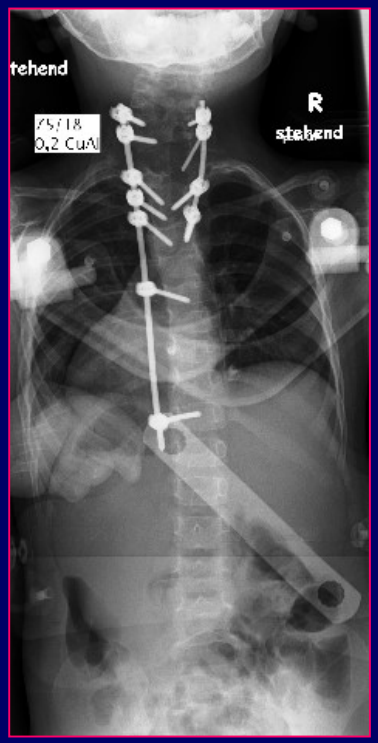
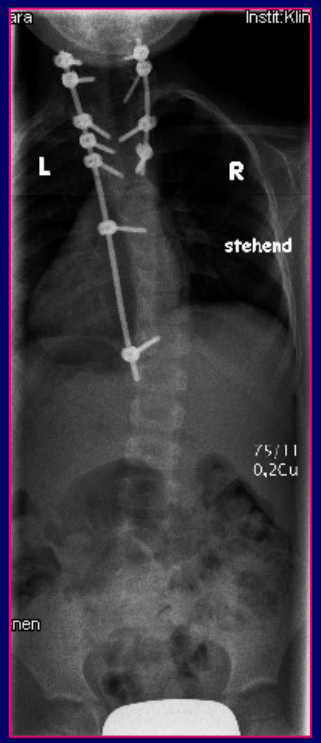
# Growth Sparing Spinal Deformity Surgical Techniques in Children < 10 Years of Age


ICEOS
Toronto
Nov 2010

L Letko
M Ruf
J Harms

# Growth Sparing Spinal Deformity Sx Techniques

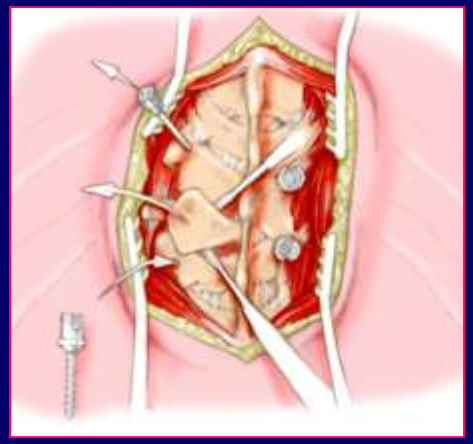

Principles

- Correction of spinal deformity when indicated
- Correction of spinal deformity at the spine
- Additional use of a VEPTR or VEPTR- like device if indicated

# Growth Sparing Spinal Deformity Sx Techniques

Principles

- Dissection extraperiosteal except in fusion area
- Use of pedicle screws & rod(s) since 1994
- Allow continued guided growth w/ periodic distractions/instrumentation change as needed



# Growth Sparing Spinal Deformity Sx Techniques

Techniques

Apical resection(s) w/ longer instrumentation
w/o fusion except at resected level(s)

Instrumentation without fusion
Bilateral
Unilateral

# Growth Sparing Spinal Deformity Sx Techniques

Indications

- Congenital/Syndromic
- NFM
- MMC
- Post thoracotomy
- Juvenile idiopathic scoliosis

# Growth Sparing Spinal Deformity Sx Techniques

- Apical resection(s) w/ longer instrumentation w/o fusion except at resected level(s) -

Indications

Rigid curve w/ flexible 2° curves

Multiple anomalies

# Growth Sparing Spinal Deformity Sx Techniques

- Apical resection(s) w/ longer instrumentation w/o fusion except at resected level(s) -

Techniques - alone or in combination

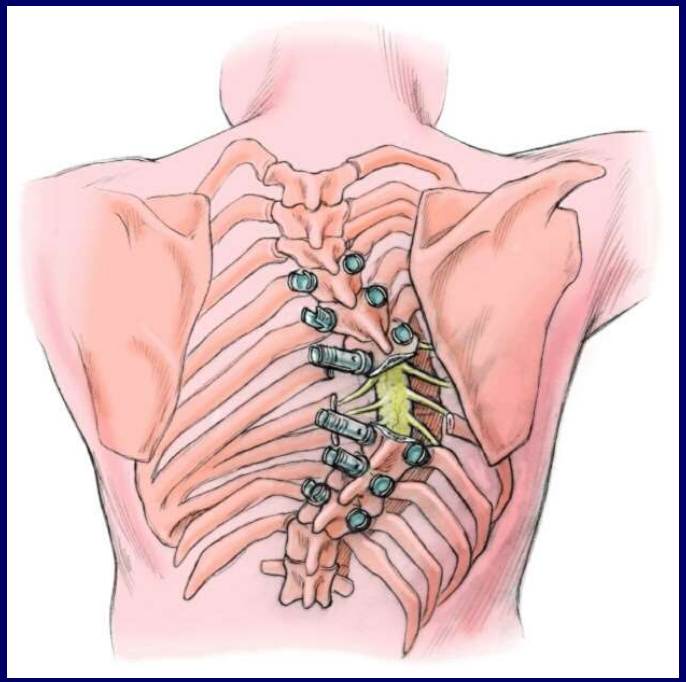
Apical resection(s)
- Hemivertebrectomy
- Vertebrectomy
- Wedge osteotomy

