Adult Scoliosis

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TOPICS

- Introduction
- Definition.
- Types of adult scoliosis.
- Prevalence
- Clinical presentation.
- Biomechanical considerations.
- Classification
- Treatment options.
- Case presentation.
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Introduction

- Adult scoliosis refers to any case of scoliosis occurring in an individual over the age of eighteen.
- Individuals with adult scoliosis are skeletally mature and have distinct differences in terms of their presentation for treatment as well as for treatment options in comparison to their pediatric counterparts.

Introduction

- An adult spine coronal deformity may develop de novo in the mature skeleton or progress from the untreared adolescent scoliosis.
- Estimates of prevalence vary from 1 to 9%.
- Adult patients present more often with pain or neurlogical symptoms than their adolescent counterparts. And surgery is generallly indicated for patients with significant deformity-related pain or progressive curves.
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Natural history of untreated AIS

- This is a slow increase in curvature that began during teenage years in an otherwise healthy individual and progressed during adult life.
- Curves may increase in size 0.5-2° per year.
- Adolescent curves less than 30° are unlikely to progress significantly into adulthood, while those over 50° are likely to get bigger.

Adult Scoliosis:

Definition:

Spinal deformity in skeletaly mature with a curve measuring > 10 degree in cobb method.

Types:

Adolescent types [AIS, Neuro muscular , congenital with structural deformity]

De novo type - degenerative scoliosis

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Types of adult scoliosis

- 1- Idiopathic scoliosis, with its onset in childhood but presenting with pain and worsening deformity in the adult.
- 2-congenital anomalies that arise in-utero,
- 3-degenerative scoliosis caused by disc degeneration,
- 4- post traumatic scoliosis (occurring as a result of fractures of the spine), and
- 5-neuro- muscular scoliosis often seen in patients with polio, muscular dystrophies, or other neuromuscular disorders.

Prevalence of adult scoliosis:

- 1-9%
- Overall = 68% age older than 60yrs.
  Demographic shift due to raising life span.

Adult degenerative scoliosis:

Over the age of 40yrs

10 degree = 64%

10-20 degree =44%

20 degree = 24%

Schwab etal. Prevalence of adult scoliosis. Spine 30 2005.

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Clinical Presentation: Adult Scoliosis

Often present with the following unlike AIS:

- Progressive deformity
- Disabling back pain
- Radicular symptoms
- Neurological signs
- Bladder symptoms
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Literature evidence:
Symptoms and signs:

- Back pain = 99% [VAS score >5 needed sx]
- Radiculopathy=85%
- Neurogenic claudication =9%
- Radicular weakness=8%
- Bladder and Bowel dysfunction=3%
- Myelopathy=1%

Predominate in ADS than AIS in adults.

Glassman et al.,Corelation of symptoms in adult scoliosis Spine 2005
Smith et al., Neurosurgical symptoms and deficit in adults with scoliosis. Spine 2008

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Physical findings

- Physical findings may include :
- Shoulder asymmetry.
- Rib hump or a prominence of the lower back on the side of the curvature,
- Pelvic level and tilt and rotation.
- Leg length discrepancy,
- Neurological assessment..

Biomechanical cosiderations

- plumb lines are used to determine coronal and sagittal balance.
- In the coronal plane, the plumb line is drawn from the center of C7 vertebra to the center of the sacrum..greater than 25mm of deviation is evidence of coronal decompensation.
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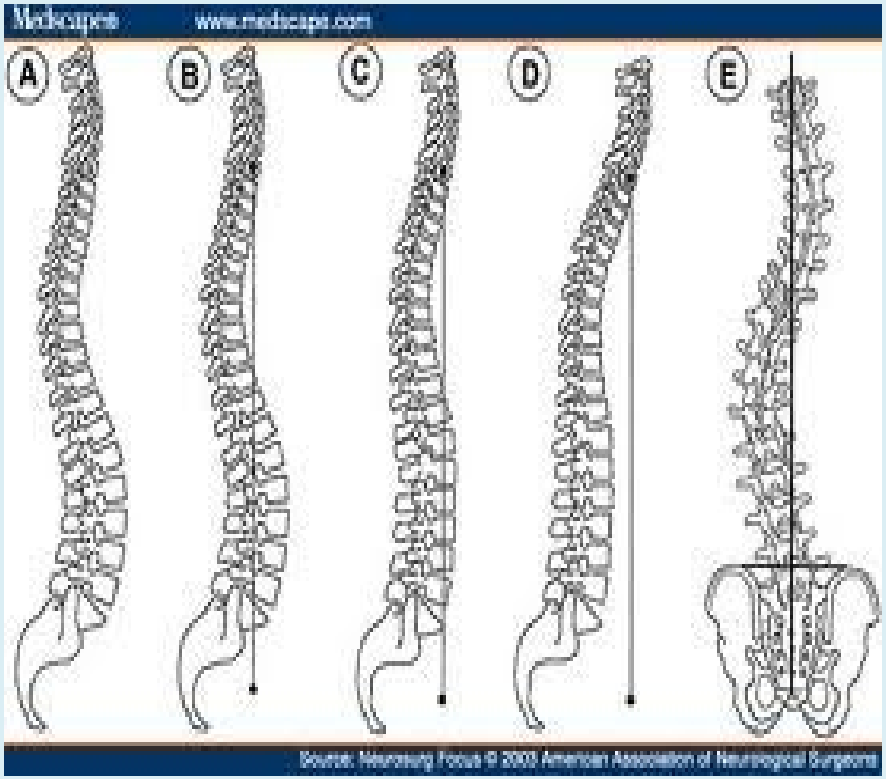

Biomechanical cosiderations

- In the sagittal plane, a line drawn from the center of C7 vertebra should intersect the S1 vertebra..a deviation of greater than 40 mm is defined as sagittal decompensation..
- By convention, when the C7 sagittal plumb line is anteriorly displaced, a positive value is assigned..
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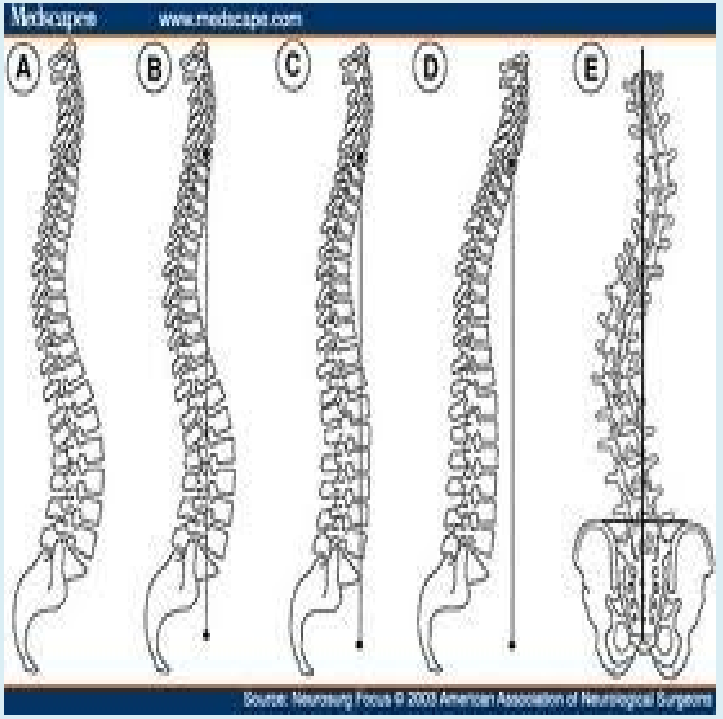

Biomechanical considerations

- **Normal Alignment**
  Understanding the normal spinal alignment will help with surgical planning.
- In the sagittal plane, the thoracolumbar junction T10 to L2 is neutral.
- There is approximately 20 to 30° more lumbar lordosis than thoracic kyphosis.
- A balanced spine is most often achieved when pelvic incidence + thoracic kyphosis (T5-T12) - lumbar lordosis (T12-S1) ≤ 45° (PI + TK - LL ≤ 45°).
- The spine is straight in the coronal plane, with the shoulders and pelvis level.
- The C7 plumb line should bisect the sacrum in both planes.
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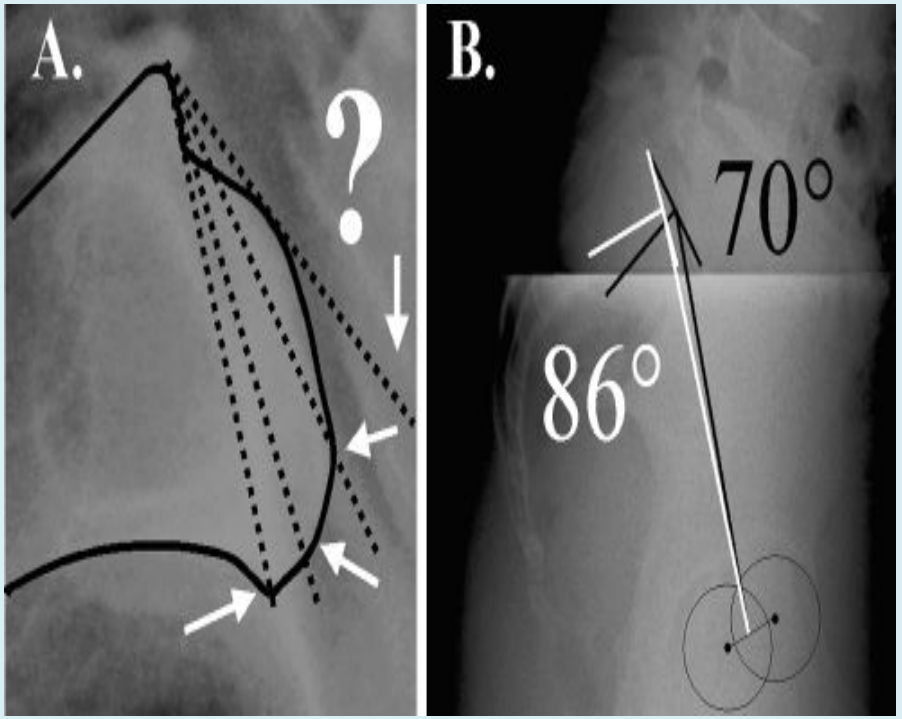
Pelvic incidence angle

- Pelvic incidence (PI), or pelvisacral angle, is defined as the angle between a line perpendicular to the sacral plate at its midpoint and a line connecting the same point to the center of the bicoxofemoral axis.



