MIS vs Open Surgery for Spinal Deformity: Treatment Algorithm

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Disclosure

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  - DePuy Spine
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  - DePuy Spine
  - Thieme Publishing
  - Quality Medical Publishers/Taylor and Francis
  - Springer Publishing
- Stock
  - Spinicity/ISD

Burgeoning Adult Deformity Patient Population

- Need to Treat More Patients with Adult Spinal Deformity
- Need to Avoid Morbidity

Why Would We Want To Do "Less" Surgery for Adult Spinal Deformity?

- Complication rates high
- Pseudarthrosis rates problematic

Mummaneni et al: Neurosurgery 2008

PEDICLE SUBTRACTION OSTEOTOMY

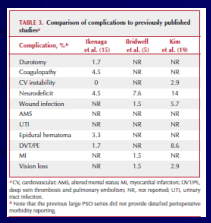


TABLE 3. Comparison of complications to previously published studies*

Complication, %†	Hensaga et al. (15)	Bridwell et al. (5)	Kim et al. (19)
Durotomy	1.7	NR	NR
Coagulopathy	4.5	NR	NR
CV instability	0	NR	2.9
Neurodeficit	4.5	7.6	14
Wound infection	NR	1.5	5.7
AMS	NR	NR	NR
UTI	NR	NR	NR
Epidural hematoma	3.3	NR	NR
DVT/PE	1.7	NR	8.6
MI	NR	1.5	NR
Vision loss	NR	1.5	2.9

*CV, cardiovascular; AMS, altered mental status; MI, myocardial infarction; DVT/PE, deep vein thrombosis and pulmonary embolism; NR, not reported; UTI, urinary tract infection.
† Note that the previous large PSO series did not provide detailed perioperative morbidity reporting.

Degen Vs Deformity

- In Degenerative 1-2 level spinal disease, MIS approaches decrease hospital stay and EBL
  - The operations are interchangeable for Most cases
- Does this hold true for deformity?
  - Are the indications for the MIS vs open deformity surgery similar?

J. Cheng and P. Mummaneni: NS Focus 2013

- Compared 50 MIS TLIF with 25 open TLIF
- MIS TLIF with fewer complications and lower EBL
- MIS TLIF had shorter LOS and saved $4k compared to open TLIF
- Long term outcomes similar

MIS Deformity

- Can decompression be achieved? Yes
- Can hardware be placed safely? Yes (even iliac screws)
- Can sag balance be restored? Maybe
- Will you match LL-PI within 10 degrees? Maybe
- Will it take a long time to do? Initially - yes
- Can a succesful fusion be established?
  - This is the Challenge…

Anand, et al. NS Focus 2010 Complications

TABLE 4: Surgery-related complications in 23 patients with adult scoliosis

Complication	No. of Patients
minor	
transient dysesthesia	17 (recovered w/in 6 wks)
major	
quadriceps palsy	2 (recovered w/in 6 mos)
retrocapsular renal hematoma	1
cerebellar hemorrhage	1
miscellaneous	
screw prominence	1
asymptomatic proximal screw fracture	1

Tormenti, et al. NS Focus 2010 Complications

TABLE 5: Complications arising from the combined approach for deformity correction with XLIF in 8 patients

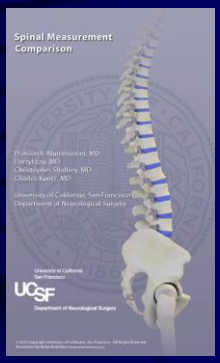
Complication	No. of Patients
bowel perforation	1
infection/meningitis	1
postop sensory radiculopathy	6
postop motor radiculopathy	2
pleural effusion necessitating chest tube placement	2
intraop hemodynamic instability	1
pulmonary embolism	1
ileus	1
durotomy (during posterior stage)	1

Dakwar and Uribe. NS Focus 2010

- Pitfall:
  - The authors concentrated on coronal curve and not on sagittal balance

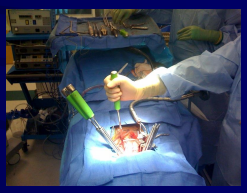
Dakwar and Uribe: NS Focus March 2010

- 1/3 of the patients did NOT have sagittal balance restored
- Remember: Coronal correction is NOT as important as sagittal correction



Wang & Mummaneni NS Focus March 2010

- 23 patients, retrospective review
- High pseudo rate if no interbody fusion is done, can not rely on MIS posterolateral fusion



When To Do MIS for Deformity?

- Need an algorithm…

NS FOCUS May 2014:

- Praveen Mummaneni
- Chris Shaffrey
- Lawrence Lenke
- Paul Park
- Michael Wang
- Frank LaMarca
- Justin Smith
- Greg Mundis
- David Okonkwo
- Bertrand Moal
- Richard Fessler
- Neel Anand
- Juan Uribe
- Adam Kanter
- Behrooz Akbarnia
- Kai Ming Fu
- MIS ISSG

Neurosurg Focus 36 (5):E6, 2014
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The minimally invasive spinal deformity surgery algorithm: a reproducible rational framework for decision making in minimally invasive spinal deformity surgery

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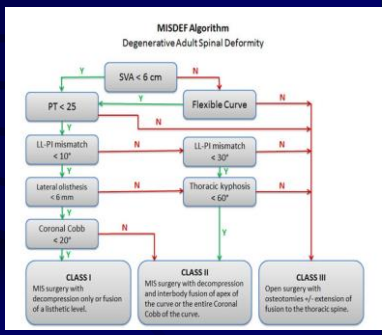
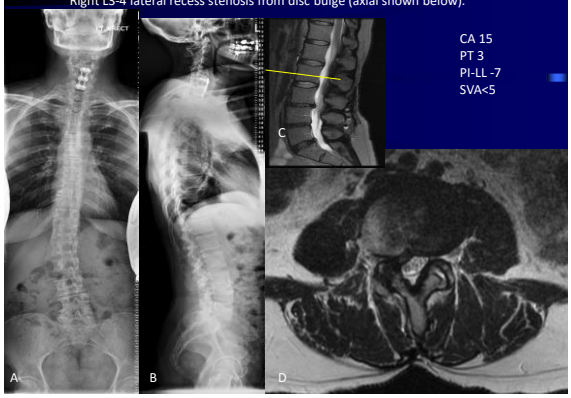


Class I Treatment

- MIS Decompression without fusion or with limited one level fusion

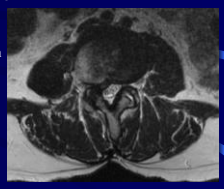
52 year old woman with radicular right leg pain. Minimal back pain. MRI with Right L3-4 lateral recess stenosis from disc bulge (axial shown below).



