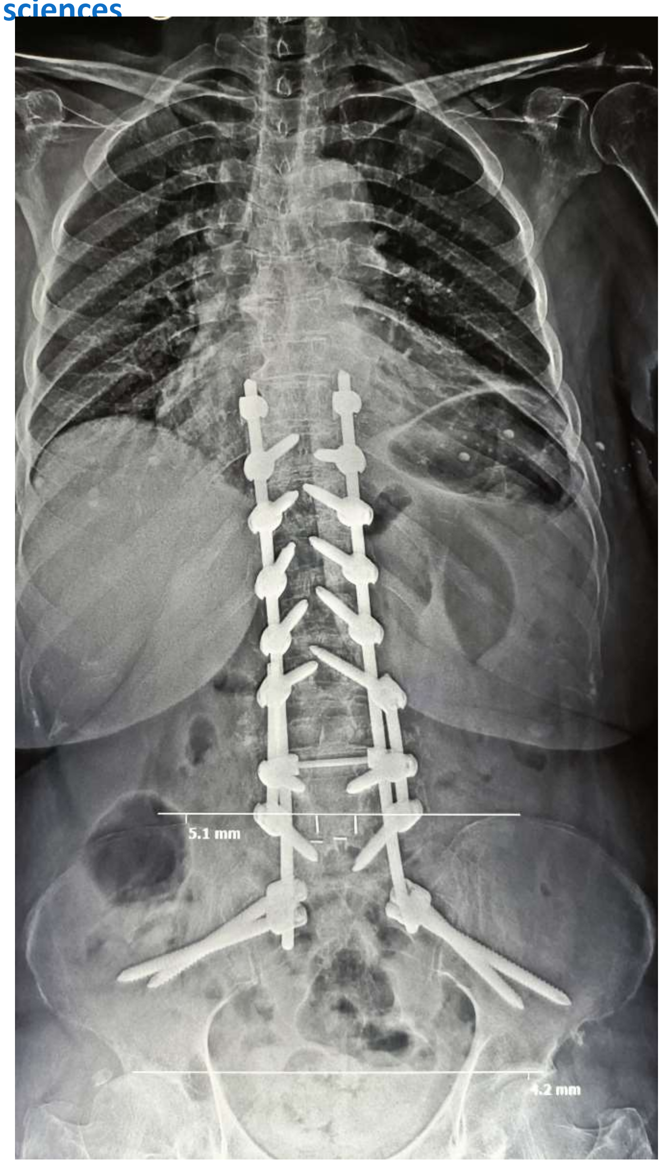

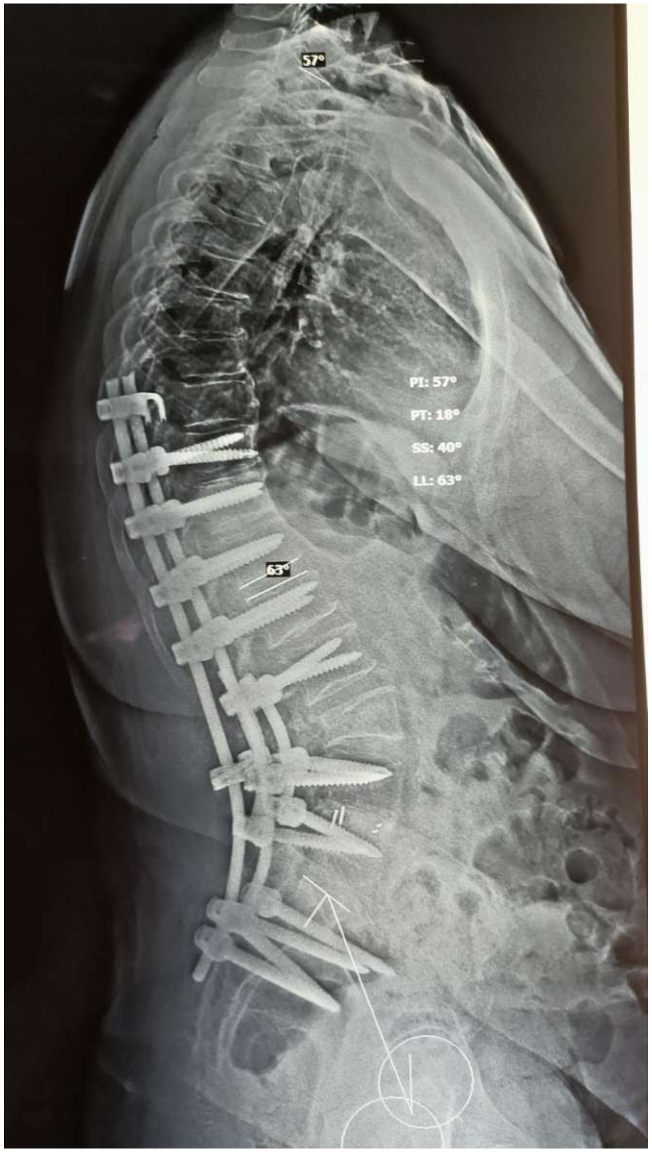

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Clinical Case

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LL:0
SVA:16cm

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Clinical Case

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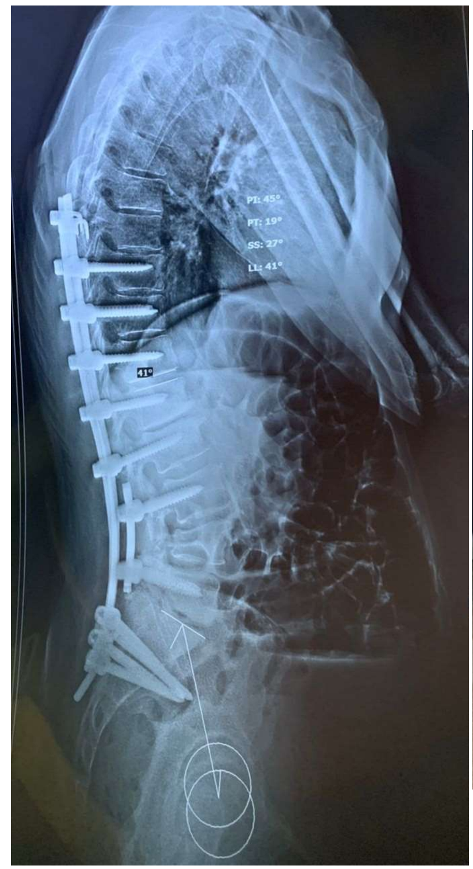
LL:0
SVA:16cm

Intraoperative image



LL:41
SVA:3.5cm

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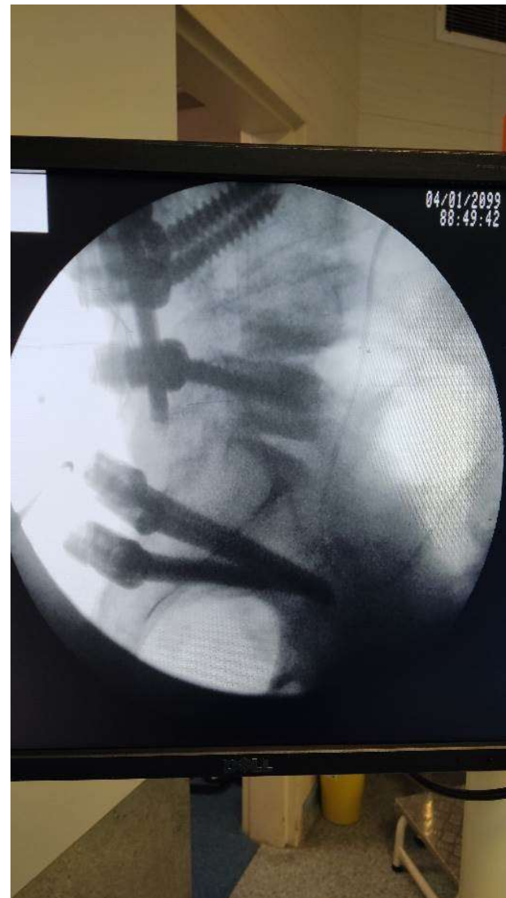