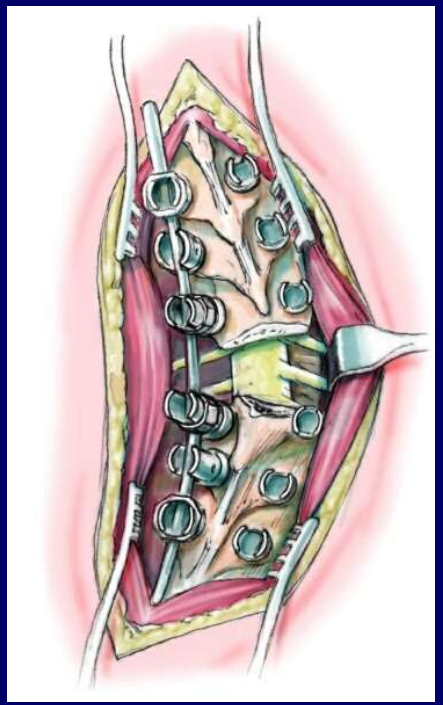
Osteotomy(ies)
- correction thru area of block or bar formation where at least partial fusion is already present

# Growth Sparing Spinal Deformity Sx Techniques

## Apical Resection Technique

Screw placement above & below the level(s) to be resected
Laminectomy & apical convex and concave rib resection
Concave rod placement and stabilization





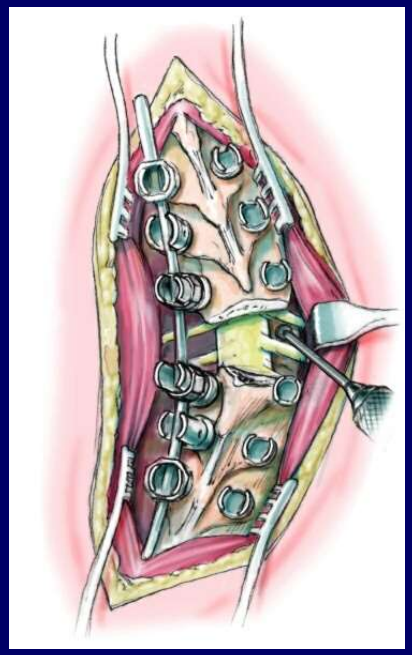
# Growth Sparing Spinal Deformity Sx Techniques