CA 15
PT 3
PI-LL -7
SVA<5

Class I Treatment

- Decompression alone
  - Neurogenic claudication secondary to central stenosis
    - Requires limited decompression
    - Minimal or no back pain
  - Radiographic findings
- Decompression w/ limited instrumented PL Fusion
  - Stenosis with minimal back pain
  - Anterior supporting osteophytes
  - No global imbalance, cobb <20,
  - No LL-PI Mismatch
  - Caution: Deformity progression and worsening of symptoms



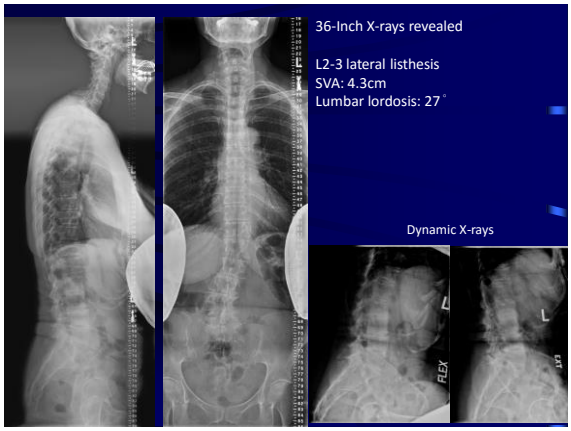
Class 2 "Medium" MIS Treatment

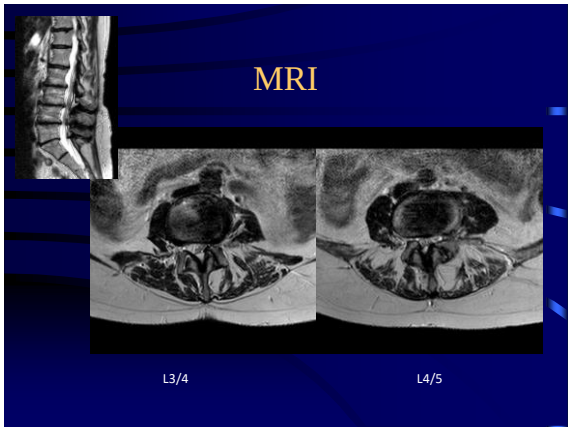
- Apex of lumbar curve is included in instrumented fusion, plus necessary decompression
  - back pain associated with deformity
- Radiographic
  - LL-PI mismatch 10-30 degrees
  - May have grade 1,2 spondylolisthesis or lateral listhesis
  - PT<25
  - Coronal cobb over 20 degrees

Silva FE, Lenke LG: Adult degenerative scoliosis: evaluation and management. Neurosurg Focus 28 (3): E1, 2010

Case Example

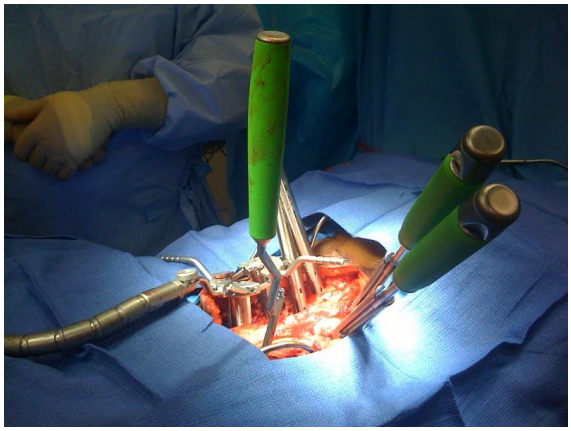
- 67 year old woman with low back pain and bilateral sciatica and anterior thigh pain
  - Failed multiple steroid injections
  - On oral narcotics

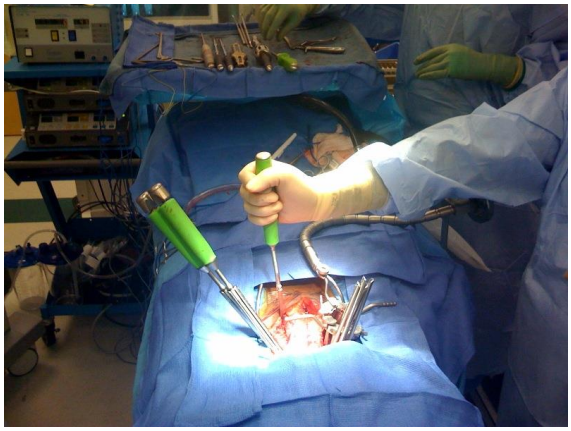

36-Inch X-rays revealed
L2-3 lateral listhesis
SVA: 4.3cm
Lumbar lordosis: 27°
Dynamic X-rays

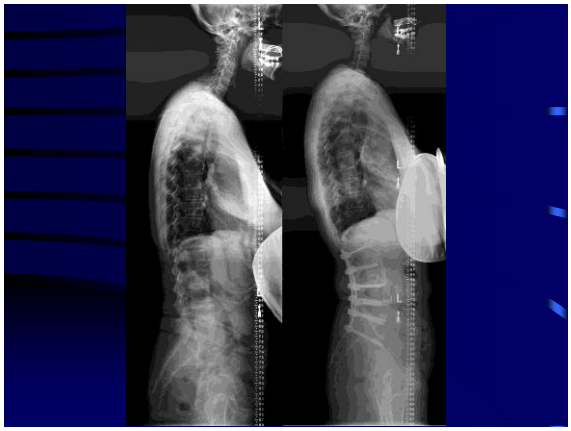

MRI
L3/4
L4/5

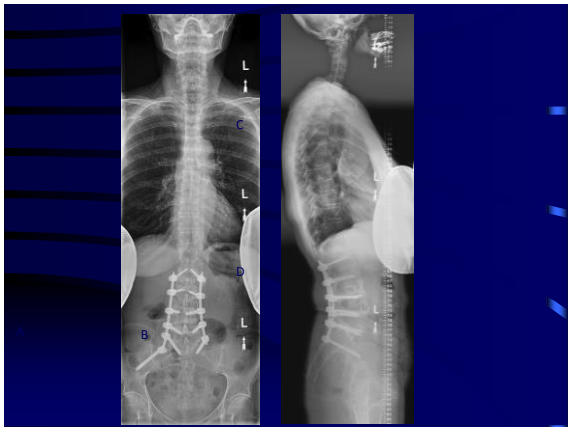

What Levels to Treat?

- 1st stage surgery:
  - Lateral interbody fusion at L2-3, L3-4, L4-5
- 2nd stage surgery:
  - Posterior MIS L2-S1 pedicle screw fixation and right iliac screw fixation
  - TLIF at L5-S1








L
C
L
D
L
B

Iliac Screws May Be Placed MIS

Percutaneous iliac screw placement: description of a new minimally invasive technique

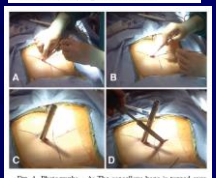


FIG. 4. Photographs. A: The cancellous bone is tapped over the properly paced K-wire. B: The bone tract is palpated after tapping with a ball-tipped probe. The K-wire serves as a guide for this maneuver. C: The iliac screw is placed with an extension head to assist with polyaxial saddle control and rod/set screw attachment. D: The contralateral screw is placed.