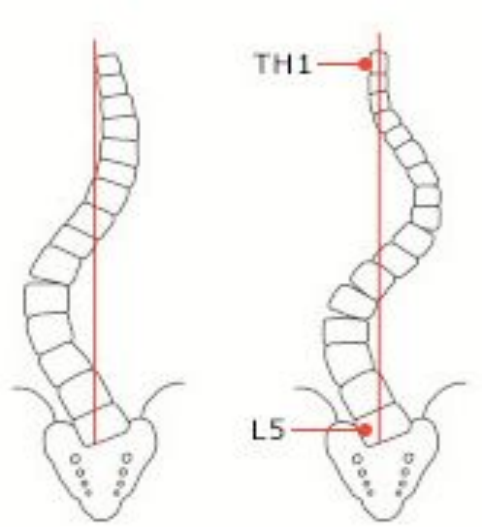
Importance of pelvic incidence

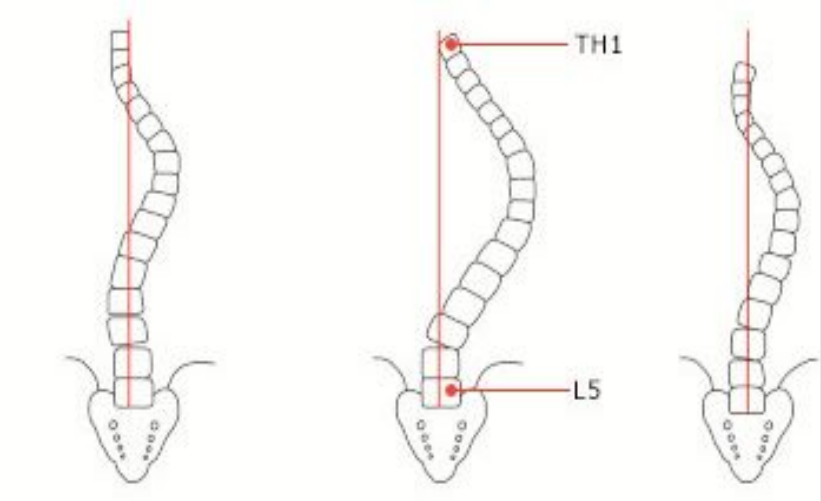
- **Pelvic incidence: a fundamental pelvic parameter for three-dimensional regulation of spinal sagittal curves** J. Legaye, G. Duval-Beaupère, J. Hecquet and C. Marty.. European Spine Journal Volume 7, Number 2, 99-103,
- A close relationship was observed, for both normal and scoliotic subjects, between the anatomical parameter of pelvic incidence and the sacral slope, which strongly determines lumbar lordosis.
-
- Taking into account the Cobb angle and the apical vertebral rotation confers a three-dimensional aspect to this chain of relations between pelvis and spine. A predictive equation of lordosis is postulated.
-
- A strict relation was described between this anatomical parameter and the sagittal tilt of the superior plate of the sacrum, and between this sacral tilt and the amount of lumbar lordosis. So the pelvic morphology modulates the sagittal spinal alignment
-
- The pelvic incidence appears to be the main axis of the sagittal balance of the spine. It controls spinal curves in accordance with the adaptability of the

Classifications

- 1- King Moe classification 1983.
- 2- Lenke classification 2001.
- 3- Aebi Classification 2005.
- 4- Schwab classification 2006.
- 5- SRS classification 2006.

KING-MOE classification 1983





KING-MOE classification 1983

- **King type I**

  Shows an S-shaped curve crossing the midline of the thoracic and lumbar curves. The lumbar curve is larger and more rigid than the thoracic curve. The flexibility index in the bending radiographs is negative.

- **King type II**

  Shows an S-shaped curve where both the thoracic major curve and the lumbar minor curve cross over the midline. The thoracic curve is larger.

- **King type III**

  Shows a thoracic curve where the lumbar curve does not cross the midline.

- **King type IV**

  Shows a long thoracic curve where the 5th lumbar vertebra is centered over the sacrum, but the 4th lumbar vertebra is already angled in the direction of the curve.

- **King type V**

  Shows a thoracic double curve where the 1st thoracic vertebra angles into the convexity of the upper curve.

Evaluation of the King classification system:

- The sagittal profile is nòt taken into consideration
- · So-called “double and triple major curves” (scoliosis forms with two or three major curves) are not considered.
- Higher inter and intra observer errors.
- King scoliosis classification is still widely used for evaluating scoliosis. A number of modifications with further subtypes have been introduced.
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LENKE CLASSIFICATION 2001

Curve type

Type	Proximal thoracic	Main thoracic	Thoracolumbar/ lumbar	Curve type
1	Nonstructural	Structural (major)	Nonstructural	Main thoracic (MT)
2	Structural	Structural (major)	Nonstructural	Double thoracic (DT)
3	Nonstructural	Structural (major)	Structural	Double major (DM)
4	Structural	Structural (major)	Structural	Triple major (TM)
5	Nonstructural	Nonstructural	Structural (major)	Thoracolumbar/lumbar (TL/L)
6	Nonstructural	Structural	Structural (major)	Thoracolumbar/lumbar— structural MT (Lumbar curve > thoracic by ≥ 10°)

Structural Criteria

Proximal thoracic: Side-bending Cobb ≥ 25°
T2-T5 kyphosis ≥ +20°

Main thoracic: Side-bending Cobb ≥ 25°

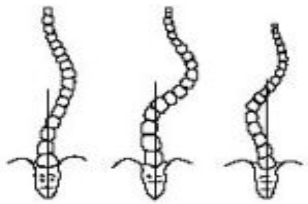
Thoracolumbar/lumbar: Side-bending Cobb ≥ 25°
T10-L2 kyphosis ≥ +20°

Location of Apex
(SRS definition)

Curve	Apex
Thoracic	T2-T11-12 Disc
Thoracolumbar	T12-L1
Lumbar	L1-2 Disc-L4

Modifiers

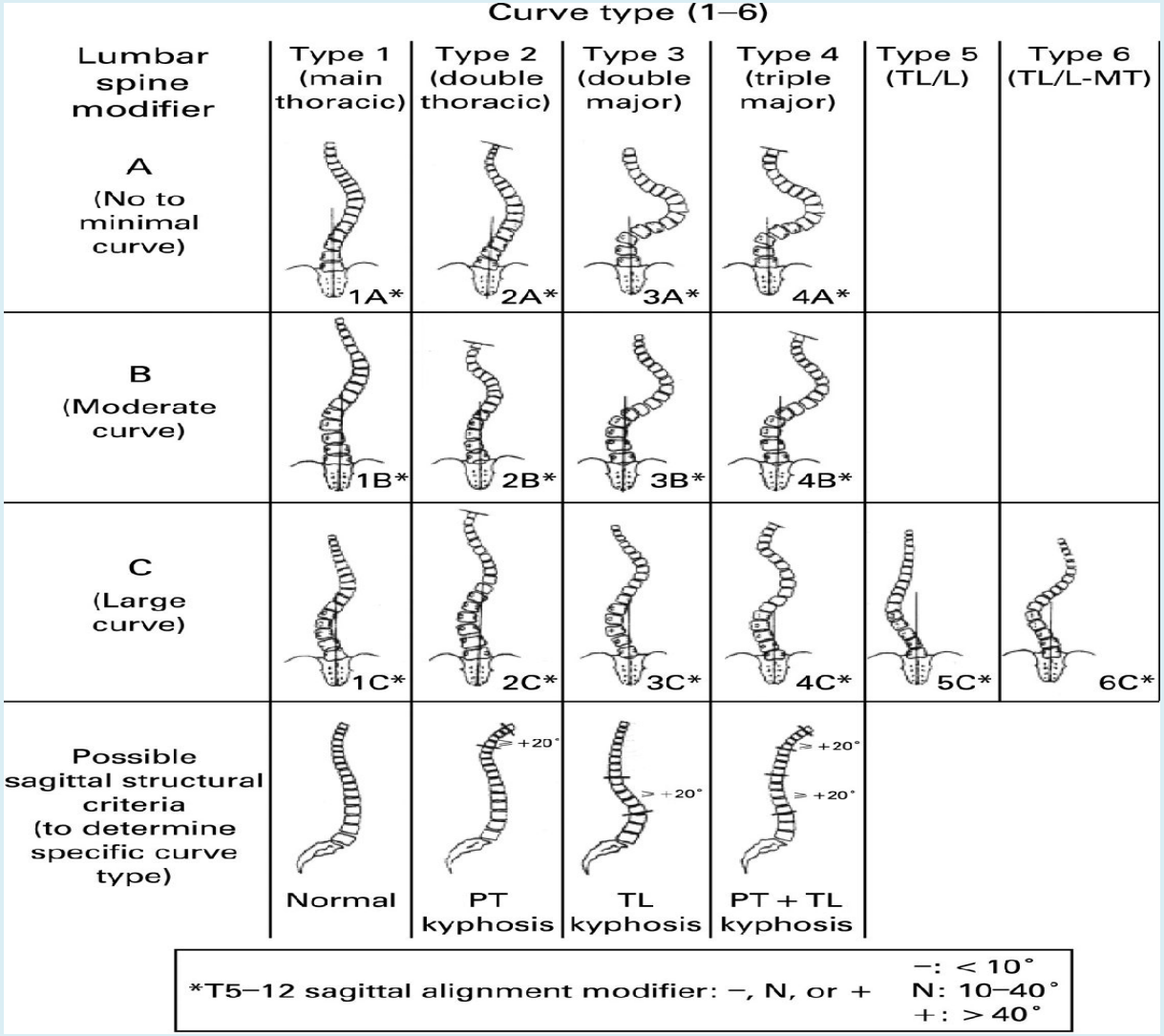
Lumbar Spine Modifier	CSVL to Lumbar Apex
A	CSVL between pedicles
B	CSVL touches apical body(ies)
C	CSVL completely medial



Thoracic Sagittal Profile T5-T12		
−	(Hypo)	< 10°
N	(Normal)	10°-40°
+	(Hyper)	> 40°

Curve type (1-6) + Lumbar spine modifier (A, B, or C) + Thoracic sagittal modifier (−, N, or +)
Classification (e.g., 1 B +):_____

Lenke classification



Lenke classification

- Lenke 1 - single thoracic = King-Moe III
- Lenke 2 - double thoracic = King-Moe V
- Lenke 3 - double major with thoracic>lumbar= II
- Lenke 4 - triple major
- Lenke 5 - thoracolumbar/lumbar curve
- Lenke 6 - double major with lumbar>thoracic= I

Curve description

- The curve type is determined by the localization, degree, and flexibility of the manifested curves.
- The curve apex is defined as follows for localization purposes:

  - Upper thoracic localization: Curve apex between Th2 and Th6

  - Thoracic localization: Curve apex between Th6 and intervertebral disc Th11/12

  - Thoracolumbar localization: Curve apex between Th12 and L1

  - Lumbar localization: Curve apex between intervertebral disc L1/2 and L4.