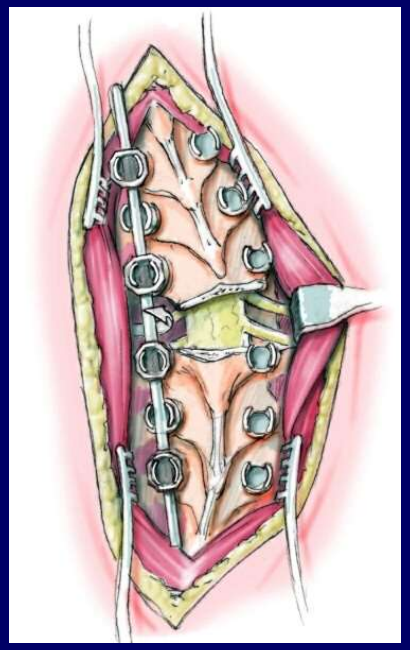
## Apical Resection Technique

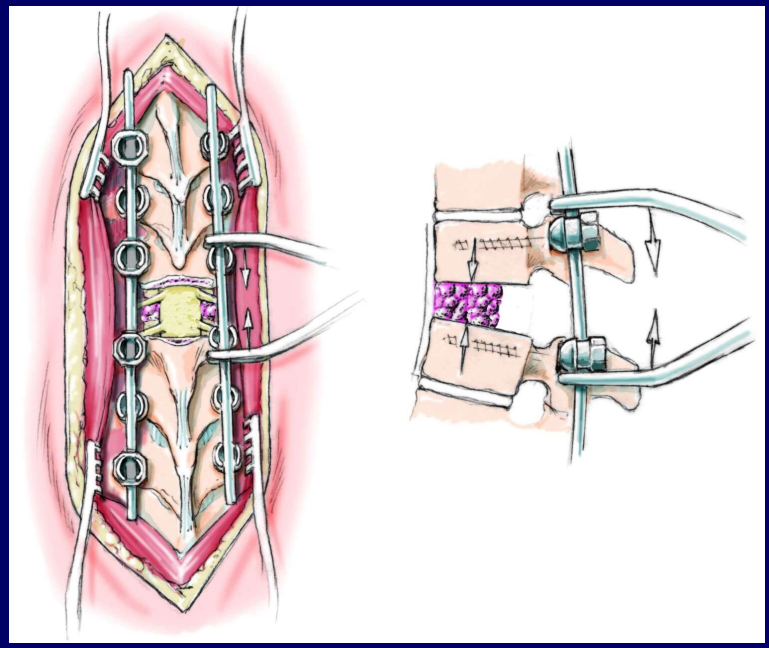
Vertebral body resection - convex

Rod rotation after vertebral body resection

Compression through the convexity







# Growth Sparing Spinal Deformity Sx Techniques –

- Apical resection(s) w/ longer instrumentation w/o fusion except at resected level(s) -

Treatment strategies

Distractions in non-fused region as needed

Replacement of rod/screws with breakage/loosening (w/ larger instrumentation system as needed)

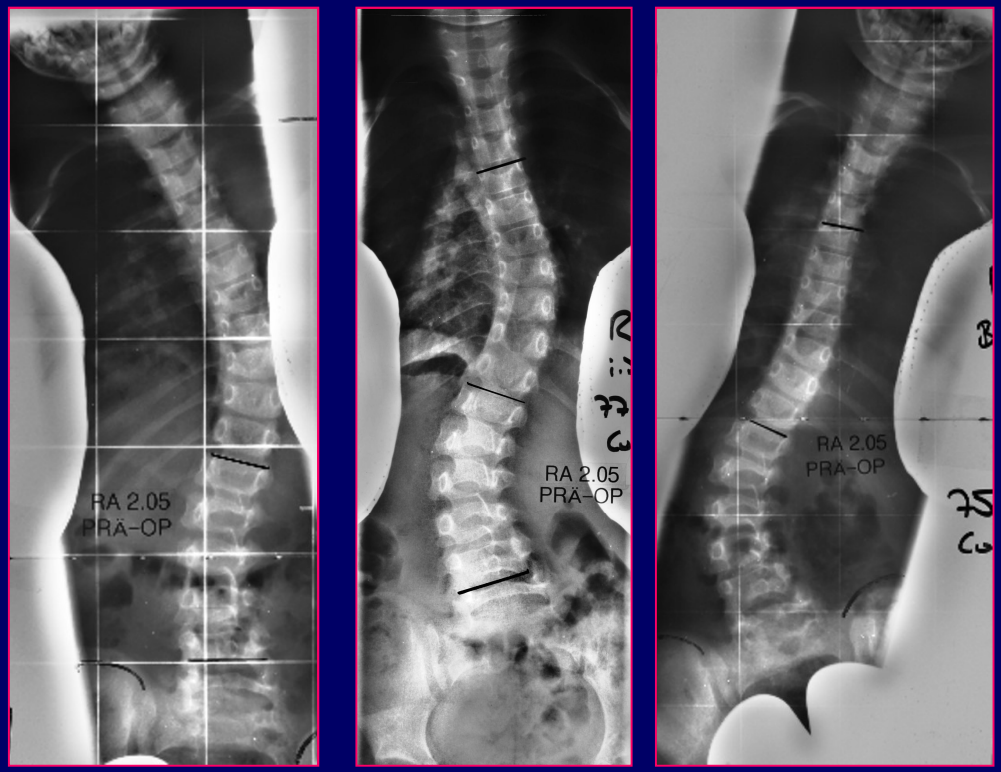
# Growth Sparing Spinal Deformity Sx Techniques –

## - Instrumentation w/o fusion -

Indications

Bilateral
Unilateral

Flexible deformity



# Growth Sparing Spinal Deformity Sx Techniques –

## Instrumentation Without Fusion- Bilateral & Unilateral

## OPERATIVE TECHNIQUE -

Spinal preparation using a scissor or scalpel staying above the periosteum

Pedicle screw placement in the area to be instrumented but not fused

Rod placement followed by correction

No brace immobilization

# Growth Sparing Spinal Deformity Sx Techniques –

## Instrumentation w/o fusion - Bilateral & Unilateral

Treatment strategies

- Distractions as needed
- Replacement of rod/screws with breakage/loosening (w/ larger system as needed)
- Transition to apical resection & instrumentation if curve(s) become rigid

# Growth Sparing Spinal Deformity Sx Techniques –

## n = 14

Retrospective review

14 patients (6 F, 8M)

| | |
|---|---|
| Congenital/syndromic | 7 |
| NFM | 2 |
| MMC scoliosis | 1 |
| Post thoracotomy | 3 |
| Juvenile idiopathic scoliosis | 1 |