Initial Results

- 24 patients underwent percutaneous iliac screw fixation
  -indications: infection, neoplasm, trauma, deformity
- 47 screws placed with fluoroscopic guidance
- All screws confirmed with CT
  - correct placement of all screws.
- No hardware complications
- One patient died of unrelated medical comorbidities

-Wang MY, Williams S, Mummaneni PV, Sherman JD. Minimally invasive percutaneous iliac screws: Initial 24 case experience with CT confirmation

MIS techniques in selected cases may diminish complications

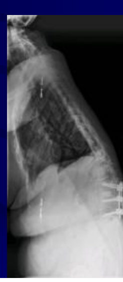
Complications in adult spinal deformity surgery: an analysis of minimally invasive, hybrid, and open surgical techniques

There is a limit (ceiling effect) to deformity correction using current MIS techniques

Less invasive surgery for treating adult spinal deformities: ceiling effects for deformity correction with 3 different techniques

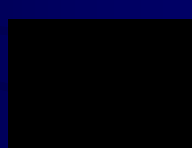
Conclusion: MIS is NOT Ideal for Class 3

- Avoid
  - Curves with Cobb >30°
  - Apical rotation > Grade II
  - Lateral olisthesis >6mm
  - Sag imbalance requiring PSO
  - Thoracic kyphosis
- These characteristics predict failure with limited MIS decompression/fusion surgery
- Need to do OPEN surgery



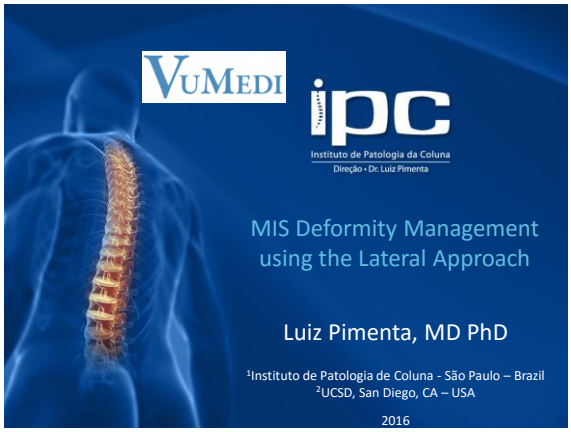
Conclusions

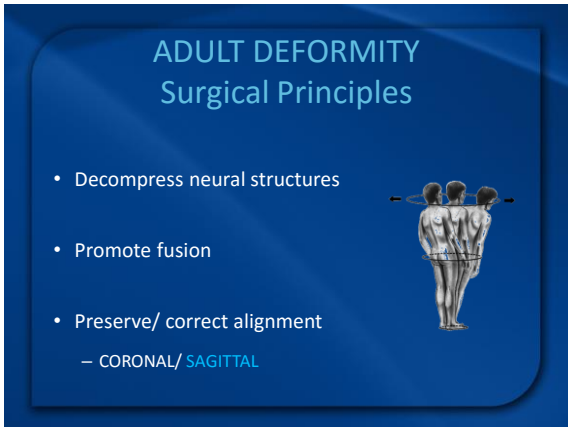
- PI is a fixed parameter
- PT may increase to compensate for loss of sagittal balance
- Goal LL = PI +/- 10 degrees
  - Match PI within 10 degrees of the lumbar lordosis

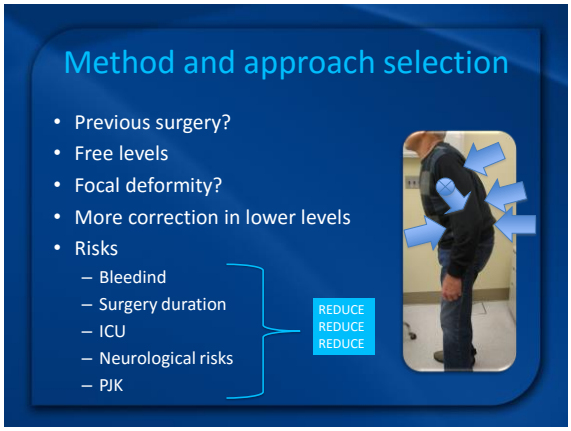


Conclusions

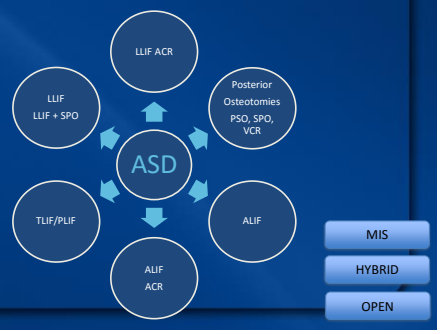
- Minimally invasive techniques:
  - Useful for MISDEF Class 1, 2 deformities
  - Don't forget to restore sagittal balance
  - Currently, MIS techniques are not ideal for cases requiring 3 column osteotomies for correction of spinal imbalance


VuMedi
ipc
Instituto de Patologia da Coluna
Direção • Dr. Luiz Pimenta
MIS Deformity Management using the Lateral Approach
Luiz Pimenta, MD PhD
[1]Instituto de Patologia de Coluna - São Paulo – Brazil
[2]UCSD, San Diego, CA – USA
2016


ADULT DEFORMITY
Surgical Principles
• Decompress neural structures
• Promote fusion
• Preserve/ correct alignment
– CORONAL/ SAGITTAL


Method and approach selection
• Previous surgery?
• Free levels
• Focal deformity?
• More correction in lower levels
• Risks
– Bleedind
– Surgery duration
– ICU
– Neurological risks
– PJK
REDUCE
REDUCE
REDUCE

Method and approach selection



- MIS
- HYBRID
- OPEN

Neurosurg Focus 35 (2):E4, 2013
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Minimally invasive lateral approach for adult degenerative scoliosis: lessons learned

Armen R. Deukmedjian, M.D., Amir Ahmadian, M.D., Konrad Bach, M.D., Alexandros Zouzias, M.D., and Juan S. Uribe, M.D.