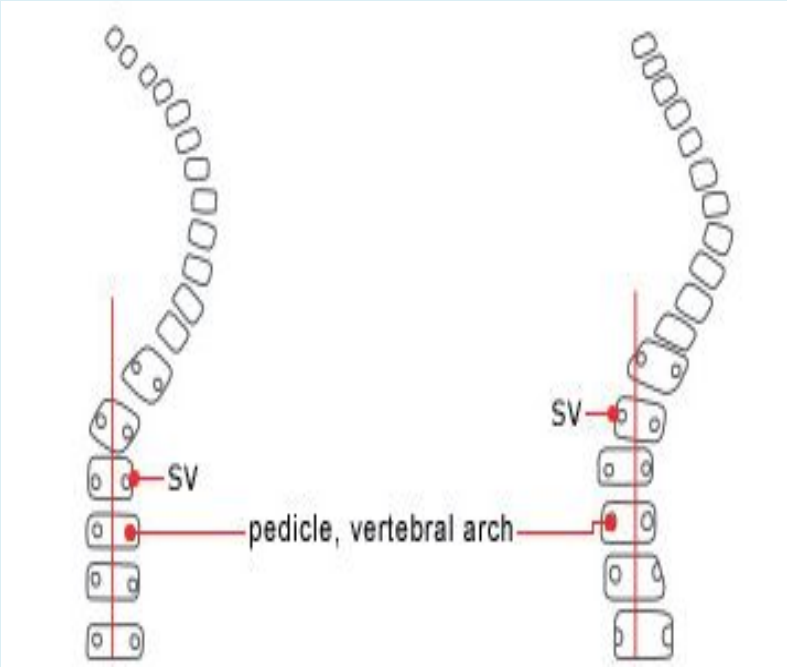
Determination of the flexibility of the curve

- The flexibility is assessed either based on the residual curve in the bending radiograph or the extent of kyphosis.
- A curve is defined as structural if the bending Cobb angle exceeds 25° or the kyphosis angle

  exceeds 20°.

Lumbar spine modifier, type A

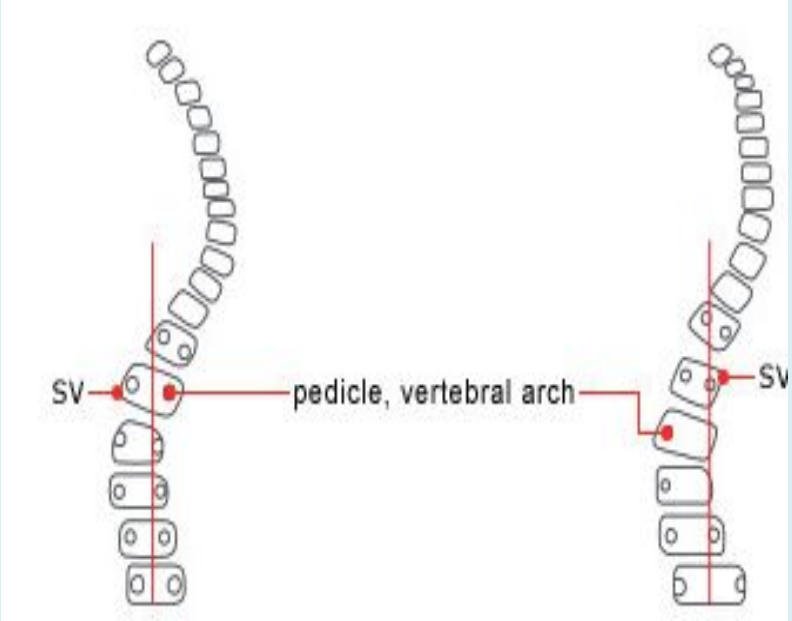
- The upright line runs between the pedicles to the stable vertebra (SV).
- This is a minimal lumbar curve.



Lumbar spine modifier type B

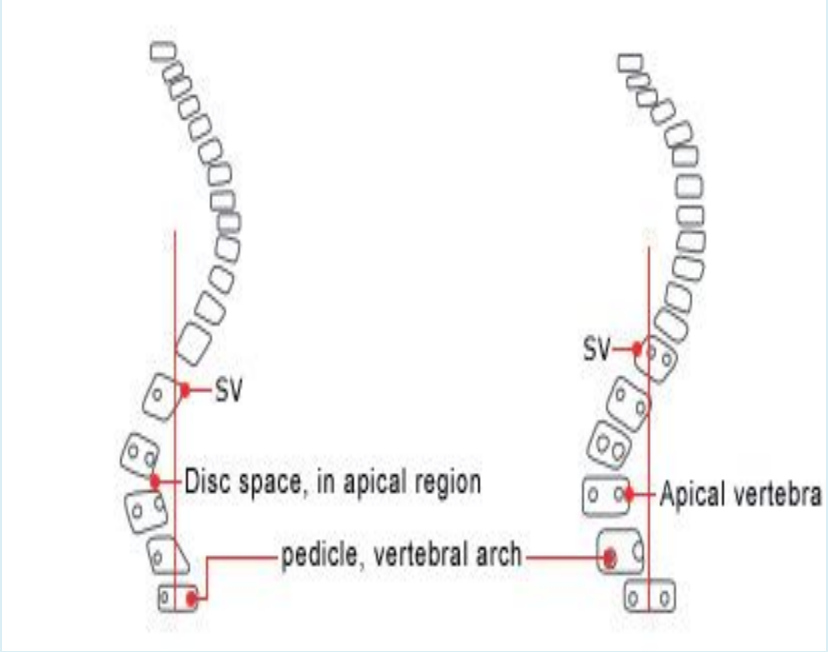
- The upright line runs between the concave-side margin of the apical vertebra and the medial margin of the concave-side pedicle.

  This is a moderate lumbar curve.



Lumbar modifier C

- The upright line is entirely medial to the apical vertebra. This is a large lumbar curve.



Definition of the “sagittal thoracic modifier”

- The last parameter determined is the extent of manifest kyphosis (humpback) in the sagittal profile (x-ray from the side).
- The measured values are entered with the indices - , N or +.
- The following Cobb kyphosis angles have been defined:
  - Cobb angle of kyphosis between Th 5 and Th 12 less than 10°: -
  - Cobb angle of kyphosis between Th 5 and Th 12 between 10° and 40°: N
  - Cobb angle of kyphosis Th 5 and Th 12 greater than 40°: +

Aebi classification of adult idiopathic scoliosis 2005

- Based on aetilogy:

  Type 1: primary degenerative scoliosis.

  Type 2: AIS of the thoracic and/or lumbar spine that progresses into adulthood.

  Type 3a: secondary adult curves due to leg-length discrepancy, hip disease or lumbosacral transitional anomaly.

  Type 3b: secondary adult curves due to metabolic bone disease.

- The Aebi system stands out from other contemporary classifications by addressing the different etiological factors of spinal deformity, but it does not quantify the deformity to aid meaningfully in surgical plannning.

Schwab classification system 2006

- Following a prospective multicenter series of 947 adult patients with spinal deformity.
- This system combines radiographic with health status measures (ODI and SRS instrument) and the initial treatment approaches.
- Patients are grouped according to 3 parameters:

  1- Apical level of scoliosis.

  2- Degree of lumbar lordosis.

  3- Amount of frontal-and sagittal plane subluxation.

Schwab classification system

- Type I: Thoracic only.
- Type II: upper thoracic major.
- Type III: lower thoracic major.
- Type IV: thoracolumbar major.
- Type V: Lumbar major

The SRS classification system of adult spinal deformity 2006

- 7 types:
- Type 1: single thoracic.
- Type 2: double thoracic.
- Type 3: double major.
- Type 4: triple major.
- Type 5: thoracolumbar.
- Type 6: lumbar idiopathic/de novo
- Type 7: primary sagittal plane deformity.

Curve identification in SRS classification

- A thoracic curvature is a curve 40 degrees or more with an apex between T2 and T-11 and T-12 disc.
- A thoracolumbar curvature is a curve of more than 30 degrees with an apex between the T12 and L1 vertebral bodies.
- A lumbar curve is a curve of more than 30 degrees with an apex between L1 and L2 discs and L4 vertebral body.

Controversial critical questions

- 1- In a thoracic and lumbar S-curve , when should a selective thoracic fusion be performed and leave the lumbar spine mobile.
- 2- In double thoracic curves, when the upper segment should be instrumented to prevent a postoperative increase in the elevation of the left shoulder.
- 3- In the thoracolumbar structural scoliosis, what are the parameters for inclusion of the thoracic compensatory curve in the fusion.

Treatment options:

- Non operative
- Operative
- No level 1 evidence to compare non operative vs operative
- Advances in operative management owing to advances in instrumentation and better understanding of the problem.
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Options of Non Operative treatment:

- Spinal rehabilitation programme
- Physical therapy
- Hydrotherapy
- Injections – Facet joint/ epidural
- Anti inflammatory
- Narcotics
- Alternative therapy

Indications for surgery

- Surgery is indicated for patients in whom curvatures have worsened over time, that are associated with pain that is unresponsive to non operative treatment, or that are associated with neurological deficits.
- Another indication for surgery is unacceptable severe spinal deformity with varying degrees of symptoms.

Deformity considerations.

- **Deformity Considerations**
- Location of the apex of the deformity in both the sagittal and coronal planes.
- Magnitude of the deformity.
- Flexible or rigid?
- Global or focal?
- Sagittal or coronal or both?
- Coronal Balance: are the shoulders and pelvis level, is there coronal translation?
- Sagittal Balance: does the C7 plumb line bisect the L5-S1 disc?
- Compensated or non-compensated plumb line: are mobile regions of the spine compensating?
- Compensation possible: can the mobile regions of the spine contribute to the deformity correction?
-

Surgical options

- Surgery in the adult patient may be performed from the posterior (back) approach, a combined anterior (front) and posterior approach, or from an anterior approach alone for lumbar or thoracolumbar scoliosis.
- Often, extensive osteotomies (cutting through bone) in rigid deformities, or vertebral column resection in which entire vertebra are removed in the most severe deformities are performed in order to re-align the spine as safely as possible.
- Often, discs in the lower lumbar region are severely degenerated, requiring the fusion to be extended down to the sacrum.
- Obtaining a fusion down to the sacrum can be challenging and often makes anterior - posterior surgery necessary. Pelvic fixation may be required to provide optimal holding power
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Historical timeline events in the field of spinal deformity

- 1- Harrington's hook/rod instrumentation system introduced in the early 1960s.
- 2- luque segmental spine instrumentation 1982.
- 3- Cotrel-Dubousset fixation system 1988..This system utilizes multiple pedicle and laminar hooks secured to 7-mm rods
- 4- The universal spine system inroduced in 1991.
- 5- video-assisted thoracoscopy used in deformity surgery 1993.
- 6- vertebral column resection used to treat rigid spinal deformity 1997.
- 7- Report of anterior spinal instrumentation for adolescent scoliosis 1999.
- 8- Dual growing rod instrumentation for AIS 2003.

Types of spinal osteotomy

- 1- Posterior osteotomy- Smith-Peterson, Ponte
- 2- Pedicle subtraction ostotomy.
- 3- vetebral column resection.

JBone JointSurg Am. 2003 Mar;85-A(3):454-63. **Pedicle subtraction osteotomy for the treatment of fixed sagittal imbalance.**

Bridwell KH, Lewis SJ, Lenke LG, Baldus C, Blanke K.