Mean age at Sx 4y 8 mo (1+7 – 9+11)

Mean age at last f/u 9y 4mo (3+3 – 14+9)

Mean f/u 4y 2 mo (1mo - 8+ 8)

# Growth Sparing Spinal Deformity Sx Techniques –

n = 14

| | |
|---|---|
| Treated w/ resection(s) | 12 |
| Treated w/ unilateral instrumentation | 1 |
| Treated w/ bilateral Instrumentation | 1 |

# Growth Sparing Spinal Deformity Sx Techniques – Treated w/ Resection(s)

n = 12

Treated w/ resection(s)

- Initial Sx 9.01 - 3.09
- Age at Sx 1y 7mo – 9y 11mo (4y 10mo)
- Halo extension pre-op 2
- Mean EBL 78 cc/kg (21 -150)
- OR time 225 – 470 min (344min)
- Mean f/u 4y 2mo (1mo – 8y 5mo)

# Growth Sparing Spinal Deformity Sx Techniques – Treated w/ Resection(s)

n = 12

Treated w/ resection(s)

Number resections

| | |
|---|---|
| Hemivertebrectomy | 8 in 5 pts. |
| Vertebrectomy | 8 in 7 pts. |
| Wedge osteotomy | 3 in 3 pts. |
| Osteotomy thru bar/block | 3 in 2 pts. |

# Growth Sparing Spinal Deformity Sx Techniques – Treated w/ Resection(s)

n = 12

Treated w/ resection(s)

Number vertebrae instrumented 6 -12 (mean 9)

Number levels fused 2 - 6 ( mean 2.7)

Number instrument related revisions 11 in 6 pts.

Number distractions 8 in 6 pts.

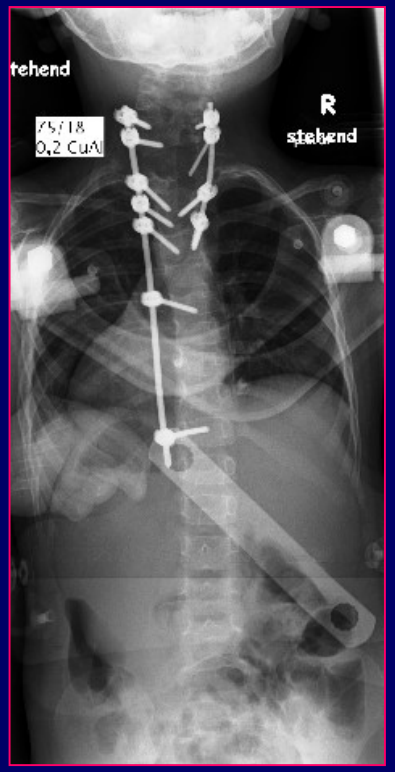
Mean growth cm/yr (n = 9) 6.5 cm/ yr (4.2 - 10 )

# Growth Sparing Spinal Deformity Sx Techniques – Treated w/ Resection(s) n = 9

| Age@ Sx yrs | Pre-op Height cm | Age @ last f/u yrs | Height last f/u cm | Yrs f/u | Change in height cm | Growth /yr f/u |
|---|---|---|---|---|---|---|
| 5 +5 | 104 | 9 +7 | 130 | 4.2 | 26 | 6.2 |
| 3 +2 | 95 | 7 +8 | 127 | 4.4 | 32 | 7.3 |
| 4 +9 | 94 | 8 +6 | 115 | 3.7 | 21 | 5.7 |
| 2 +7 | 84,5 | 11 +9 | 130 | 8.4 | 35,5 | 4.2 |
| 8 +10 | 127 | 13 +5 | 149,5 | 4.6 | 22,5 | 4.9 |
| 1 +10 | 76 | 6 +10 | 111,5 | 4.9 | 35,5 | 7.2 |
| 2 + 9 | 84 | 10 +2 | 132 | 7.4 | 48 | 6.5 |
| 1 +7 | 78 | 3 +2 | 94 | 1.6 | 16 | 10 |
| 3 +2 | 88 | 6 +9 | 120,5 | 3.5 | 22,5 | 6.4 |

# Growth Sparing Spinal Deformity Sx Techniques – Treated w/ Resection(s) Case Study


pre-op




post-op 1

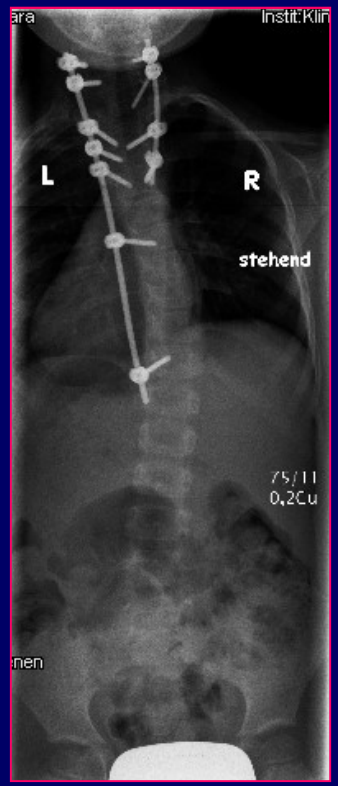
3y 2 mo F
88cm
Bar C7 – T3 right
R T6 – T12
compensatory curve