	Mild	Moderate	Severe
CCA	<30°	>30	>30
PI-LL	<20°	20°- 30°	>30°
SVA	<5cm	5 - 9cm	>10cm
PT	<25°	25-30°	>30°
Anterior arthrodesis	Limited MIS-LIF consider standalone if PT<20°	MIS-LIF to neutral vertebrae + ALLR	MIS-LIF to neutral vertebrae ± ALLR
Posterior fixation	Percutaneous fixation	Percutaneous fixation ± facetectomy	Pedicle screw fixation + osteotomy

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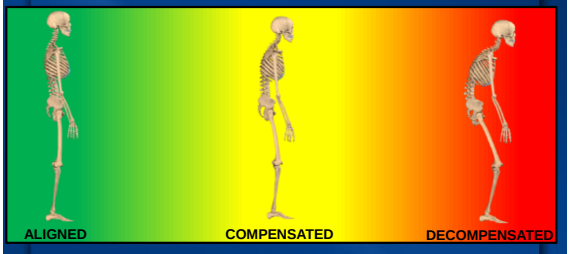


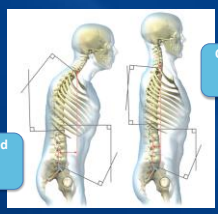
The majority of the cases are
"ALIGNED to COMPENSATED"…

Not only SVA but also PI-LL

Surgical treatment of pathological loss of lumbar lordosis (flatback) in patients with normal sagittal vertical axis achieves similar clinical improvement as surgical treatment of elevated sagittal vertical axis

Clinical article

Disability is underappreciated in compensated cases



Compensated
✓ SVA
x PI-LL

Decompensated
x SVA
x PI-LL

Both groups experienced similar improvements with sagittal correction

Examples

Minimally invasive lateral approach for adult degenerative scoliosis: lessons learned

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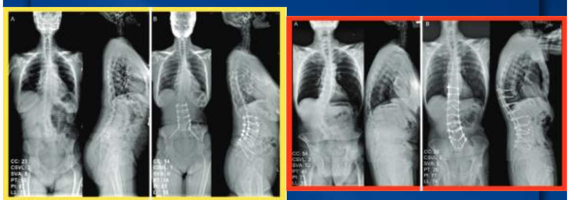
Examples



Neurosurg Focus 35 (2):E4, 2013
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MIS X **HYBRID** X **OPEN**

MIS	HYBRID	OPEN
ALIF LLIF MIS post	ALIF LLIF Limited open posterior	Open posterior osteot/fixation

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Summary
MIS; HYB; OPEN

- Complications
  MIS < HYB < OPEN
- Surgery duration
  OPEN = MIS < HYB
- EBL
  MIS < HYB < OPEN
- Power of correction
  OPEN > HYB > MIS

Neurosurg Focus 36 (5):E12, 2014
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Less invasive surgery for treating adult spinal deformities: ceiling effects for deformity correction with 3 different techniques

JNS SPINE

Comparison of two minimally invasive surgery strategies to treat adult spinal deformity

Complications in adult spinal deformity surgery: an analysis of minimally invasive, hybrid, and open surgical techniques

Comparison of radiographic results after minimally invasive, hybrid, and open surgery for adult spinal deformity: a multicenter study of 184 patients

Spine Deformity

Thirty-Day Reoperation and Readmission Rates After Correction of Adult Spinal Deformity via Circumferential Minimally Invasive Surgery—Analysis of a 7-Year Experience

Neel Anand, MD, Zeeshan M. Sardar, MD, Andrea Simmonds, MD, Babak Khandehroo, MD, Sheila Kahwaty, PA-C, Eli M. Baron, MD

PLF/ TLIF/ PLIF and Alignment

PLF alone average reported pre- to post-op lordosis change per level treated was **-10.7° to 0°** in lordosis (1)

PLIF/TLIF alone average reported pre- to post-op lordosis change per level treated was **-5.6° to 0°** in lordosis (2)

PLIF/TLIF plus SPO average reported pre- to post-op lordosis change per level treated was **15° to 20°** lordosis per level (3)

1. Hsieh, P.C., Koski, T. R., O'Shaughnessy, B. A., Sugrue, P., Salehi, S., Ondra, S., & Liu, J. C. (2007). Anterio r lumbar interbody fusion in comparison with transforaminal lumbar interbody fusion: implications for the restoration of foraminal height, local disc angle, lumbar lordosis, and sagittal balance.
2. Kepler, C. K., Rihn, J. A., Radcliff, K. E., Patel, A. A., Anderson, D. G., Vaccaro, A. R., ... & Albert, T. J. (2012). Restoration of lordosis and disk height after single-level transforaminal lumbar interbody fusion. *Orthopaedic surgery*, 4(1), 15-20.
3. Jagannathan, J., Sansur, C. A., Oskouian Jr, R. J., Fu, K. M., & Shaffrey, C. I. (2009). Radiographic restoration of lumbar alignment after transforaminal lumbar interbody fusion. *Neurosurgery*, 64(5), 955-964.

3-column osteotomy

Neurosurg Focus 36 (5):E18, 2014
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Complications and intercenter variability of three-column osteotomies for spinal deformity surgery: a retrospective review of 423 patients

Kristina Bianco, B.A.,[1] Robert Norton, M.D.,[1] Frank Schwab, M.D.,[1] Justin S. Smith, M.D., Ph.D.,[2] Eric Klineberg, M.D.,[3] Ibrahim Obeid, M.D.,[4] Gregory Mundis Jr., M.D.,[5] Christopher I. Shaffrey, M.D.,[2] Khaled Kebaish, M.D.,[6] Richard Hostin, M.D.,[7] Robert Hart, M.D.,[8] Munish C. Gupta, M.D.,[3] Douglas Burton, M.D.,[9] Christopher Ames, M.D.,[10] Oheneba Boachie-Adjei, M.D.,[11] Themistocles S. Protopsaltis, M.D.,[1] and Virginie Lafage, Ph.D.,[1] on behalf of the International Spine Study Group[12]

423 consecutive patients (8 Surgical centers)

- Major Intraop complications – 7%
  - spinal cord deficit (2.6%)
- Major Periop complications – 39%
  - Unplanned reop (19.4%)
- Major overall complications – 42%

Higher risk of complications

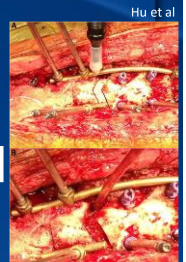
average % of total blood volume lost - 55% !!!

Major blood loss (over 4 L) – 25%

3-column osteotomy – Minimize colateral damage

- ultrasonic bone ressectors

Hu et al



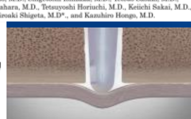
Technical Note
The use of ultrasonic bone curettes in spinal surgery
H. Nakase, R. Matsuda, Y. Shin, Y.-S. Park, and T. Sakaki

ORIGINAL ARTICLE
Use of an ultrasonic osteotome device in spine surgery: experience from the first 128 patients
Xiaobang Hu · Donna D. Ohnmeiss · Isador H. Lieberman

Surgical Pitfalls of an Ultrasonic Bone Curette (SONOPET) in Spinal Surgery

Safety of spinal decompression using an ultrasonic bone curette compared with a high-speed drill: outcomes in 337 patients
Clinical article

Safe and Minimally Invasive Laminoplastic Laminotomy Using an Ultrasonic Bone Curette for Spinal Surgery: Technical note
Kiyoshi Ito, M.D., Shigetoshi Ishizaka, M.D., Tetsuo Sasaki, M.D., Takahiro Miyahara, M.D., Tetsuyoshi Horiuchi, M.D., Keiichi Sakai, M.D., Hiroaki Shigeta, M.D*., and Kazuhiro Hongo, M.D.