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CORNER Os

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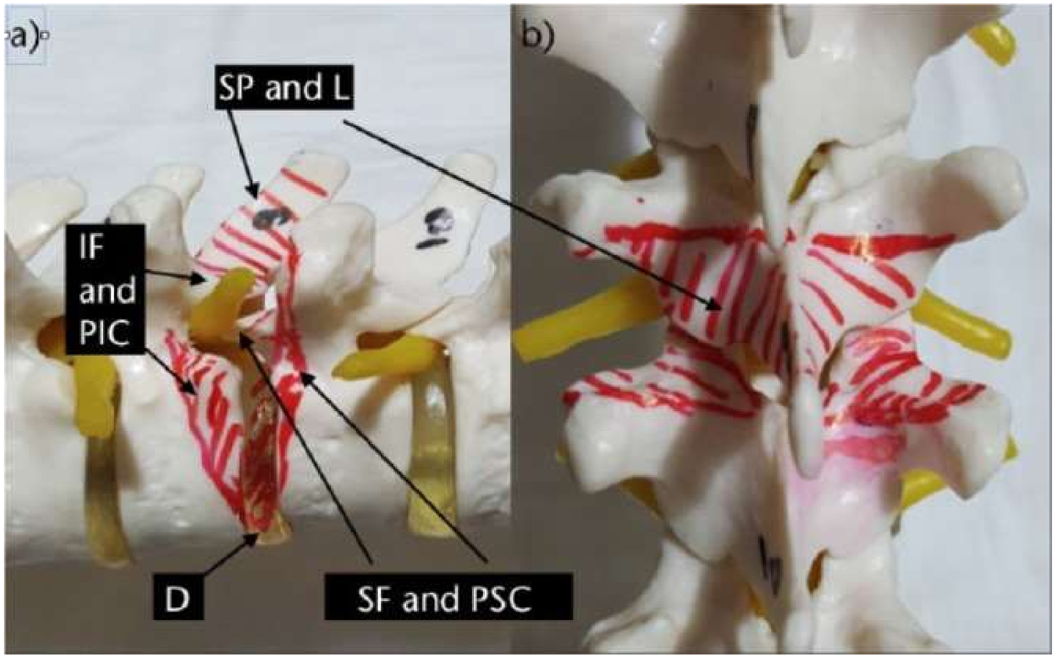
Corner Osteotomy: an osteotomy done both above and below a disc level and the resection includes the disc with its adjacent end-plate(s). It typically provides **correction rates in the range of 35° to 60°**



The main indications are deformities with the disc space as the apex or centre of the rotational axis (CORA) and severe sagittal plane deformities that necessitate correction rates exceeding those that a simple PSO can provide.

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CORNER Os

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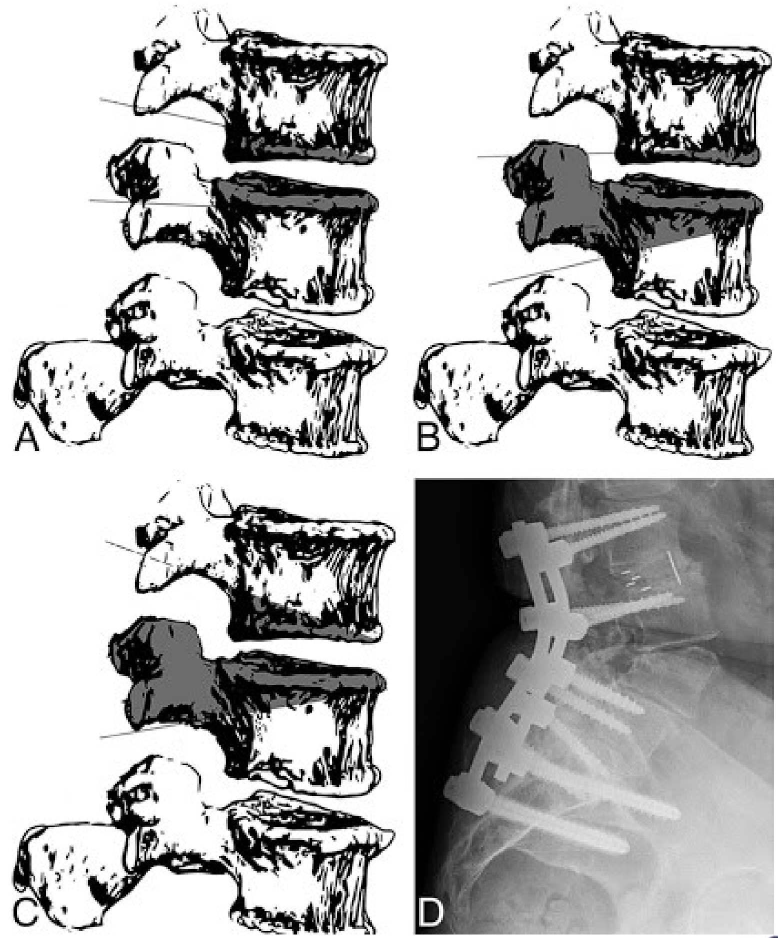
Ozturk et al suggested that the major advantage of Corner Osteotomy compared with posterior-only VCR (PVCR) is applicability at the lumbar spine without sacrificing the nerve roots while providing correction rates closer to PVCR

A Corner osteotomy may be impossible or hard to apply in ankylosing spondilitis patients when the anterior annulus is calcified or ossified.

Corner osteotomy may theoretically be complicated with damage to the vascular structures especially when an anterior lengthening is done through the disc space