3.07 Wedge osteotomy
T1/2 L
Bar osteotomy R
Instrumentation
C6 - T6 R
C6 - T12 L

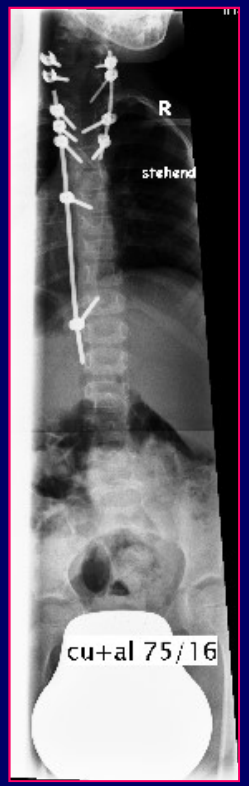

pre-op


post-op 1

# Growth Sparing Spinal Deformity Sx Techniques – Treated w/ Resection(s) Case Study




pre-op 2

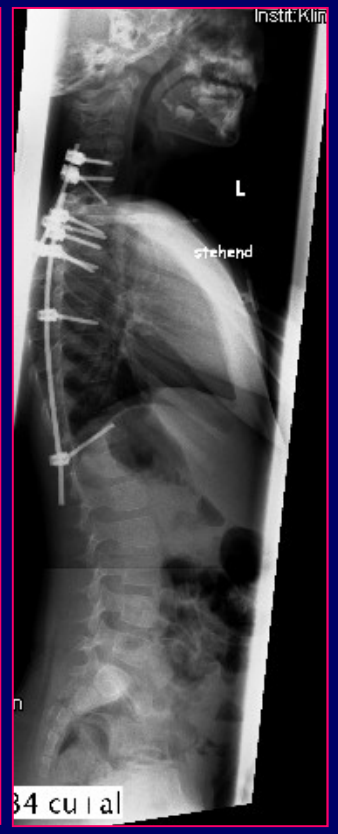



post-op 2

3.08
4y 2mo
105 cm
Increase in scoliosis to16 °

3.08 new instrumentation
& distraction T5-T12 L


pre-op 2




post-op 2

# Growth Sparing Spinal Deformity Sx Techniques – Treated w/ Resection(s) Case Study


pre-op 3


post-op 3

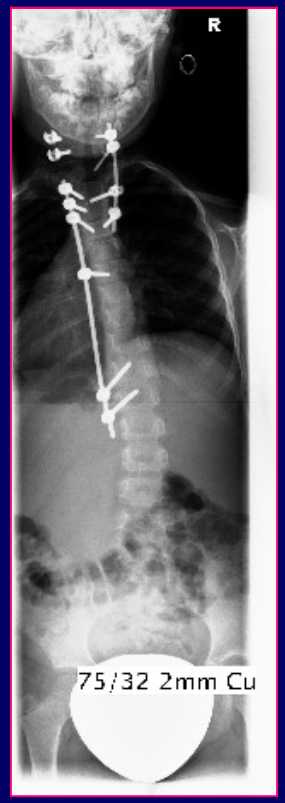
2.09
5y 1mo
106 cm
Increase in scoliosis to 12°

2.09 dorsal distraction
T5-T12 L
Insertion of L1 screw


pre-op 3


post-op 3

# Growth Sparing Spinal Deformity Sx Techniques – Treated w/ Resection(s) Case Study




post-op 3

last f/u

9.10
6y 8mo
120.5 cm
Maintained correction


post-op 3

last f/u

# Growth Sparing Spinal Deformity Sx Techniques –
## Treatment w/ Instrumentation w/o Fusion
### n = 2

1 treated w/ unilateral instrumentation

41 cm in 5 1/2 yrs since 1st Sx (7.4 cm /yr)

27.5 cm sitting growth (5 cm/yr)