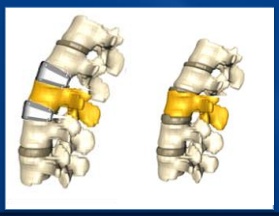
Safe and effective
Decrease the risk of soft tissue injury
Decrease blood loss

"Standard" Lateral LIF

Good for coronal realignment

Poor for sagittal correction

- Posterior Osteotomies (SPO)
- Pedicle subtraction osteotomy (PSO)
- Vertebral column resection (VCR)
- **Anterior Column Realignment (ACR)**



NEW OPTIONS FOR MIS powerful correction

Posterior shortening
x
Anterior elongation

LLIF and Alignment

LLIF average reported pre- to post-op lordosis change per level treated was **1.2° to 3.6°** in lordosis

LLIF with SPO average reported pre- to post-op lordosis change per level treated **27.6°** in lordosis

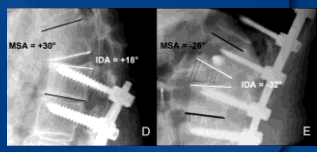
LLIF ACR average reported pre- to post-op lordosis change per level treated was **10° to 30°** in lordosis

Rodgers, W. B., Gerber, E. J., & Patterson, J. R. (2010). Fusion after minimally disruptive anterior lumbar interbody fusion: analysis of extreme lateral interbody fusion by computed tomography. SAS Journal, 4(2), 63-66

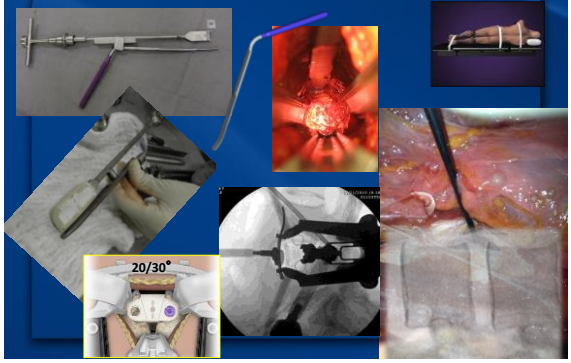
Anterior Column Realignment (ACR) by the lateral approach

- Segmentar Sagittal Correction →
  - Lateral/ Anterior access
  - ALL ressection
  - Hyperlordotic cages

Regional/ Global changes



Anatomical Considerations - ALL

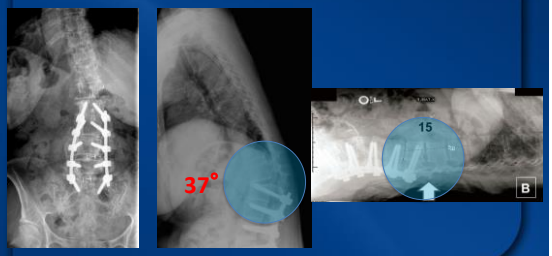


Planning for a lateral ACR

- **CLINICAL ANALYSIS**
  - Hip flexion contractures
  - Neuromuscular conditions
  - Dynamic flexibilty supine vs. Prone vs. standing
  - Neurologic impairment (UMN)

- **RADIOGRAPHIC ANALYSIS**
  - 36" XRAYS, CT, and MRI
  - Sagittal parameters
  - Pelvic parameters
  - Mobile interbody disc
  - Hyper-extension view to evaluate disk space motion

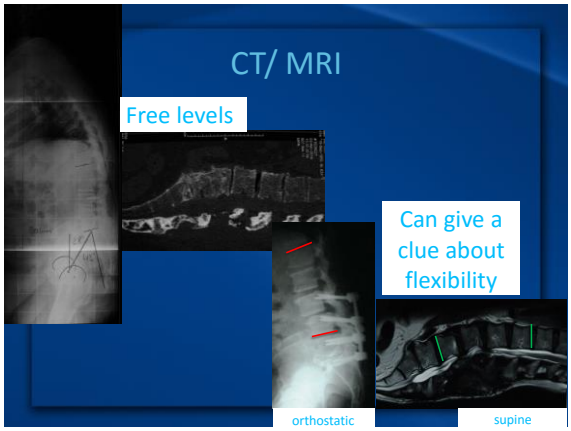
Dynamic X-Rays
Dorsal Decubitus + Bolster



Courtesy: Dr Akbarnia

CT/ MRI

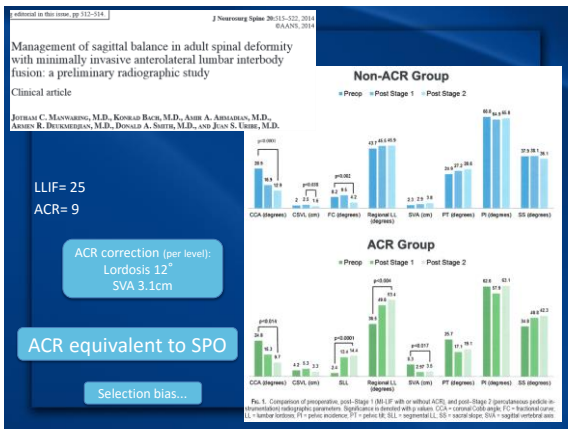
Free levels



Can give a clue about flexibility

orthostatic

supine



Management of sagittal balance in adult spinal deformity with minimally invasive anterolateral lumbar interbody fusion: a preliminary radiographic study

Clinical article

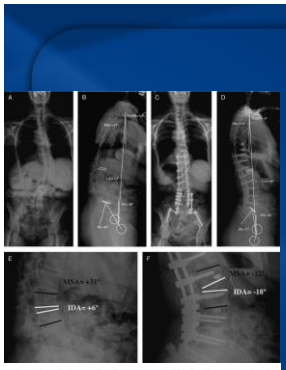
Jotham C. Manwaring, M.D., Konrad Bach, M.D., Amir A. Ahmadian, M.D., Akmen R. Dickmeisen, M.D., Donald A. Smith, M.D., and Juan S. Uribe, M.D.

LLIF= 25
ACR= 9

ACR correction (per level):
Lordosis 12°
SVA 3.1cm

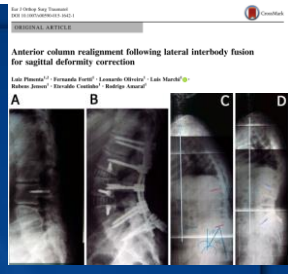
ACR equivalent to SPO

Selection bias...