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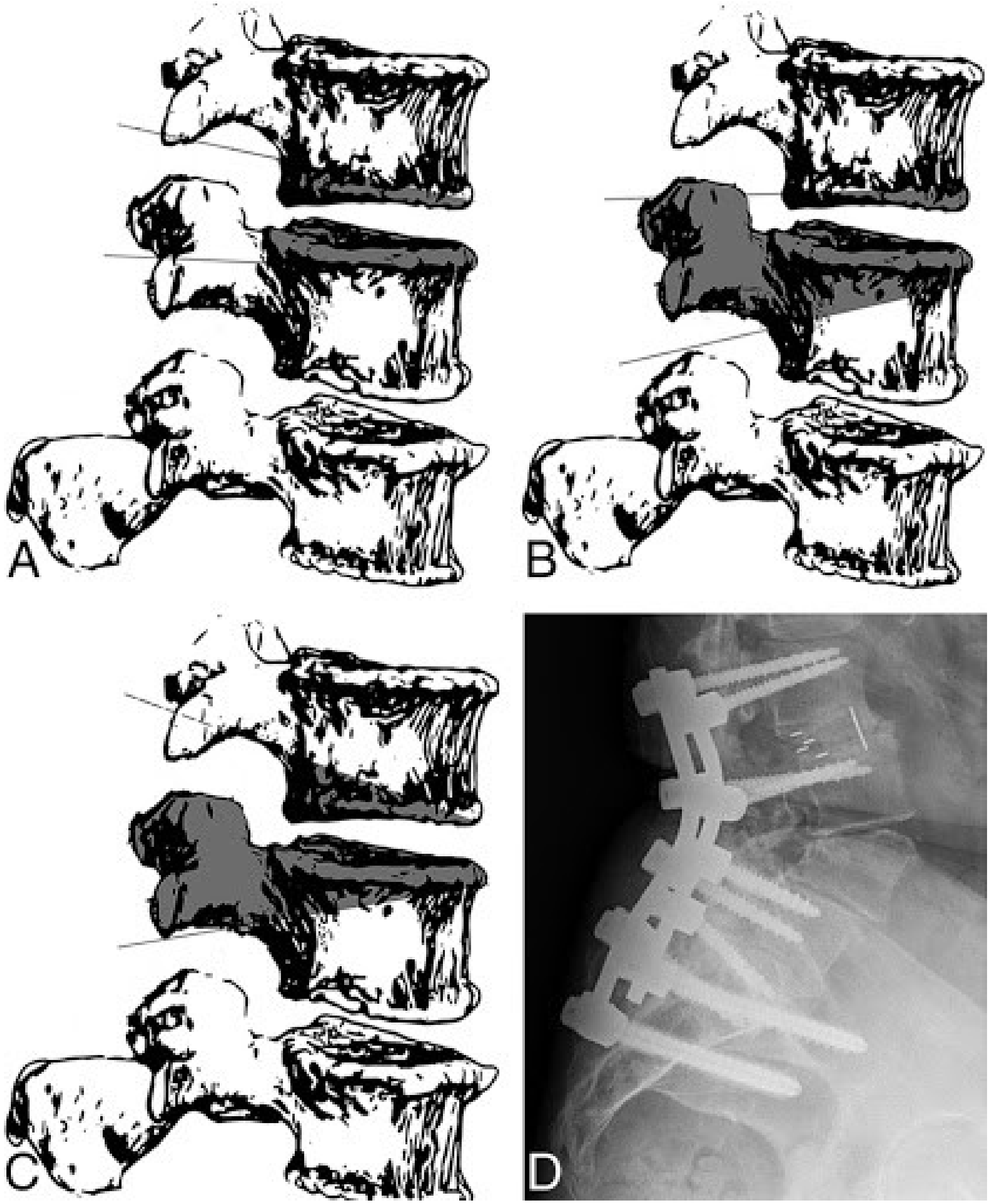
Introduction



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Corner Osteotomy

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Under general anesthesia, the patient is placed prone on a **Jackson table**, allowing for abdominal decompression and for **reverse break of the table at the level of the osteotomy**, to assist in its closure.

it is advisable to extend the instrumentation **at least two levels above and below the osteotomized vertebra. In case the fusion area includes S1, include iliac bolts in the instrumentation.**

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After complete subperiosteal exposure, reaching bilaterally the tips of the transverse processes, and insertion of pedicle screws, ***the rods are cut and pre-bent to reduce the time to closure of the osteotomy after it has been performed.***

The choice of the rod must take into account the high mechanical demand on it, and **a large diameter (6 or 6.35 mm) titanium rod or a 5.5 mm CoCr titanium alloy can be preferable.**

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It is also important **to avoid damage to the rod, avoiding sharp contouring, repeated contouring and reverse-contouring in the same region and, specially, the use of in situ benders**, as they tend to leave marks in the rod that behave as stress risers favoring rod breakage after cycles of load.

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L4 Corner Osteotomy

As a ruler of thumb, in an L4 corner osteotomy, **the rod usually has to be bent nearly 90° (or even more, depending on the final correction needed) to appropriately engage the iliac, S1, L5, L3 and L2 screws.**

After contouring, **chisels are used to excise the inferior facets of L4 and L3 bilaterally** and a rongeur is used to excise the spinous processes of L3, L4 and L5. **Complete resection of the arch of L4, yellow ligaments between L3 and L5 and the superior facet joints of L4 and L5 follows.**

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L4 Corner Osteotomy

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The ventral capsule of the facet joints of L3–L4 and L4–L5 is freed to bilaterally expose the L3 and L4 roots in the foramina. Bleeding usually is intense in the foraminal area and can be controlled by cautious use of bipolar coagulation or with hemostatic agents

Once the exposure is completed, **the only remaining posterior elements of L4 are the pedicles** that at this point are resected with a rongeur to the point where they meet the posterior wall

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L4 Corner Osteotomy

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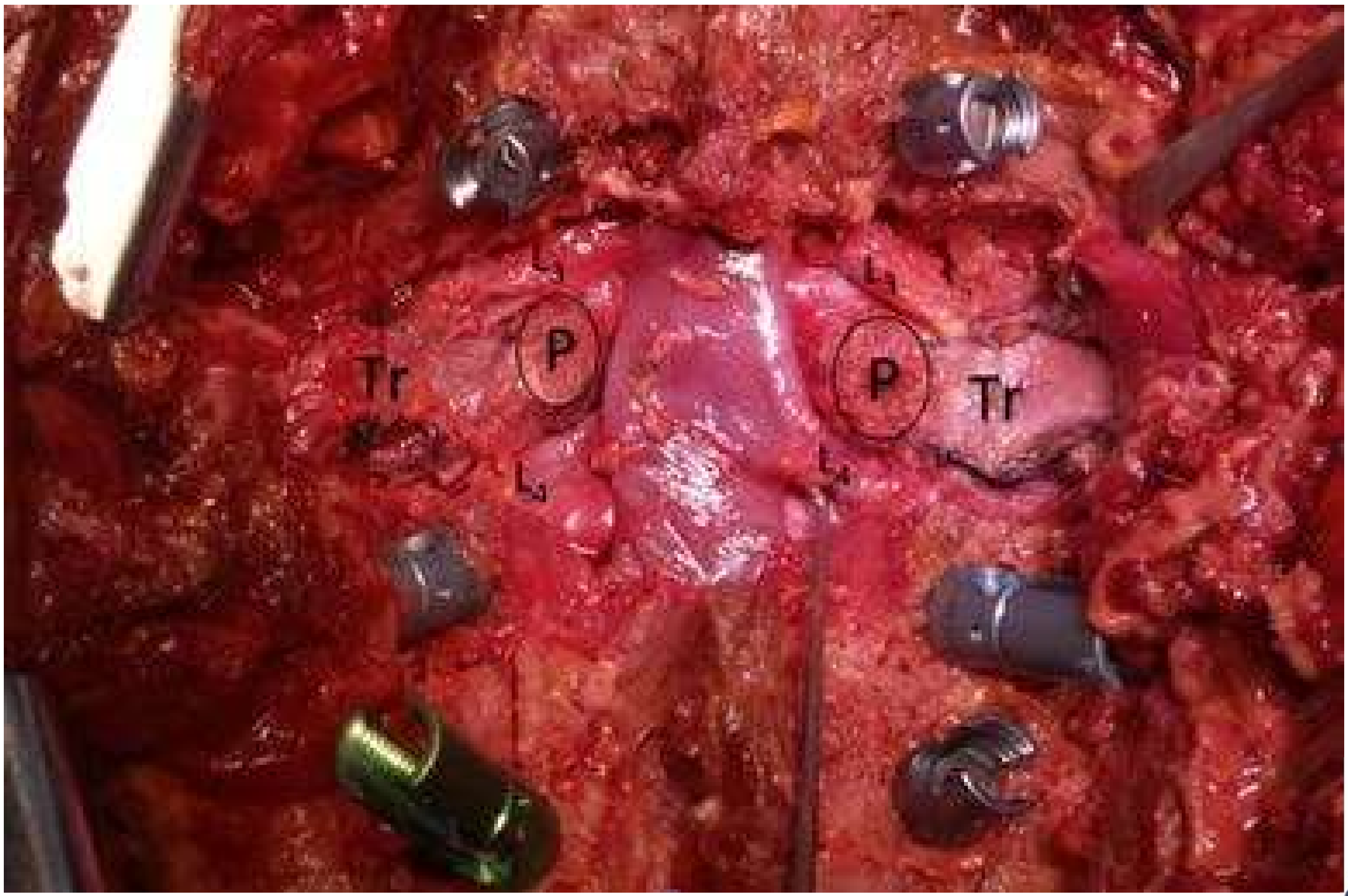