1 additional distraction

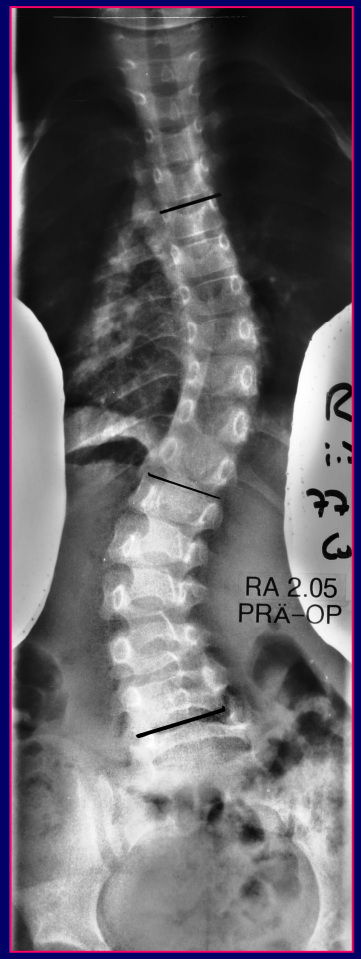
2 revisions due to rod breakage

1 treated w/ bilateral instrumentation

11 cm in 2 yrs since Sx

no distractions to date

# Continued Spinal Growth in Early Onset Scoliosis : Treatment w/ Unilateral Instrumentation w/o Fusion
# - CASE STUDY –
# JIS




pre-op

4 year 7 mo F

1st surgery (4.05) - 106 cm tall

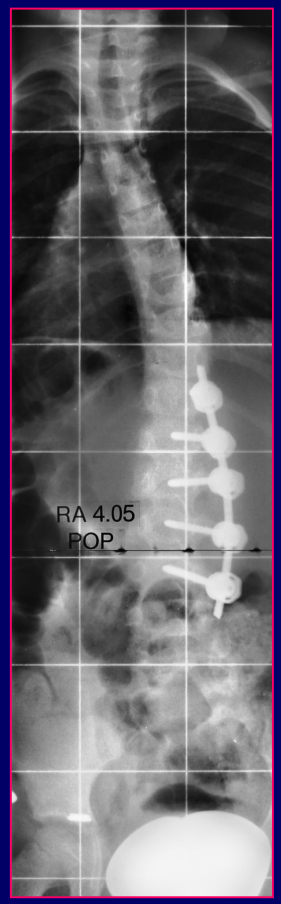
| | |
|---|---|
| right T6 – T11 | 37 ° → 14° |
| left T12 – L3 | 35 ° → 17° |

Instrumented right T12- L3


pre-op

# Continued Spinal Growth in Early Onset Scoliosis: Treatment w/ Single Rod Instrumentation w/o Fusion

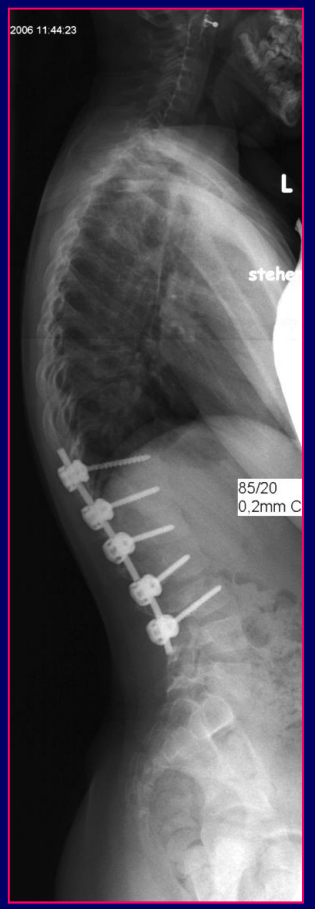
## - CASE STUDY – JIS





post-op 1
4.05

Increase height to 124.5 cm in 4.07 despite rod breakage and increase in curve to 23°




pre-op 2
4.07

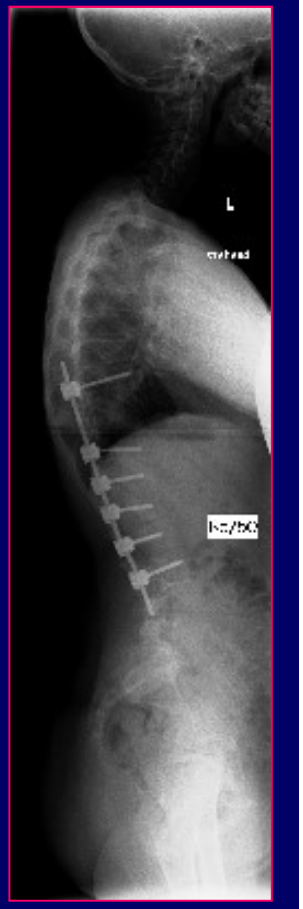
# Continued Spinal Growth in Early Onset Scoliosis: Treatment w/ Single Rod Instrumentation w/o Fusion