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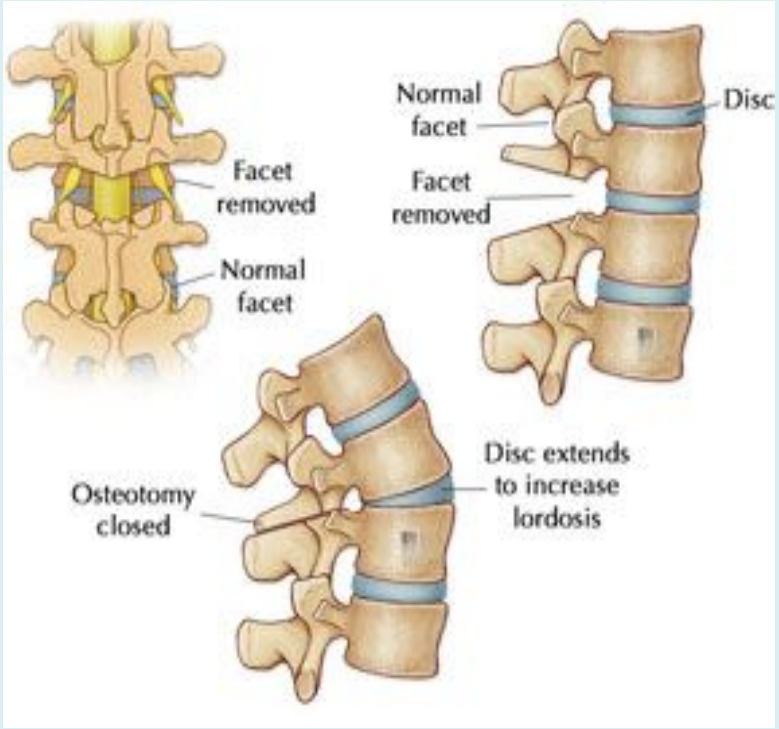
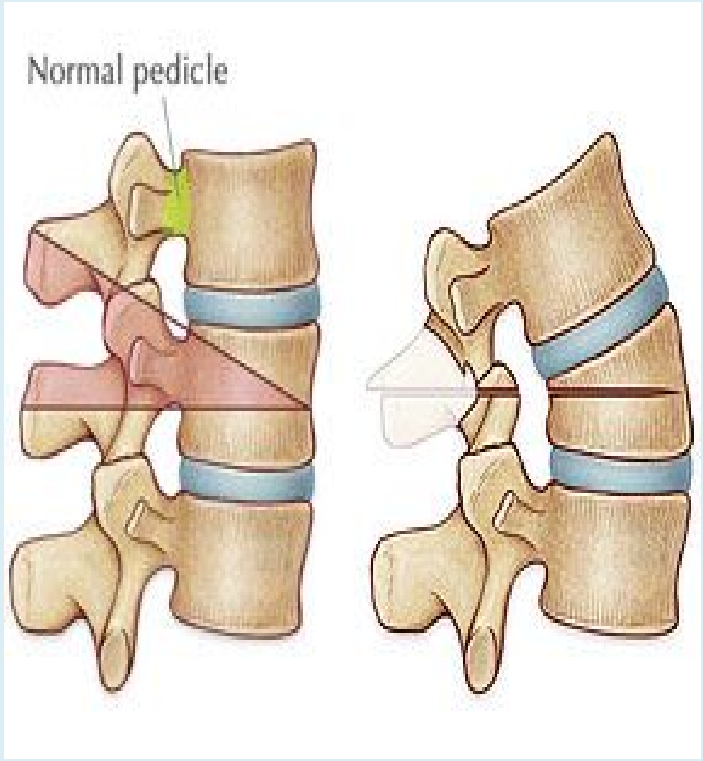
Posterior osteotomy

- TH required multiple posterior osteotomies (called “Smith-Peterson” or “Ponte Osteotomies”) to straighten her spine to normal degrees of kyphosis.
- Normally the vertebra contact each other through 3 joints at each level: one disc in the front, and two sliding facets in the back.
- In this osteotomy, we remove the facets and bend the spine backward further than normal.
- Over one level, only a little bit of correction will occur (5-15 degrees). However, over many levels, large amounts of correction can be achieved.

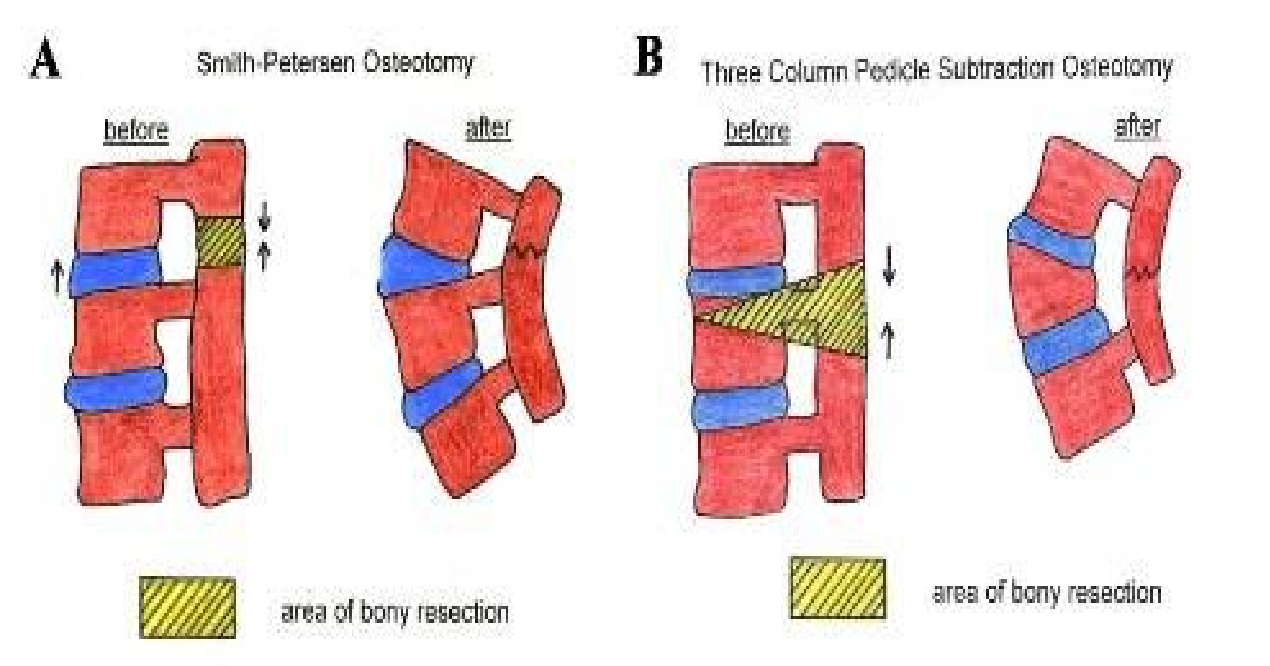


Pedicle subtraction osteotomy

- The goal of a pedicle subtraction osteotomy procedure is to create a normal amount of lumbar lordosis (approximately 50 degrees). In this type of osteotomy, the “pedicle” (a bony tube going from the back and front of the vertebra) is “subtracted” (removed).
- A wedge is taken from the bone, and the whole vertebra is bent backwards.
- This allows 20-40 degrees of lordosis to be restored at a single level. It is not dependent on the flexibility of the discs like the Smith-Peterson osteotomy does.

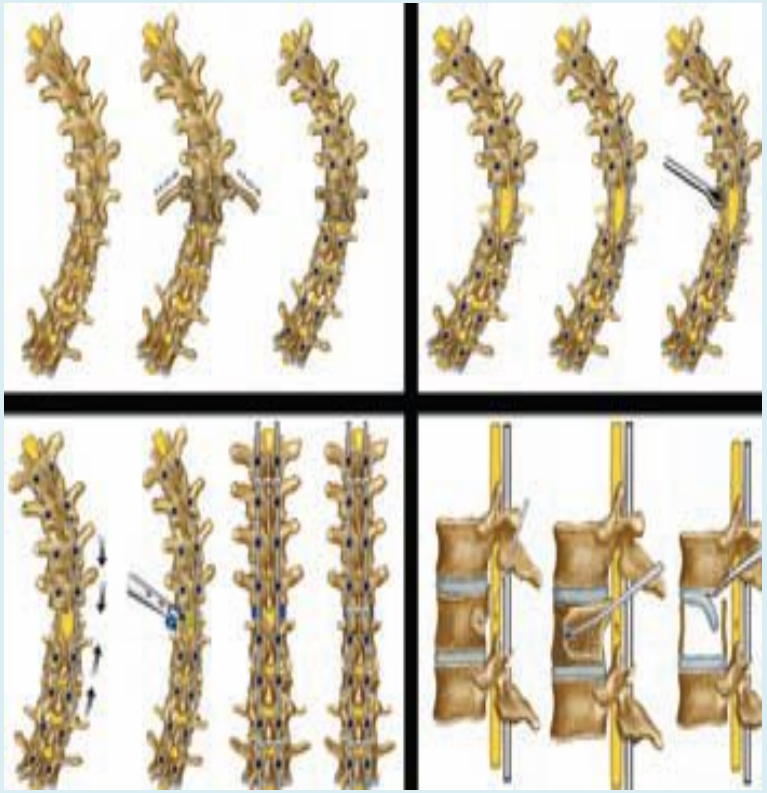


Area of bone resection



3. Vertebral Column Resection (VCR)

- Resection of a complete vertebra to allow multi-planar correction.
  -Preferred approach is through an all posterior (costaotransversectomy) approach.
  - Interbody device (cage) inserted to direct correction:
- i. if primarily sagittal plane desired, cage placed anteriorly
  ii. if primarily coronal plane desired, cage placed in posterior concavity
- Expected correction: sagittal plane: 30 - 50° coronal plane: < 30°



Surgical treatment outcome :

Authors & Year	Level of Evidence	Study Design	Total No. of Patients	Mean Age (yrs)	Mean FU (yrs)	Mean ODI	SRS-30 Equivalent	Major Curve Reduction (°)	Major Curve Reduction (%)	No. of Complications	No. of Pseudarthroses
Bridwell et al., 2009	II	prospective, matched cohort	85	60	2	20	114	29	52	31	—
Smith et al., 2009	II	prospective	147	51	2	35	93	—	—	—	—
Khan et al., 2009	III	retrospective	14	65	3.7	—	108	40	87	4	1
Rose et al., 2009	II	prospective, matched cohort	34	38.3	3	—	111	29.5	47	0	0
Kim et al., 2009	III	retrospective	62	47.9	10.3	25	—	—	—	4	—
Glassman et al., 2009	III	prospective cohort	283	50	2	22.8	111	—	—	—	—
Peelle et al., 2008	III	retrospective	30	40	3.3	—	90	18	50	0	0
Wu et al., 2008	III	retrospective	26	64.2	3	25.8	—	9.1	55	2	—
Weistroffer et al., 2008	III	retrospective	50	54	9.7	—	—	—	—	35	12
Chang et al., 2008	III	retrospective	83	66.1	2	—	98.4	42.2	1	26	3
Deviren et al., 2008	III	retrospective	15	37.5	3.9	—	69	34	67	4	0
Kim et al., 2008	III	retrospective	48	49.6	3.7	—	74.4	25	42	10	4
Wang et al., 2008	III	retrospective	13	31	2.54	—	76.9	53.9	59	4	0
Kim et al., 2007	III	retrospective	125	57.1	4.5	—	67.5	12	51	—	21
Buchowski et al., 2007	III	prospective	108	54.8	2	29.5	97.1	32.2	65	15	0
Daubs et al., 2007	III	retrospective	46	67	4.2	25	—	—	—	26	—

Adult scoliosis surgery outcomes: a systematic review

Sanjay Yadla, M.D., Mitchell G. Maltenfort, Ph.D., John K. Ratliff, M.D., and James S. Harrop, M.D. Neurosurg Focus 28 (3):E3, 2010

- A systematic review of adult scoliosis surgery outcome analyzed outcome data for adult spine deformity surgery for a minimum 2-year follow up. The average major curve correction in these series was 26.6 degrees, or about 40.7% correction of the original curve.
- Based on the most commonly reported clinical outcomes measures, the ODI and SRS instrument, surgery for adult scoliosis appears to improve clinical outcomes at a minimum 2 year follow up.
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Intraoperative Neurophysiological monitoring

- 1- Somatosensory evoked potentials.
- 2- Motor evoked potentials.
- 3- Electromyographic recording.