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The base of the transverse processes is cut with a Kerrison or an osteotome. **With a small Cobb elevator the psoas muscle and the lumbar plexus are carefully dissected laterally from the upper half of the lateral wall of the vertebral body**

Care is taken to avoid in this maneuver **damage to the segmental vessels and the lumbar plexus**. **A large leaf of Surgicel** is inserted between bone and soft tissue as protection. At this point, the surgeon has control on the lateral wall of the osteotomized vertebra.

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the ventral dura is mobilized from the posterior longitudinal ligament and again bipolar coagulation is used to control bleeding. Mobilization of the dura to expose medially the L3–L4 disc is possible. **The posterior annulus is excised with a scalpel**. ***The posterior annulotomy is extended laterally to the lateral annulus while protecting the exiting L3 root that is retracted cranio-laterally. This maneuver will allow for easy extraction of the lateral wall fragment after the osteotomy.***

With shavers and curettes (as usual for PLIF), **all the disc is carefully excised bilaterally in all its width and length, and the endplate of L3 is carefully prepared for fusion, with resection of all the endplate cartilage.**

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L4 Corner Osteotomy

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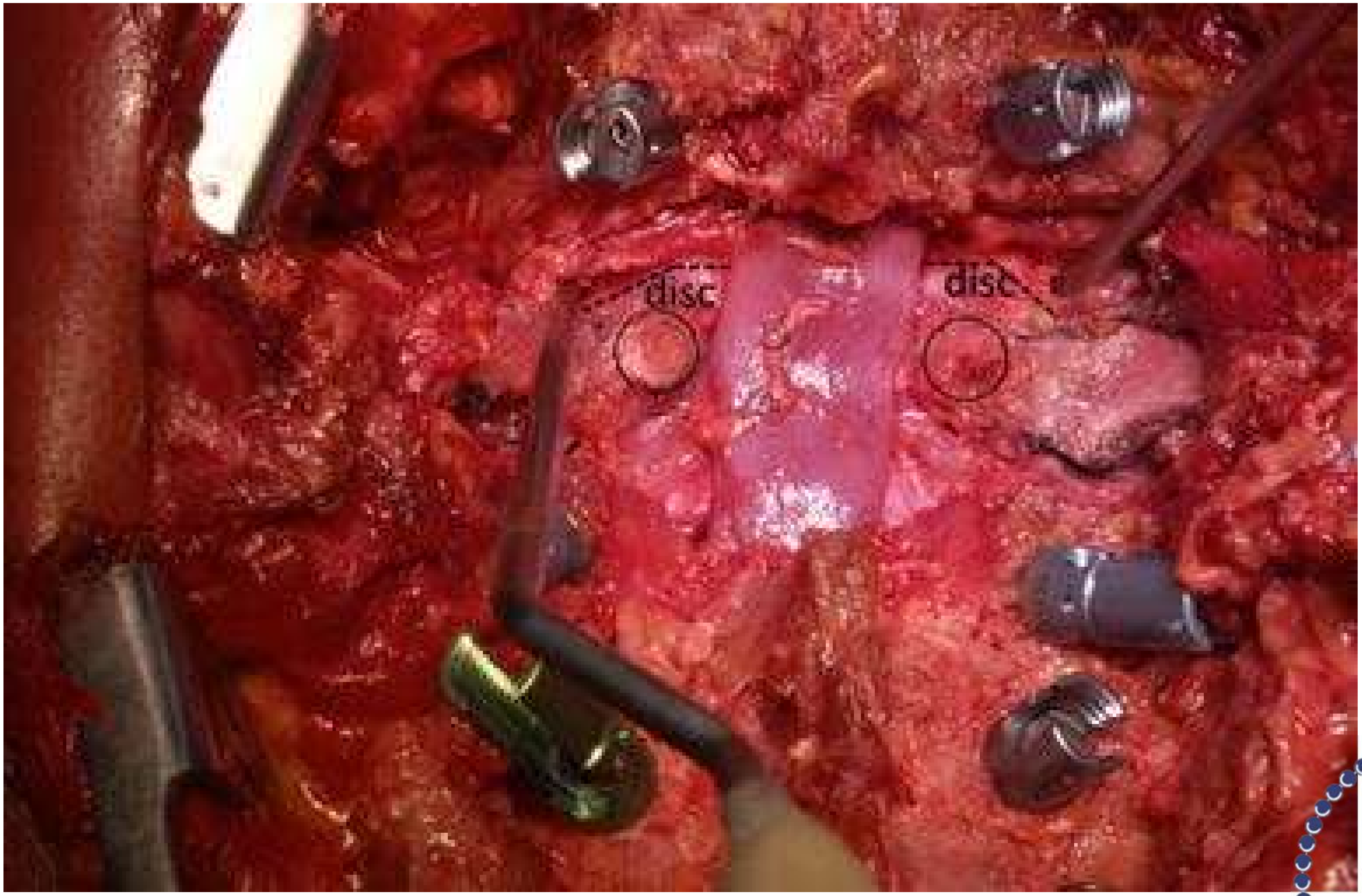

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L4 Corner Osteotomy

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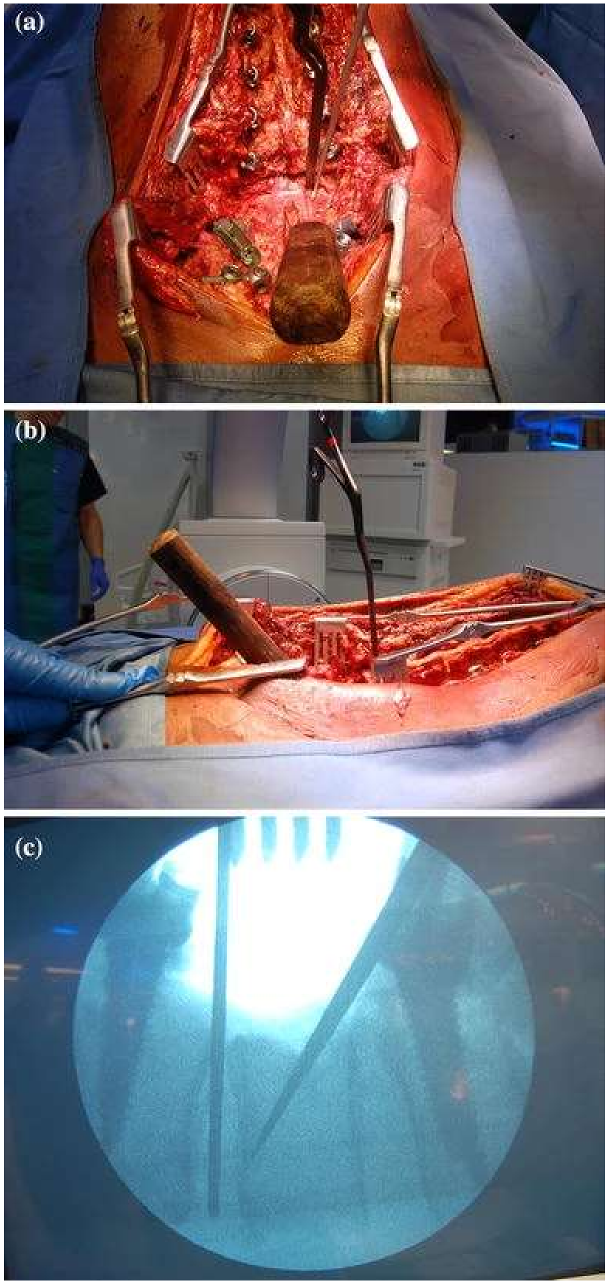
Once this step is completed, a shaver or rongeur is inserted deep into the L3–L4 disc space. This will serve as a reference for the direction of the endplate and to align the osteotomy plane with the desired angle.