Anterior Column Realignment (ACR) for Focal Kyphotic Spinal Deformity Using a Lateral Transpsoas Approach and ALL Release

Behrooz A. Akbarnia, MD,*† Gregory M. Mundis, Jr. MD,* Payam Moazzaz, MD,* Nima Kabirian, MD,* Ramin Bagheri, MD,* Robert K. Eastlack, MD,‡ and Jeff B. Pawelek, BS*

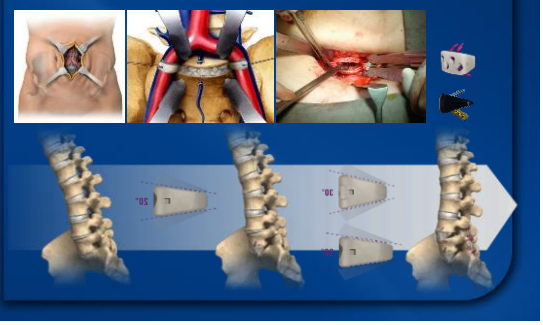


Anterior column realignment following lateral interbody fusion for sagittal deformity correction

Luiz Pimenta[1,2] · Fernanda Fortes[2] · Leonardo Oliveira[2] · Luis Marchi[2] · Rubens Jeronis[2] · Osvaldo Coutinho[2] · Rodrigo Amaral[2]

Lessons learned:
limited posterior osteotomies (Pontè) can give superior correction

Hyperlordotic ALIF



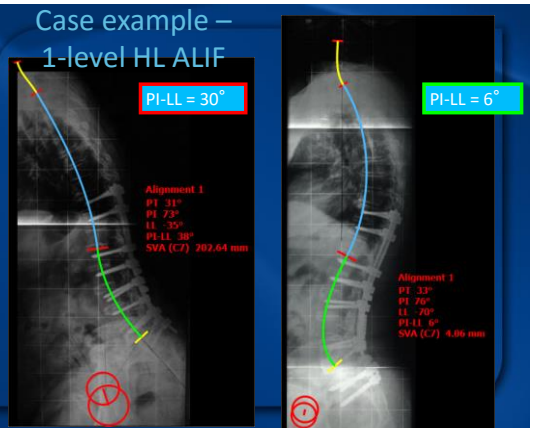
ALIF and Alignment

ALIF Alone average reported pre- to post-op lordosis change per level treated was **5.6°** in lordosis

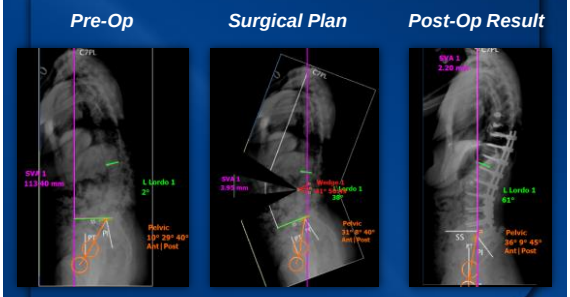
ALIF + SPO average reported pre- to post-op lordosis change per level treated was **15° to 20°** in lordosis

ALIF ACR average reported pre- to post-op lordosis change per level treated was **10° to 30°** in lordosis

Case example – 1-level HL ALIF



Importance of PLANNING



Summary
Anterior colunm reconstruction

- Proper indication and planning
- Adequate exposure
- Safety (protection of neurovascular & monitoring)
- Complete release (ALL & annulus; any posterior?)
- Proper cage position & size
- Cage fixation & screw
- Good stabilization & fusion technique
- Achievement of Goal


ipc
Instituto de Patologia da Coluna
Direção – Dr. Luiz Pimenta
www.patologiadacoluna.com.br

MIS Applications for Pediatric Deformity

Firoz Miyanji MD, FRCSC

VuMedi Seminar 2016

12 yo ♀

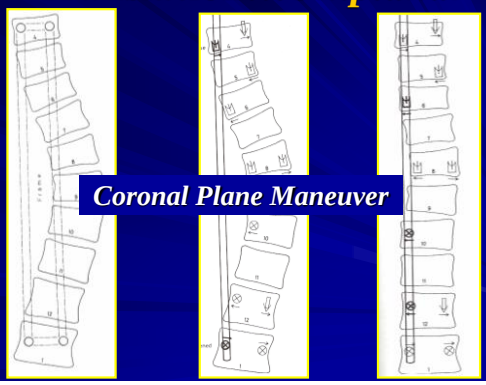
How can we achieve the correction through MIS?

Deformity Correction

- Remains a delicate balance between construct and application of forces and surgical technique of mobilizing the spine
- With changes in available instrumentation, techniques for deformity correction have also evolved
- A number of traditional techniques exist for open procedures ***not all*** of which are available for MIS

Correction Maneuvers…

Translation…*Uniplanar*

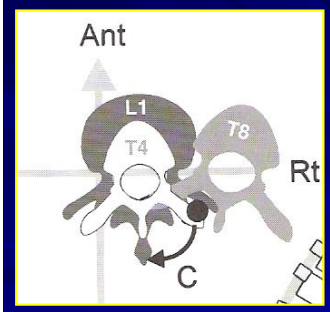


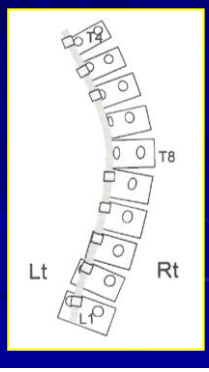
Coronal Plane Maneuver

Compression/Distraction…*Uniplanar*

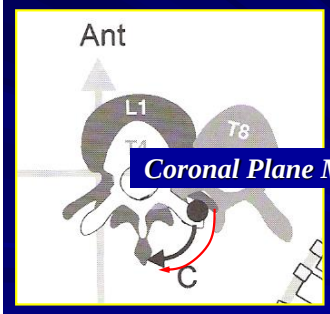
Coronal Plane Maneuver (affects sagittal plane)