Case study:

- 41 yrs/f
- Untreated AIS
- Severe low back pain 18months
- Bilateral leg pain
- Transient improvement with non operative
- Affecting GI functions with NSAIDS
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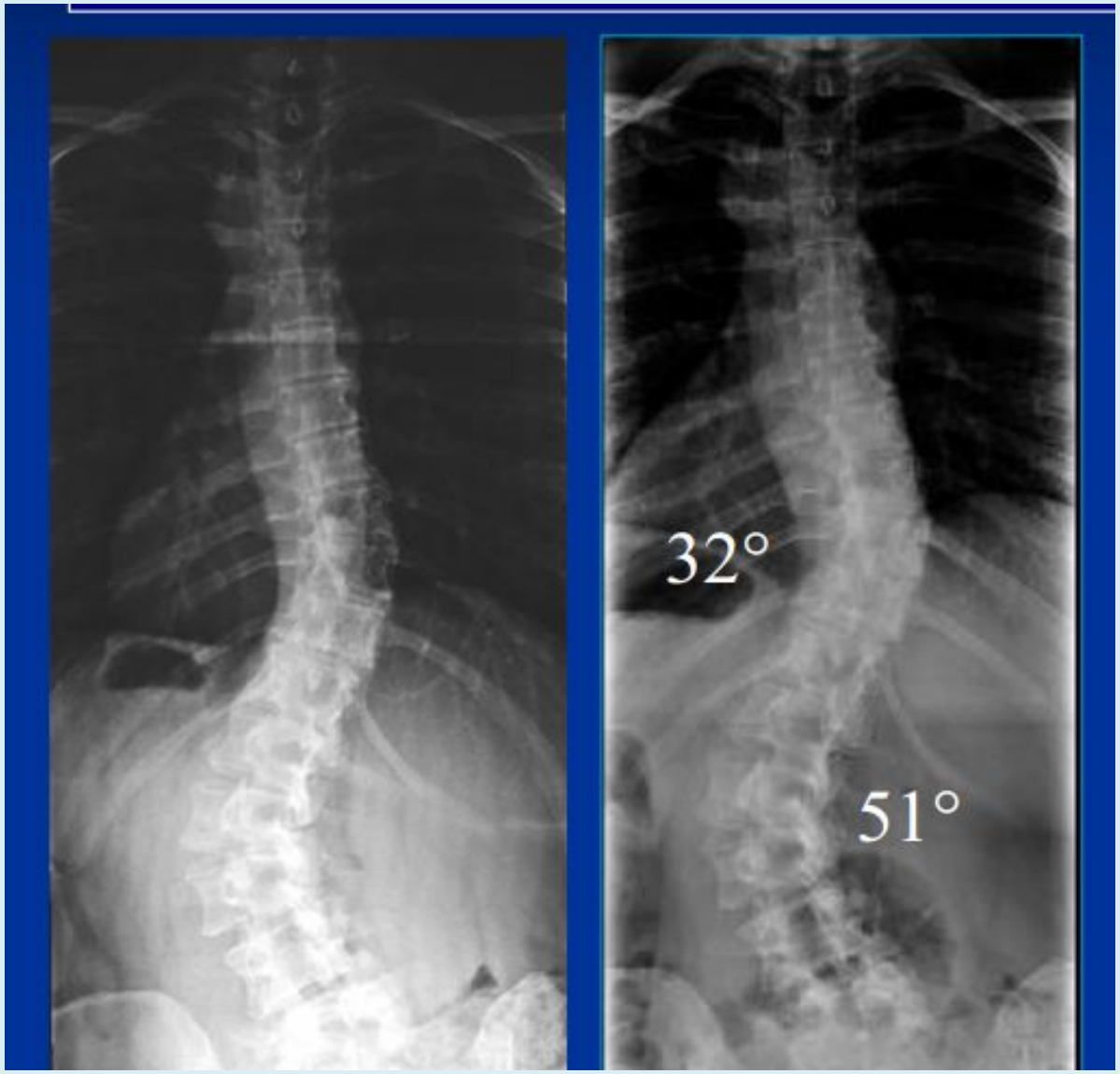
Xray Ap Lateral standing:



Surgical procedure

- 1- segment spine instrumentation T10 to sacro pelvis.
- 2- Smith-Petersen spinal osteotomy L1-L4
- 3- Anterior interbody fusion using PEEK cage at L5-S1. and L4-5 with anterior screw fixation and reduction of spondylolisthesis.
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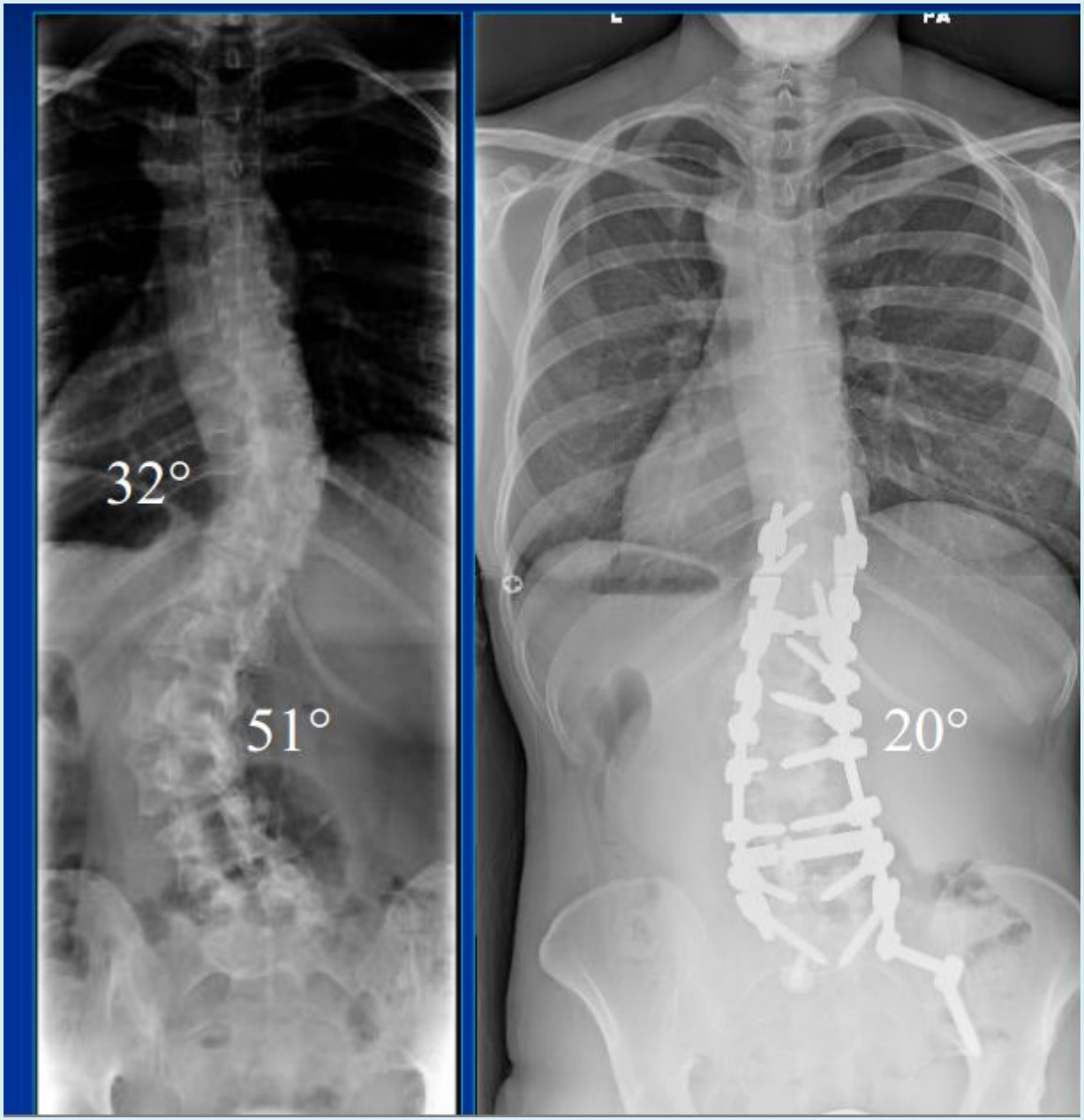
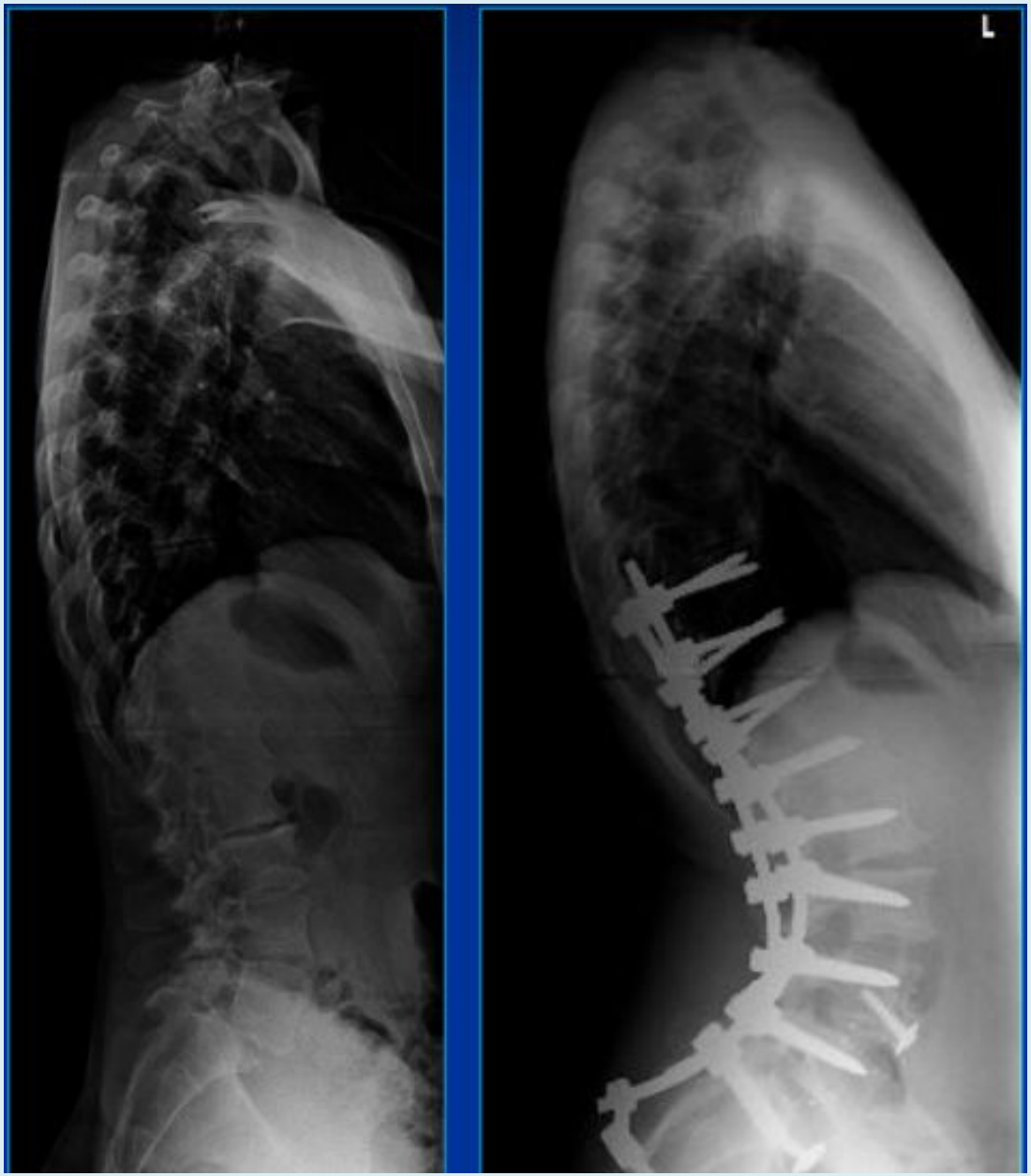
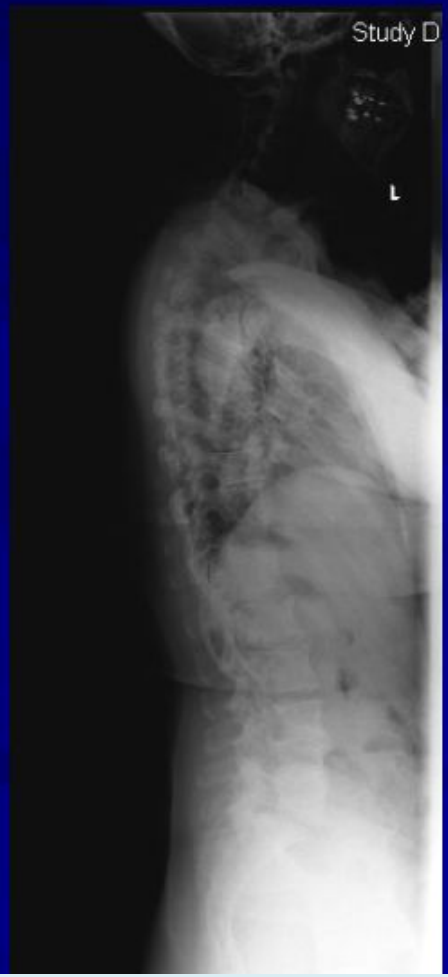
Pre and Post op Coronal balance:



Pre and Post op sagital balance:



Pre-op X-rays



- 50-year-old female
- Adult Idiopathic Scoliosis, with a triple major curve. On physical examination, she has right thoracic fullness, left lumbar fullness
- Grade I spondylolisthesis L5-S1
- Right shoulder depression due to the high thoracic curve.
- Low back pain
- Leg pain

Surgical strategy

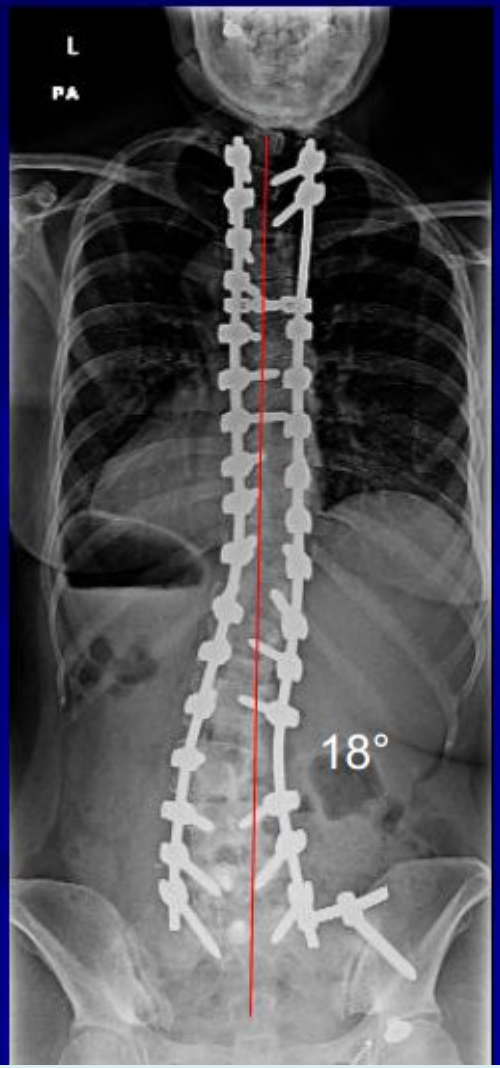
- 1- segmental spinal instrumentation T2 – Pelvis.
- 2- posterior spinal osteotomy.
- 3- Laminotomy and foraminotomy for lateral recess stenosis.

Post-Op Films

One year post-op the patient is doing very well. She is highly functional and working.

The patient is happy with her symptomatic and cosmetic outcome.

Pre-Op/Post-op Comparison



The patient has improved balance in the coronal plane.

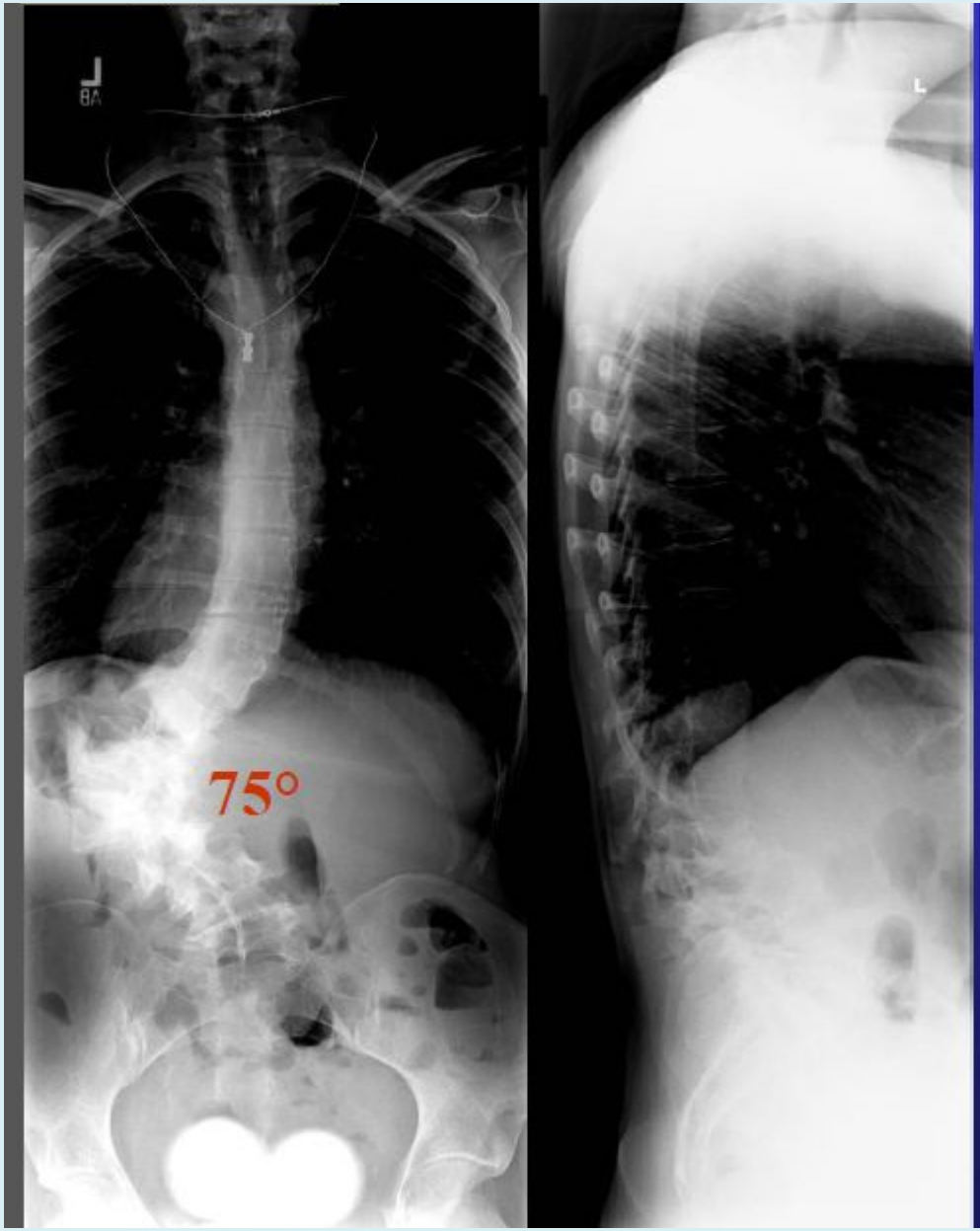
Pre-Op/Post-op Comparison

The patient is well balanced in the sagittal plane. Her head is balanced over her hips.