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L4 Corner Osteotomy

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At this point the osteotomy is performed. **The assistant retracts the L4 root medially and caudally and the lumbar plexus laterally to the vertebral body.** ***A 10–15 mm wide osteotome is placed horizontally usually below the lower margin of the pedicle.*** Using as a reference the instrument in the disc space, the planned angle of osteotomy is reproduced.

A 30° to 35° osteotomy is performed starting just below the lower limit of the pedicles and reaching the L4 endplate at the union of the posterior 2/3 and the anterior 1/3 of its length. After this first cut, a vertical cut is made medially to the pedicle. This permits mobilizing and extracting the first fragment of bone

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L4 Corner Osteotomy

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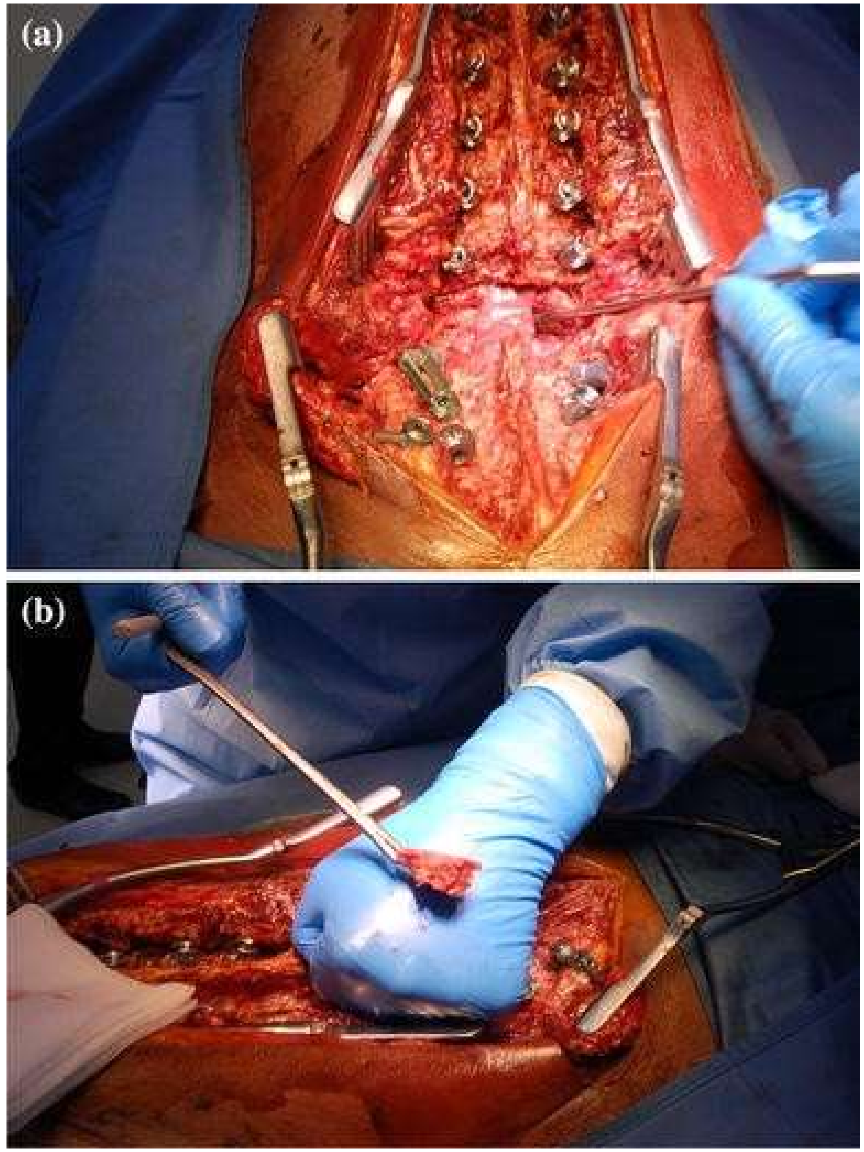

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L4 Corner Osteotomy

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At the end of the contralateral resection **a thin bone bridge can remain in the midline.** In this case, the surgeon can decide to resect it with the osteotome from one side or by decancellation and impaction of the remaining posterior wall. Once the osteotomy is completed

Once the osteotomy is completed, **it is closed by reverse break of the table and assisted by manual force carefully applied to the spine in anterior direction.** ***The preserved anterior annulus and longitudinal ligament act as a hinge and anterior tension band, and prevent dislocation of the spine***

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L4 Corner Osteotomy

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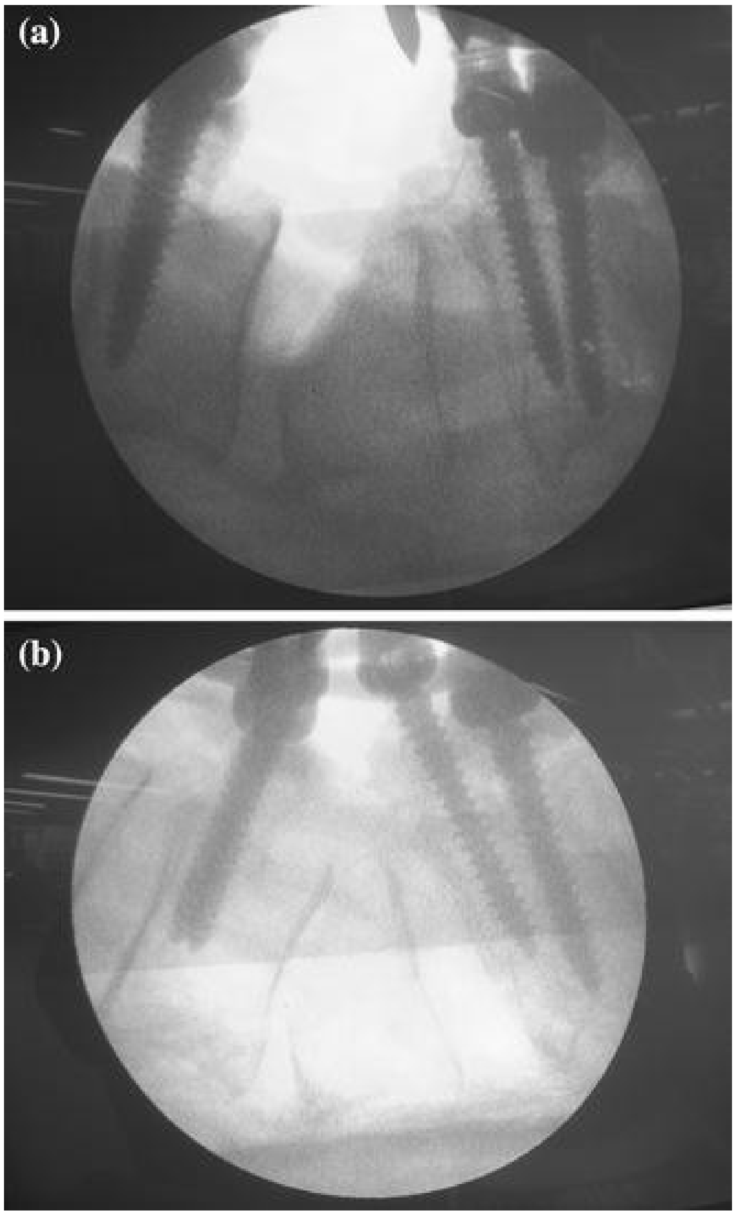