## - CASE STUDY – JIS



post-op 2
6.07

Re-instrumented to T8 in 6.07 w/ continued increase height to144 cm w/ rod breakage & curve increase to 32° in 9.10


pre-op 3
10.10

# Continued Spinal Growth in Early Onset Scoliosis: Treatment w/ Single Rod Instrumentation w/o Fusion

## - CASE STUDY – JIS



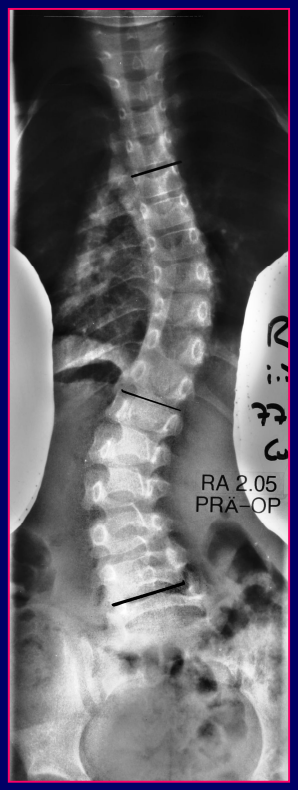
pre-op 3
10.10

Re-instrumented
to L4 right,
T9 – L4 left
w/ wedge
osteotomy L2
fusion L1- L3

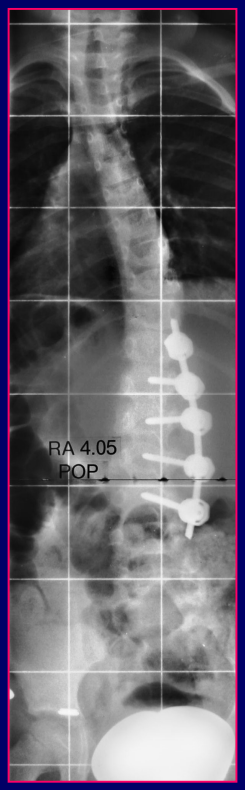


post-op 3
11.10

# Continued Spinal Growth in Early Onset Scoliosis : Treatment w/ Unilateral Instrumentation w/o Fusion
# - CASE STUDY –
# JIS




pre-op
4.05




post-op 1
4.05

pre-op 2
4.07


post-op 2
6.07


pre-op 3
9.10


latest f/u
11.10

# Continued Spinal Growth in Early Onset Scoliosis : Treatment w/ Unilateral Instrumentation w/o Fusion
## - CASE STUDY –
## JIS


pre-op
4.05


post-op 1
4.05


pre-op 2
4.07


post-op 2
6.07


pre-op 3
9.10


latest f/u
11.10

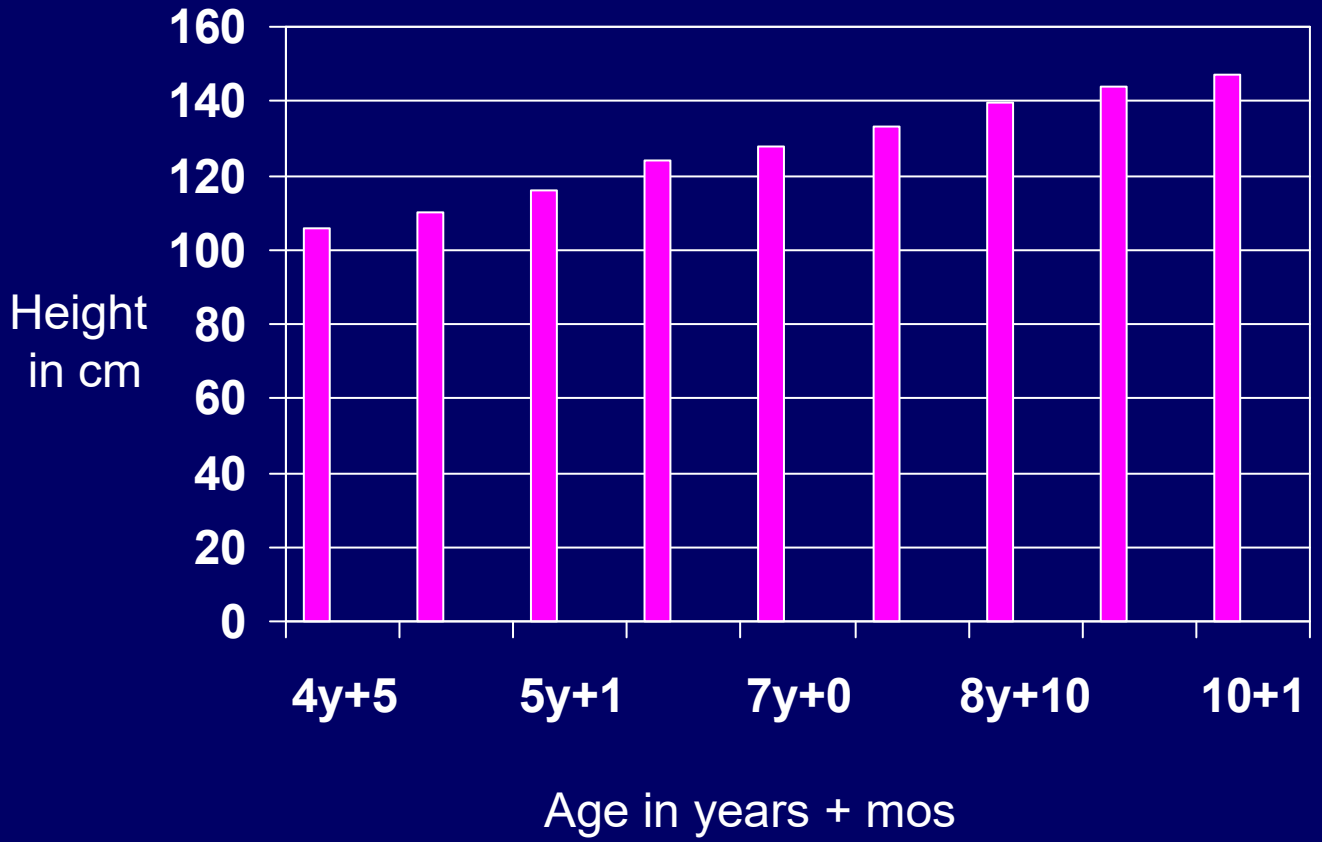
# Continued Spinal Growth in Early Onset Scoliosis : Treatment w/ Unilateral Instrumentation w/o Fusion
# - CASE STUDY –
# JIS