Case 3:

Patient History

- 31 Year old female
- Diagnosis: Progressive Adult Idiopathic Scoliosis with Lumbosacral Kyphosis
- Patient diagnosed at age 12, did not wear her brace
- Four inch height loss
- Low back pain, leg pain
- Failed to respond to conservative therapy

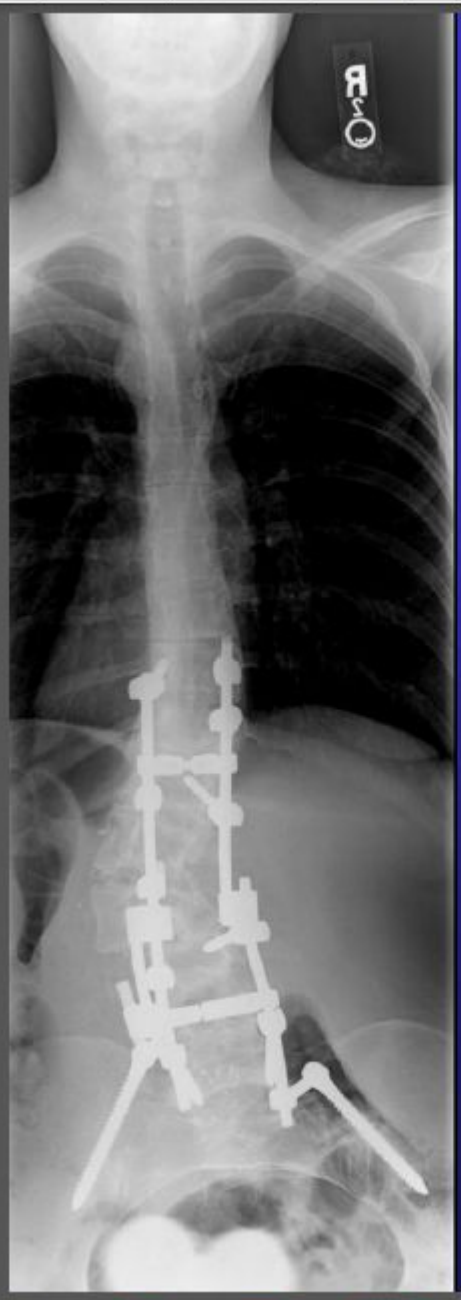


Pre-Operative X-Rays

- 75° curvature of the lumbar spine, rotated approximately 90°
- 2 cm decompensation

Surgical Strategy

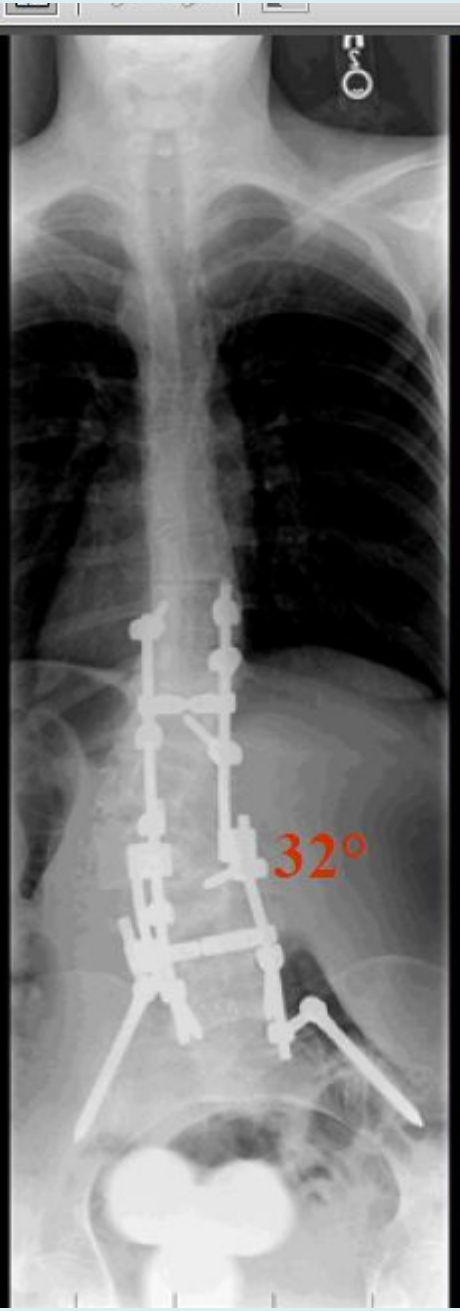
- Radical discectomy of T10-L1 (7 levels)
- Anterior interbody fusion L4-S1, using PEAK and autogenous rib bone graft
- Anterior interbody fusion T10-L4 using morselized bone graft
- Posterior Spinal Fusion T10 to Sacral Pelvis



Results

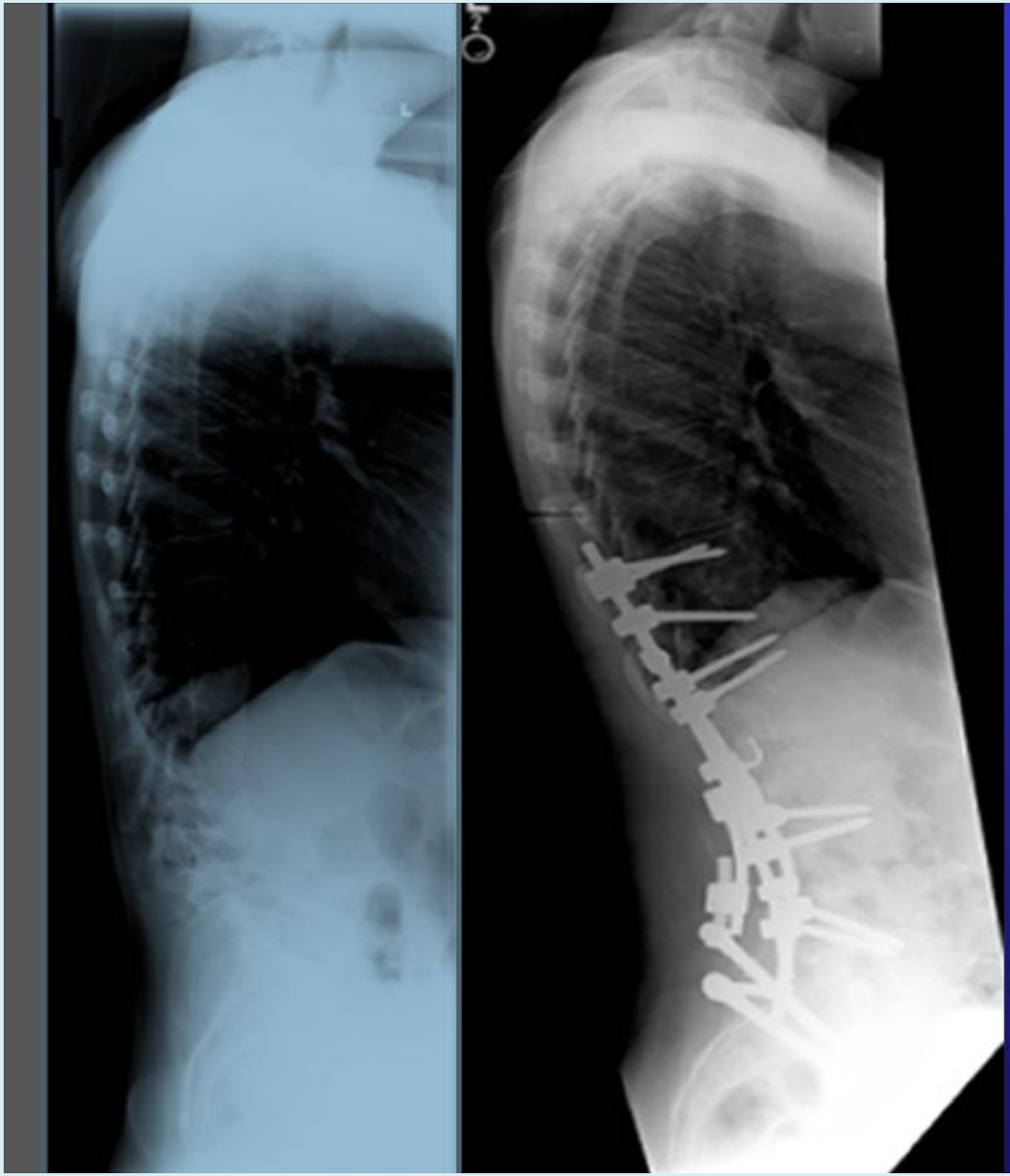
The original surgical plan was to fuse T10 to S1.

Spinal balance was achieved by T12, therefore two levels were spared.



Pre-Op/ Post-op Comparison

A correction of 57% was obtained. The lumbar kyphosis has been corrected in the frontal plain.

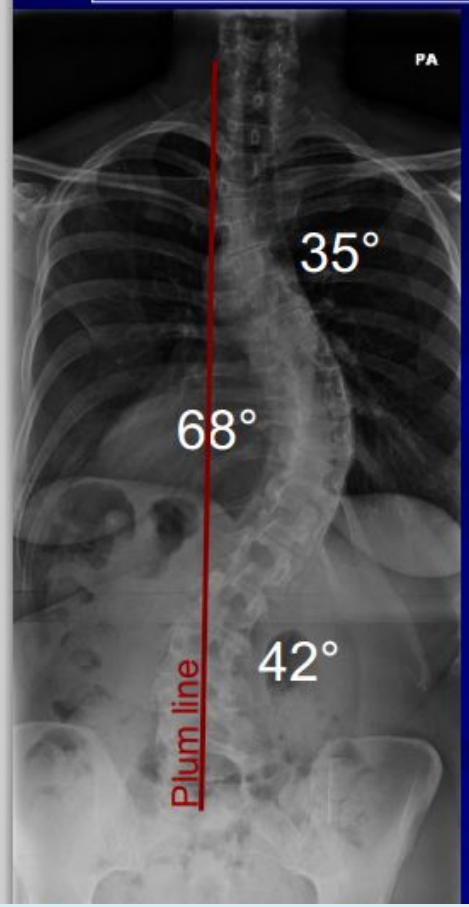


Thoracic kyphosis corrected. The pre-operative pain that she was experiencing in her back and legs has significantly decreased, and she requires minimal pain medication. The patient is quite pleased with her appearance.

Patient History

- 59-year-old female, has known adolescent idiopathic scoliosis that has progressed into adult idiopathic scoliosis.
- She had some neck pain for a year, mid-back pain and low back pain for 25 years, on- and-off numbness of the hands and the right hip. She denies tingling. No acupuncture, PT or injections. Chiropractic temporarily helped.
- She has global truncal shift to the right. This is associated with significant the right-sided thoracic curvature and a 3-cm right rib hump. She does plum centrally, maybe somewhat to the right but otherwise her balance is good in the frontal and sagittal plane and neurologically she is intact. The curvatures of her posterior spine are obvious by direct examination of her back.

Pre-op X-rays



The 36 x 14 x-rays show that the patient has a primary structural thoracic curve measuring 68° with an upper thoracic curve of 35°. Her shoulders are level, but this is probably a structural upper thoracic curve just based on the fact that it is adult idiopathic curve. She plumb lines slightly to the right.

She has a 42°, highly rotated lumbar curve and although this is compensatory, it probably came secondarily structural.