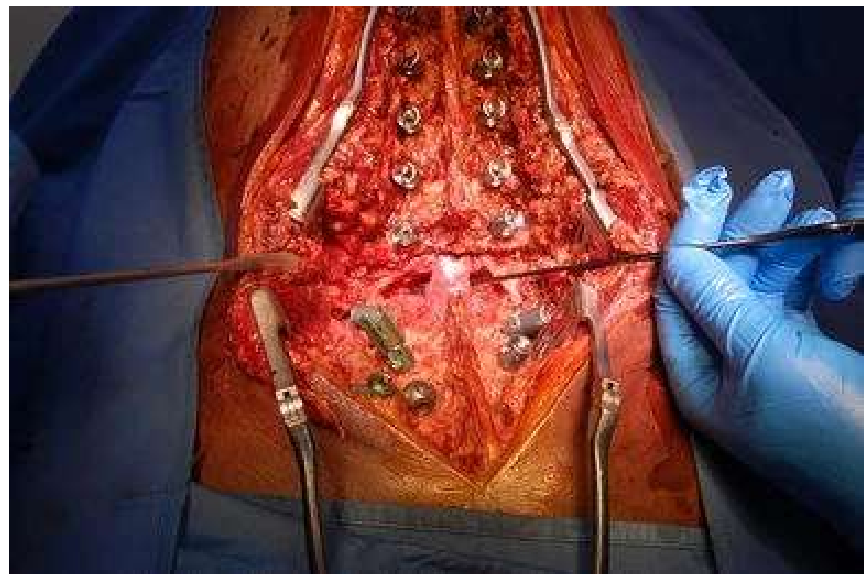

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L4 Corner Osteotomy

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During reduction, the L3 and L4 roots and the sac are visualized bilaterally to avoid impingement. **Care must be taken to maintain manual pressure on the rods until at least 2 + 2 proximal screws have been engaged to prevent pullout of screws.**

It is preferable to systematically include an **interbody fusion below the osteotomized vertebra** (in this case at L4-L5) with autologous graft and a cage. **implanting the cage after the closure of the posterior construct results in compression between the L3 lower endplate and the spongiosa of L4, increasing the chance of interbody fusion**

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L4 Corner Osteotomy

LL: +39.6
PI:40
SVA: 21.3 cm

LL: -49
PI:40
SVA: 1.4 cm

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Table 1 Characteristics of the cohort at baseline

	Corner osteotomy	PSO	*p* value
PI (°)	53.8 ± 8.8	50.4 ± 14.7	ns
PT (°)	30.4 ± 10.4	30.9 ± 13.0	ns
LL (°)	24.0 ± 23.6	22.2 ± 14.0	ns
TK (°)	28.2 ± 15.8	47.3 ± 31.0	<0.001*
SVA (mm)	91.0 ± 72.7	70.9 ± 49.0	ns
Number of cases	10	20	
Primary/revision surgery	40/60 %	70/30 %	
Associated anterior surgery (same stage)	40 %	5 %	
Average age (years)	70 ± 4	62 ± 4	

ns not significant

* Statistically significant, Mann–Whitney *U* test

Table 3 Comparison of postoperative sagittal spinopelvic parameters

Postoperative parameters	Corner osteotomy	PSO	*p* value
PT (°)	15.7 ± 7.2	22.0 ± 11.6	0.001*
LL (°)	58.1 ± 9.9	36.9 ± 14.9	0.87
TK (°)	40.4 ± 12.0	39.7 ± 17.3	0.017*
SVA (mm)	23.7 ± 28.3	42.2 ± 44.8	0.008*
Variations preop to postop			
ΔPT	−14.0 ± 12.0	−8.9 ± 11.7	0.28
ΔLL	34.5 ± 25.0	16.2 ± 22.0	<0.001*
ΔSVA	68.6 ± 97.0	28.7 ± 46.3	0.005*
Lordosis angle at osteotomy (°)	36.6 ± 8.2	16.5 ± 9.5	<0.001*

ns not significant

* Statistically significant, Mann–Whitney *U* test

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Table 4 Perioperative variables

	CO	PSO
Duration of surgery (min)	516 ± 83	397 ± 35
Blood loss (cc)	1,419 ± 386	1,427 ± 294
Days hospitalized	15 ± 3	12 ± 3
% patients transfused	100	84
Red blood cells (bags/pt)	3.2 ± 1	2.6 ± 1
Platelet concentrates (bags/pt)	1.8 ± 2	1.3 ± 1

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Corner Osteotomy

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Data of operation of patients who underwent grade 3 or 4 osteotomy, using single our double S2 Alar iliac surgery

Variables	Single (n=32)	Double (n=83)	P-Value
Upper Instrumented Vertebrae			0.23
T10	14 (43.7%)	39 (46.9%)	
T9	10 (31.2%)	26 (31.3%)	
T8	2 (6.3%)	12 (14.4%)	
T4 or upper	6 (18.8%)	6 (7.2%)	
Stage(s) of Operation			0.31
Single Stage	30	81	
Two Stages	2	2	
Operation time (Minute)	618 ± 174	654 ± 170	0.31
Blood Loss	1550 ± 288	1668 ± 349	0.09
Type of Osteotomy			0.12
Pedicle Subtraction Osteotomy, n (%)	24 (75%)	72 (86.7%)	
Corner Osteotomy, n (%)	8 (25%)	11 (13.3%)	
Level of Osteotomy, n (%)			0.30
L2	6 (18.8%)	11 (13.2%)	
L3	11 (34.3%)	20 (24.1%)	
L4	15 (46.9%)	52 (62.7%)	
Number of SPOs at other levels	3.6 ± 2.0	4.3 ± 2.1	0.11
Length of hospital stay postop	7.2 ± 2.4	7.0 ± 2.3	0.68
SPO: Smith Peterson Osteotomy			

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Corner Osteotomy

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Complication profile of patients with single versus double S2 Alar iliac screws who underwent grade 3 or 4 osteotomies