What we did wrong in this case

Unilateral instrumentation resulted in:
- lateral “crankshaft”
- vertebral body wedging

Rod, too long distally, resulted in bone bridge L3/4 facet

# Continued Spinal Growth in Early Onset Scoliosis : Treatment w/ Unilateral Instrumentation w/o Fusion
# - CASE STUDY –
# JIS



# Growth Sparing Spinal Deformity Sx Techniques –

## Complications & Instrumention Related Events

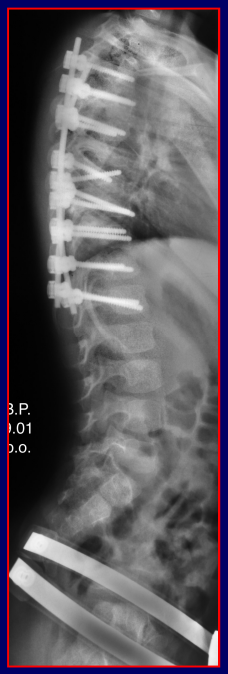
## n = 14

| | |
|---|---|
| **Complications** | |
| Dural leak by ROH | 1 |
| Transient post-op brachial plexus palsy | 2 |
| Post-op wound infection | 1 |
| Adding on | 3 |
| | 7 |
| **Instrumented related events** | |
| Development of thoracic lordosis/ hypokyphosis | 4 |
| Scoliosis development after rod removal to Tx thoracic lordosis | 3 |
| Rod breakage in non-fused region | 4 in 3 patients |
| Proximal screw prominence requiring removal | 2 |
| | 13 |
| | 20 in 10 patients |

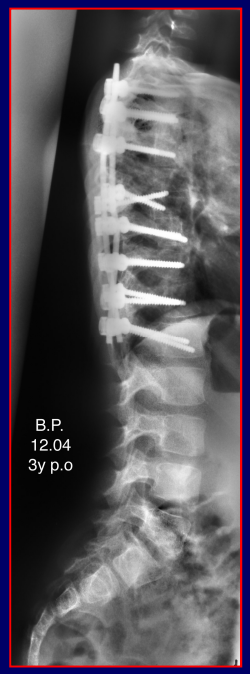
No proximal junctional kyphosis
No spinal cord neurological deficits
No crankschaft in fused region

# The Development of Thoracic Hypokyphosis/Lordosis After Dorsal Hemivertebra Resection & Instrumentation


pre-op
2 yrs old



post-op




3 yrs
post-op


12.04


5 1/2 yrs
post-op
3.07

L Letko, R Jensen, J Harms ICEOS 2007, IMAST 2007

# Growth Sparing Spinal Deformity Sx Techniques –

## Issues

Do these patients need to be definitively fused ?

If so, when?

Crankshaft? Not in fused region rather an adding on with rotation below the instrumented levels

Development of 2° “ idiopathic like curve”

# Growth Sparing Spinal Deformity Sx Techniques – - Conclusions -

Apical resection(s) w/ longer instrumentation w/o fusion except at resected level(s) and uni or bilateral instrumentation w/o fusion allow for excellent spinal deformity correction & continued spinal growth

Extraperiosteal dissection is essential in areas where fusion is not desired

An increase in scoliosis &/or rod breakage is expected with growth

Posterior segmental pedicle screw instrumentation may result in posterior tethering w/ continued anterior growth & the development of hypokyphosis /lordosis in the growing thoracic spine

This may be reversed by rod removal indicating continued growth

# Growth Sparing Spinal Deformity Sx Techniques – - Conclusions -

Adding on may develop & need to be treated in the growing spine

No cases of proximal junctional kyphosis have occurred to date in our patients

With bilateral segmental pedicle screw instrumentation, no patient has been revised due to crankshaft in the fused region