Rod Rotation…*Biplanar*

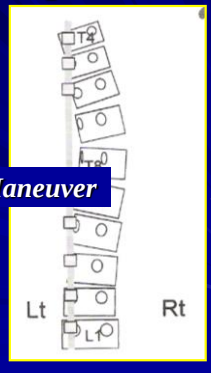




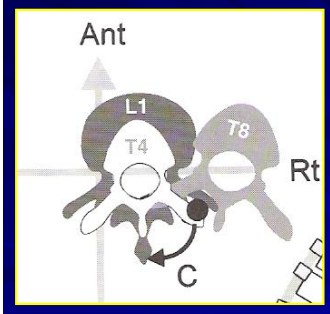
Rod Rotation…*Biplanar*

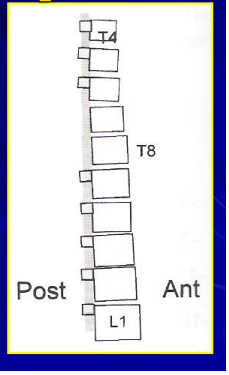


Coronal Plane Maneuver

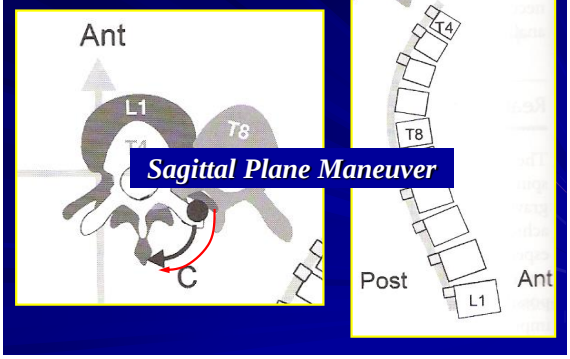


Rod Rotation…*Biplanar*



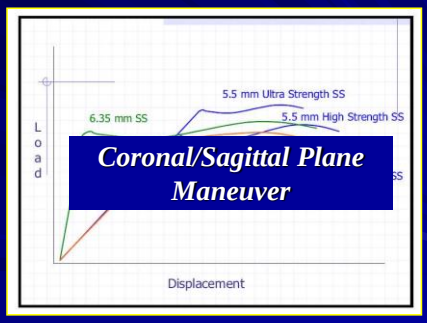


Rod Rotation…*Biplanar*



Sagittal Plane Maneuver

In Situ Contouring

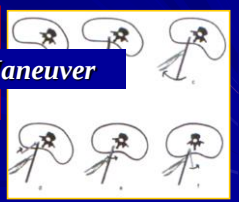


Coronal/Sagittal Plane Maneuver

Direct Vertebral Apical Derotation (DVAD)

Direct Vertebral Rotation: A New Technique of Three-Dimensional Deformity Correction With Segmental Pedicle
Idiopathic Scolios

Sang-Min Lee, MD, PhD, Se-Il Suk, MD, PhD, and Few-Ryong Chung, MD, PhD



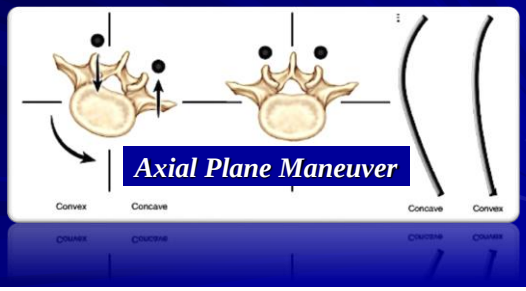
Axial Plane Maneuver

Apical Derotation in the Treatment of Idiopathic Scoliosis

Wichien Laohacharoensombat MD*, Suphaneewan Jaovisidha MD**, Wiwat Wajanavisit MD*, Sorasak Suppaphol MD*

Direct Vertebral Apical Derotation (DVAD)

Differential Rod Contouring : "Newtonian Principle"



Intra-operative Halo-Femoral Traction

- Increasingly popular in open deformity procedures for large, stiff curves
- Advantage in MIS – powerful indirect deformity correction away from operative field

Intra-operative Halo-Femoral Traction



Deformity Correction - MIS

- Correction maneuvers rely heavily on:
  - ***Rod derotation***
  - ***Differential Rod Contouring***
  - ***DVAD***
  - ***Compression/Distraction fairly limited due to exposure and size of available instruments***

Steps – MIS Deformity

- Exposure
- Grafting – fusion
- Screw placement
- Deformity Correction

Fluoroscopy: Midline Skin Incisions Planned

Paramedian Fascial Incisions - 1 Fingerbreadth from Midline

Blunt muscle splitting approach in line with fibres

Traditional Wiltse

•Multifidus *medial* and Longissimus *lateral*

***MIS*: Multifidus retracted more medial to expose facet joint…important for "release" and "fusion"**

Exposure of Facet Joints

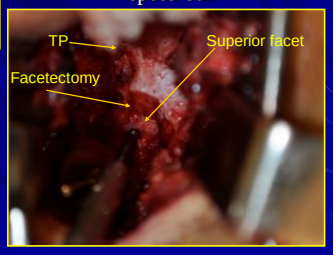
Principle of Wide Facetectomy

- Similar to open technique as posterior release to mobilize column
- Cannulated bone pegs allow for bilateral facetectomies prior to rod passage and application of correction maneuvers
- Ponte releases can be considered through apical area by doing a hybrid procedure

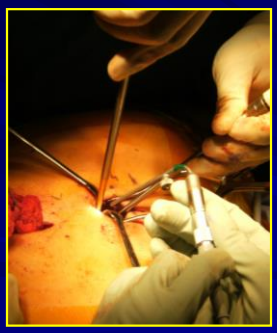
Facetectomy followed by Decortication

Facetectomy

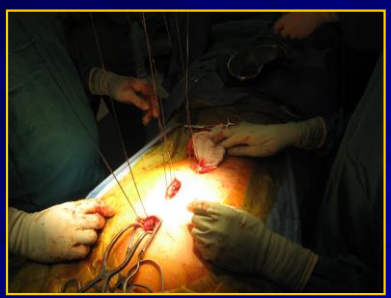
Decortication using high-speed burr

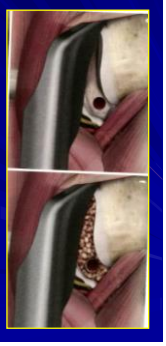


Pedicle cannulation using 'free-hand' technique



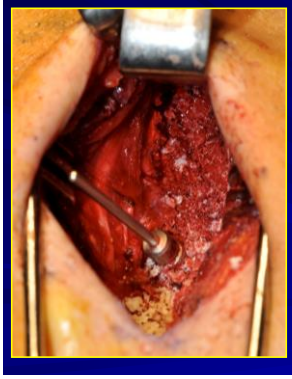
Guide wires inserted to keep cannulated pedicles localized





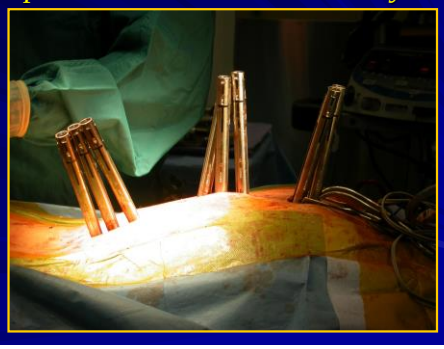
Meticulous decortication and bone grafting prior to screw insertion

Bone grafting prior to screw insertion



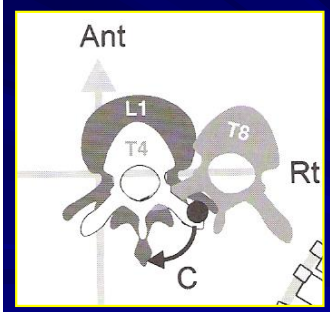
- Bone Peg option prior to guide wire insertion
- Allows for less cluttering of operative field
- Enables bilateral facetectomies prior to rod insertion

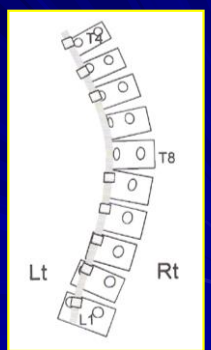
After grafting, pedicle screws are placed – concave side initially