Variables	Single (n=32)	Double (n=83)	P-Value
Need to Reoperation	11 (34.3%)	20 (24.1%)	0.26
PJK	6 (18.7%)	9 (10.8%)	0.25
PJF	6 (18.7%)	8 (9.6%)	0.18
Pedicular Screw pseudo arthrosis	5 (15.6%)	7 (8.4%)	0.25
SAI screw pseudo arthrosis	6 (18.7%)	1 (1.2%)	<0.01
SAI screw dislodgement	4 (12.5%)	0 (0)	<0.01
Rod Fracture	6 (18.7%)	5 (6.0%)	0.03
Incidental durotomy	5 (15.6%)	6 (7.2%)	0.17
Surgical Site Infection	3 (9.3%)	6 (7.2%)	0.70
Sepsis	2 (6.2%)	2 (2.4%)	0.31
DVT	6 (18.7%)	9 (10.8%)	0.18

PJK: Proximal Junctional Kyphosis; PJF: Proximal Junctional Failure; SAI: S2 alar Iliac
DVT: Deep Vein Thrombosis

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Corner Osteotomy Vs PSO

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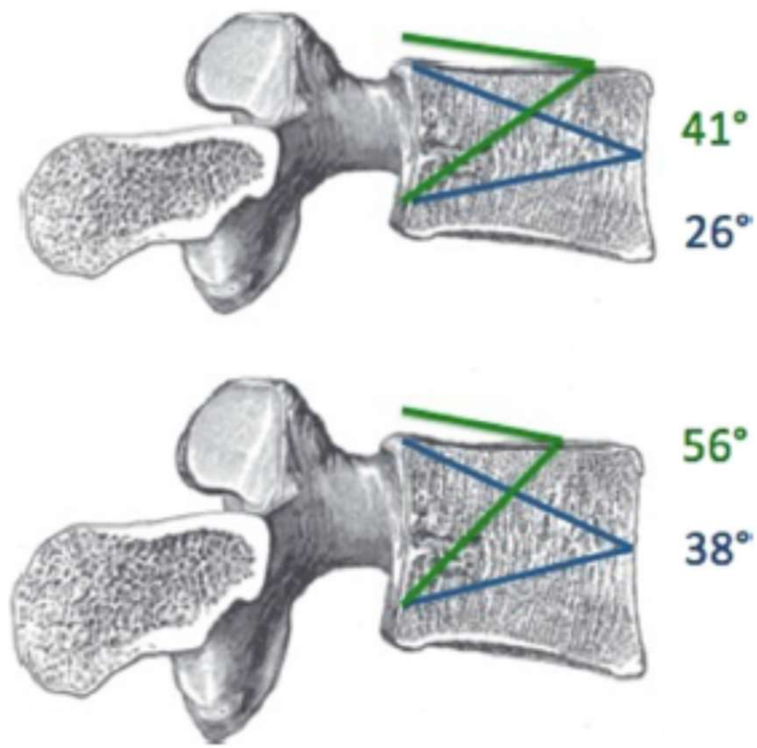

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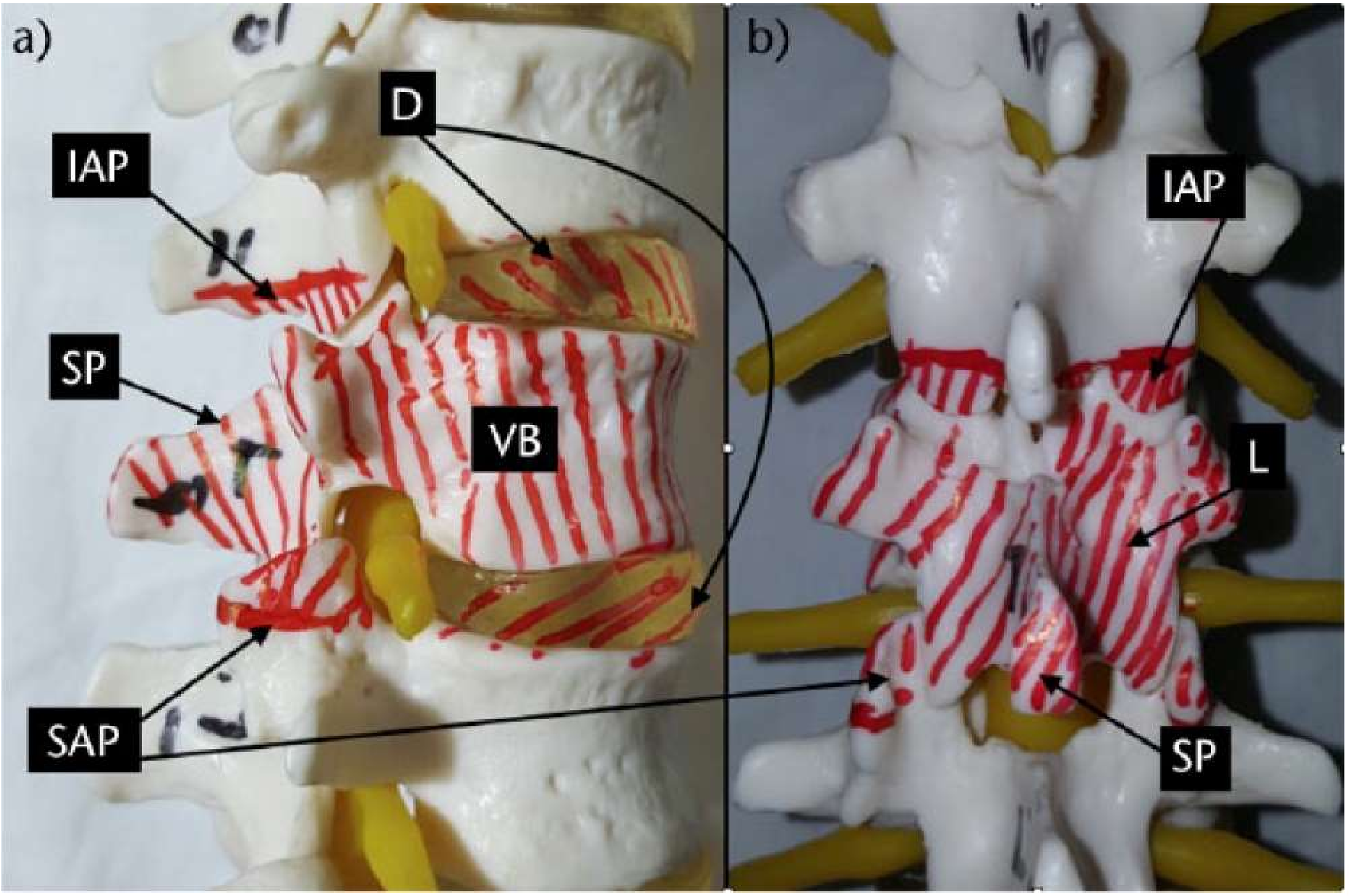

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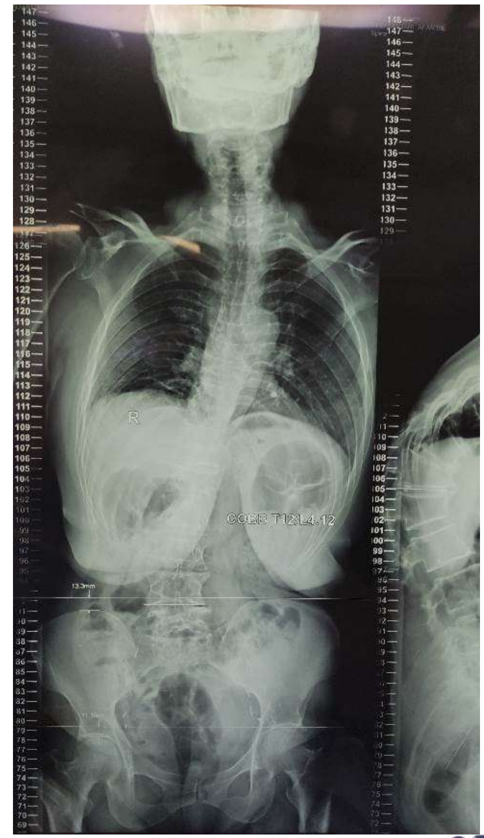