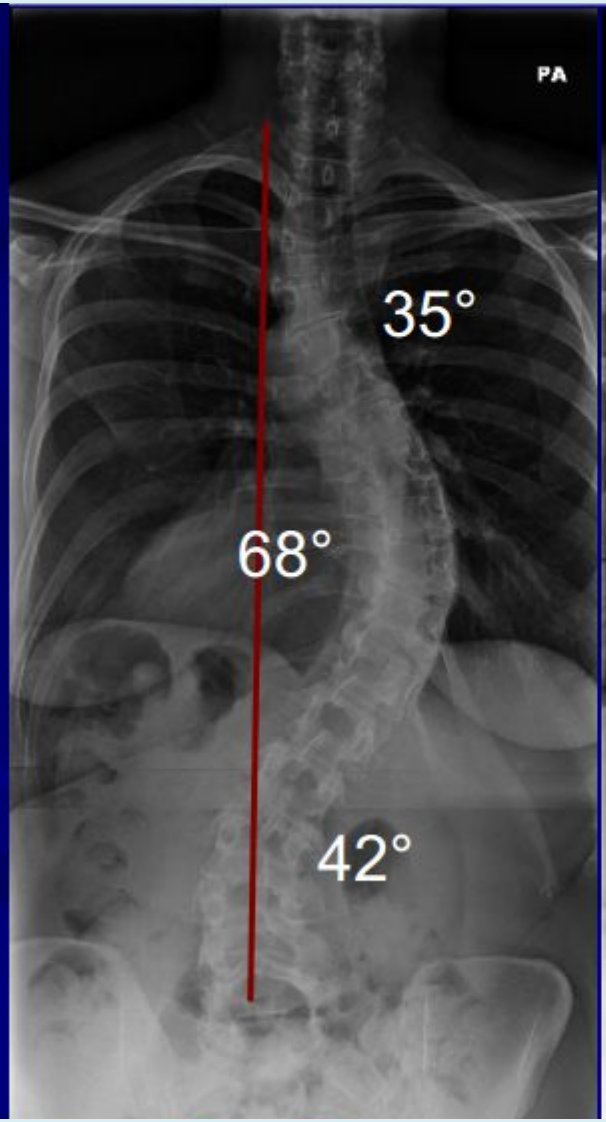
Indications for Surgery

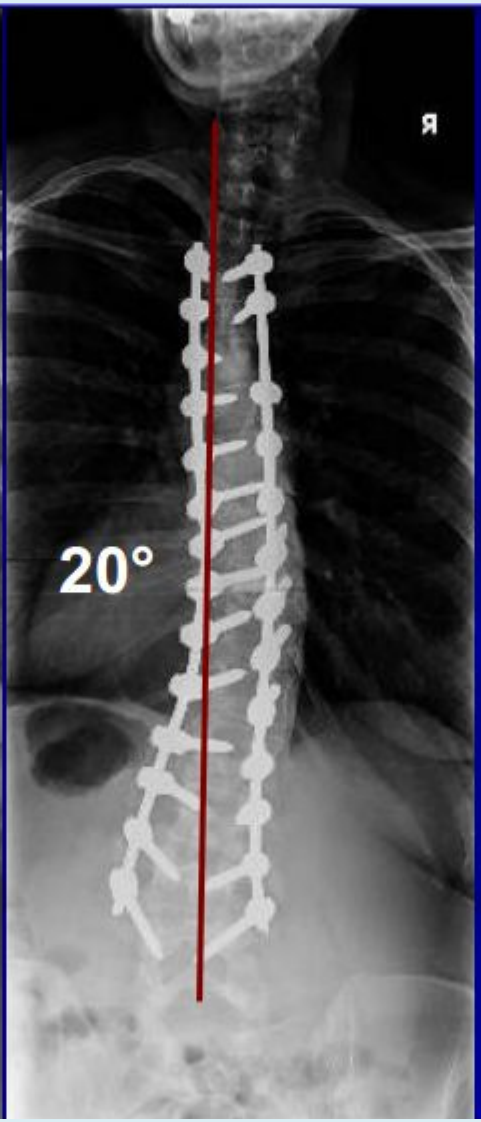
- Rigid Adult Idiopathic Scoliosis 68° thoracic, 42° lumbar with significant rotation and spinal deformity.
- Rigid progressive deformity with decompensation of coronal and sagittal plane necessitating multiple level osteotomy.
- Progressive upper low back pain and lower back pain, failed conservative therapy.
- Radiculopathy secondary to spinal stenosis and lateral recess stenosis. Facet arthropathy lumbar 1 through lumbar 4 bilaterally.
- Multiple comorbidities with increased blood pressure depression.

Surgical strategy

- 1- Segmental spinal instrumentation T3-L4.
- 2- Ponte osteotomy T5-L3.
- 3- Lateral recess decompression L1-L4.

Pre and Post op AP views:





The patient's curvature was corrected by 48°. As importantly, her balance has been improved.

Sagittal balance restored

Case 5:

- 38 / F
- Diagnosed with AIS at the age of 9
- Initial brace treatment
- Represented for increasing deformity , back pain and leg pain.
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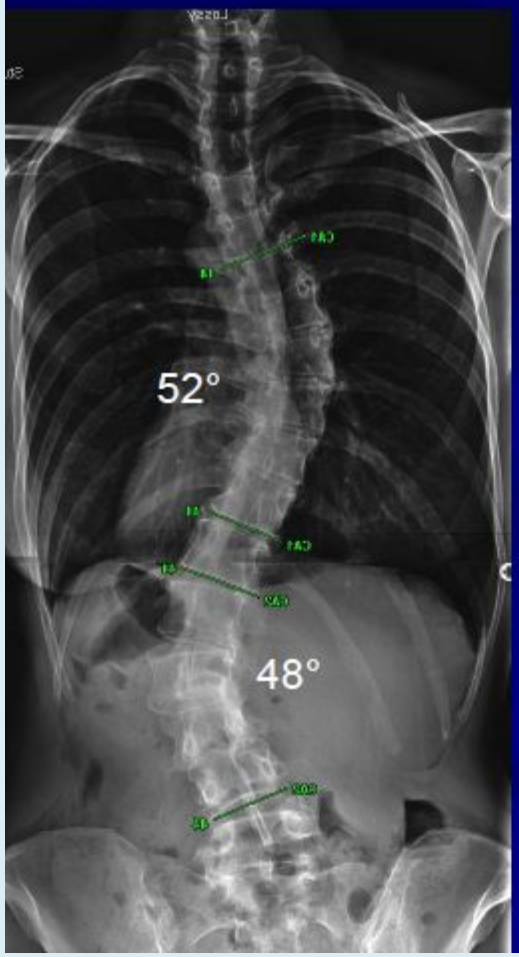
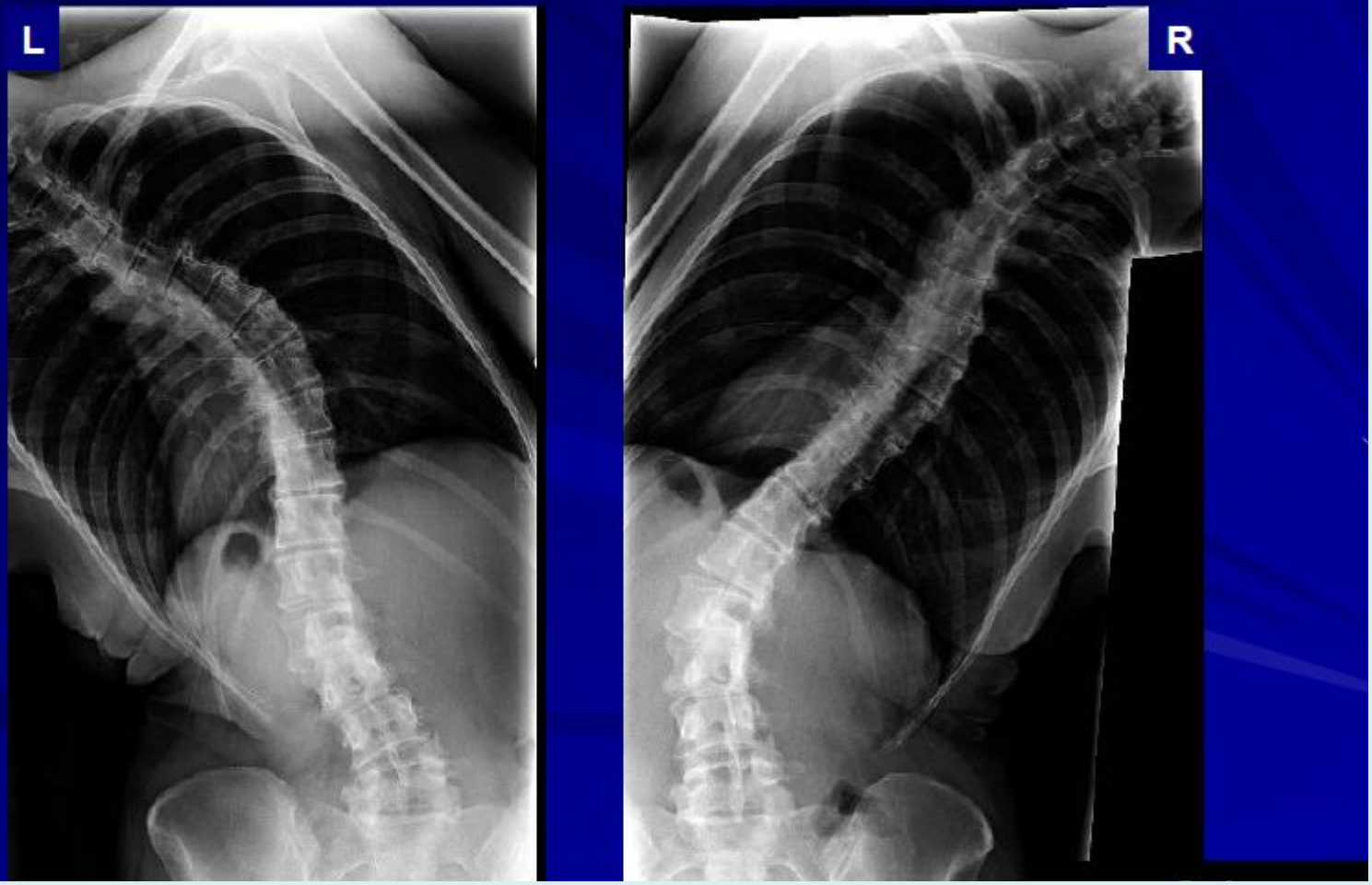
-

Pre-op X-rays



There was significant rotation in both curves, and actually the thoracolumbar or lower lumbar curve was more deforming in that she had a significant elevation of her left flank. This was due to fractional kyphosis at the thoracolumbar junction. There was no question that the spinal fusion and reconstruction need to traverse both curves.

Bending X-rays



Surgical strategy

- 1- segmental spinal instrumentation T3-L4.
- 2- Ponte osteototomy T5-L3.
- 3- Subtotal laminectomy T12-L4 for decompression of spinal canal stenosis.

Post-Op Films

The patient is doing quite well. Her balance is excellent, the incision is well healed. She has minimal pain, and has no radiculopathy.

X-rays show excellent balance in the frontal and sagittal plane. This is a very good result early on.

Thank you

Any questions?