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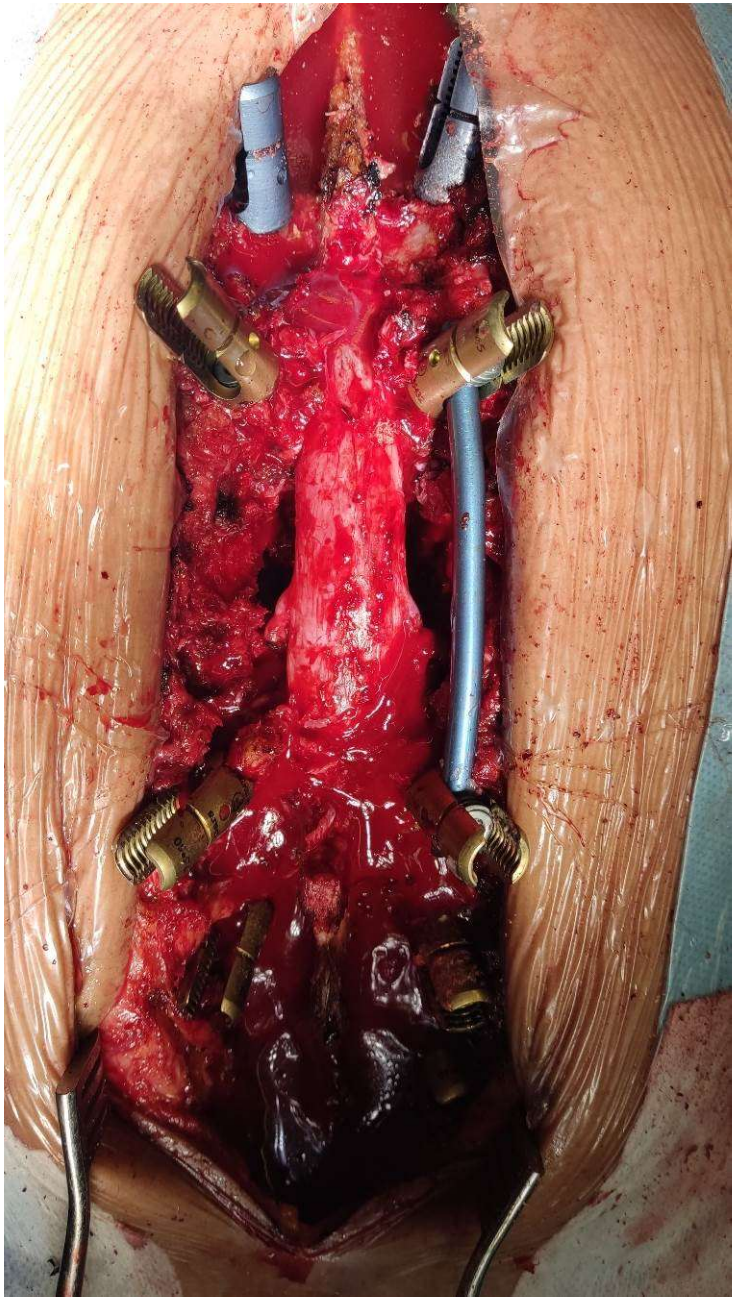

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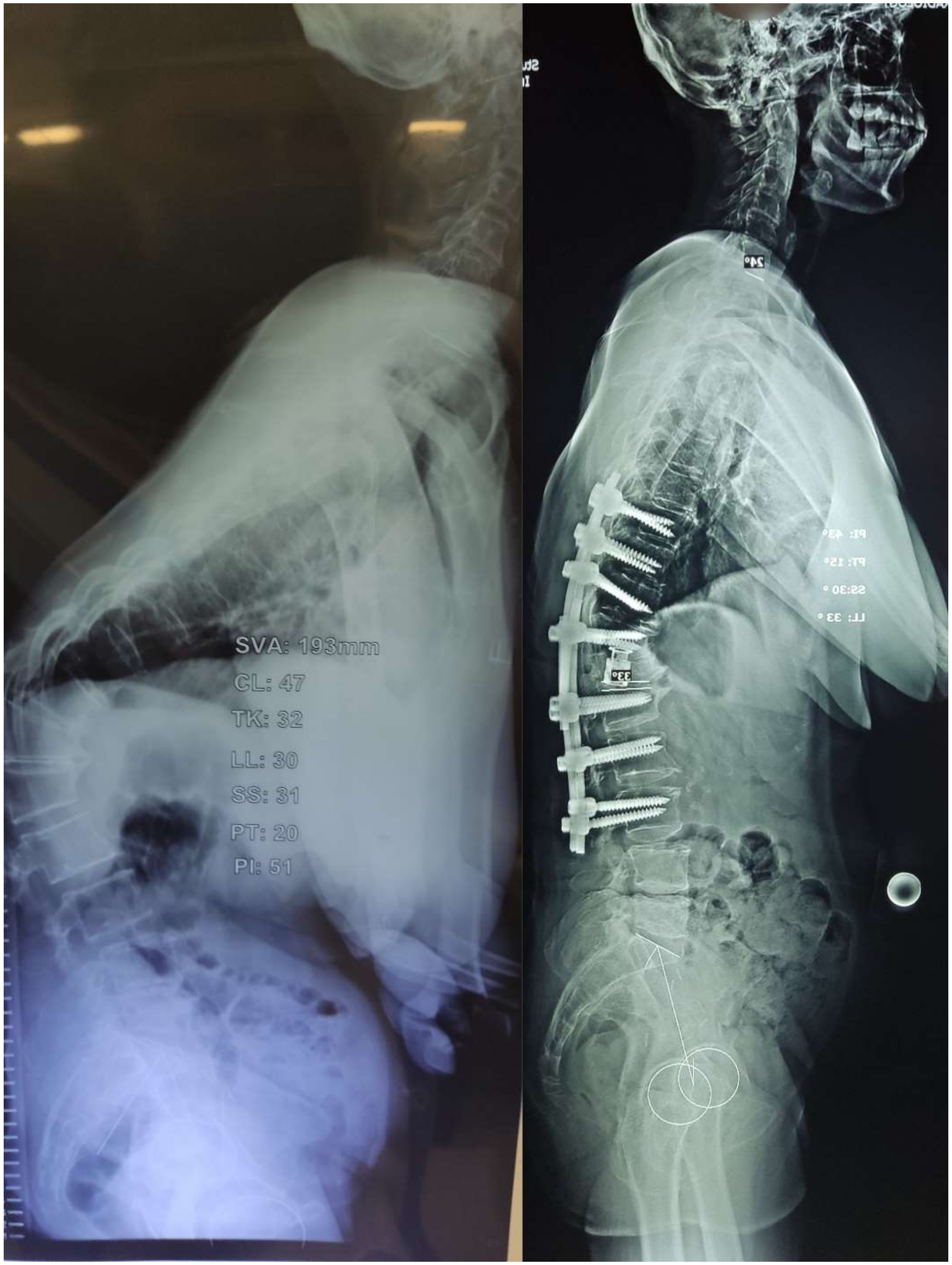

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Thank you

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