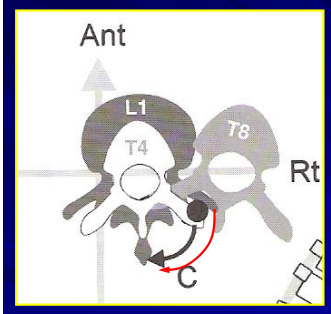
Concave Rod Passed First - Distal to Proximal

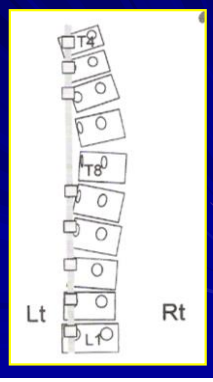
Rod Rotation



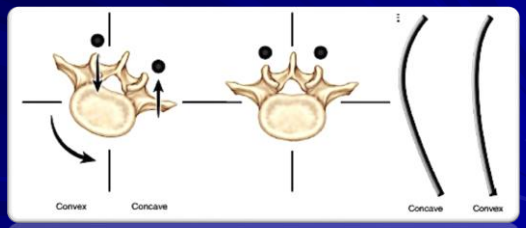


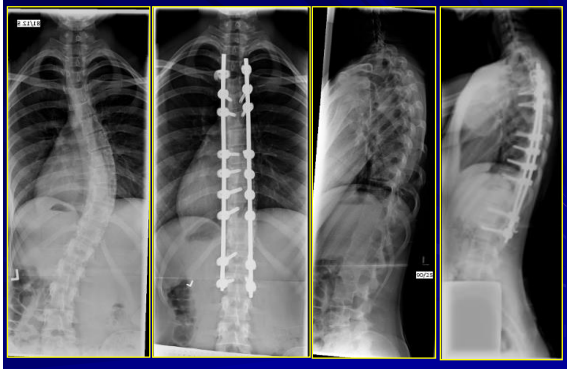
Rod Rotation

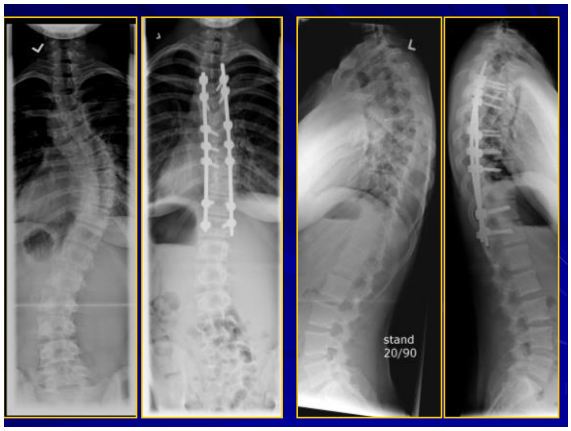


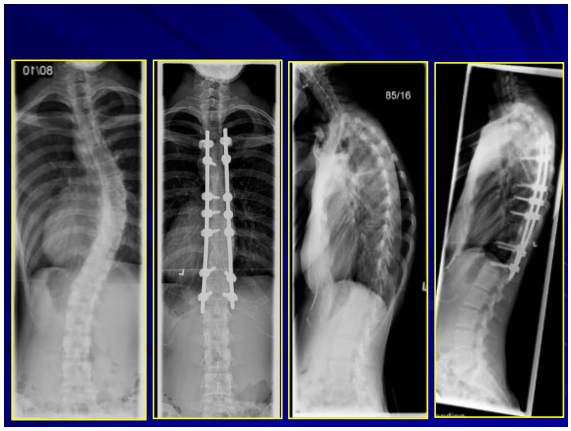


Differential Rod Contouring : "Newtonian Principle"



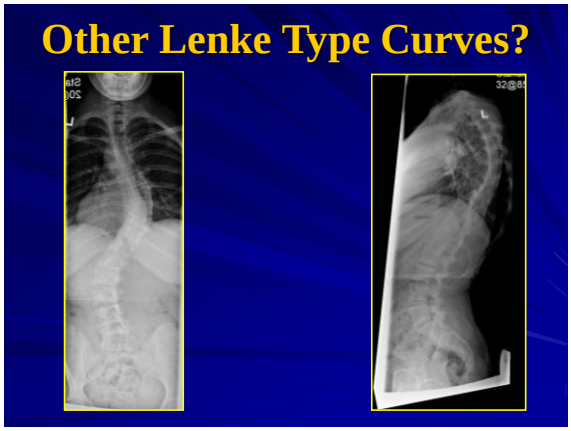


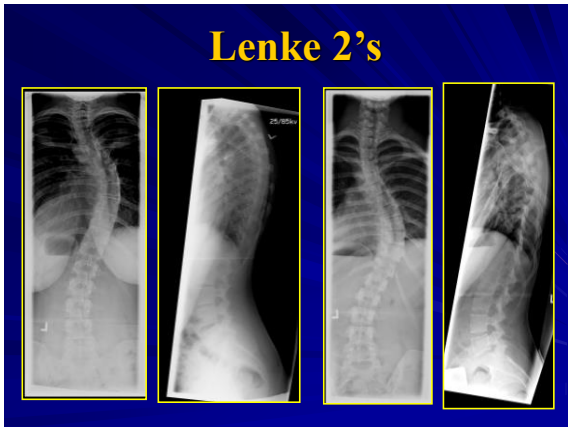

stand
20/90


07\08
85/16


Pre-op
2.5 Years Post-op


Pre-op
2.5 Years Post-op


Other Lenke Type Curves?

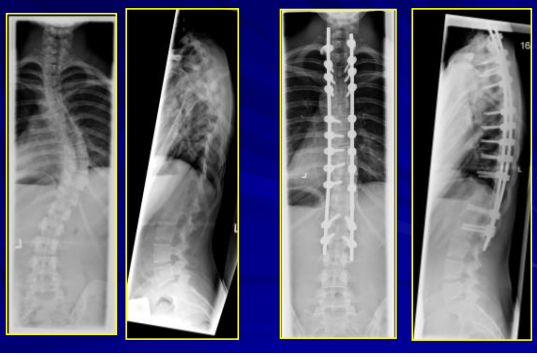

Lenke 2's

Lenk 2 – Structural PTC

Right and Left Bend Films

High Left shoulder

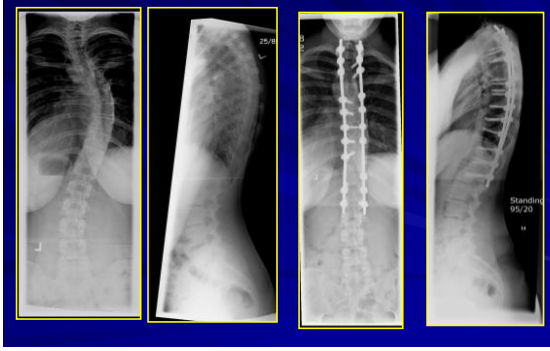
2 Years Post-op



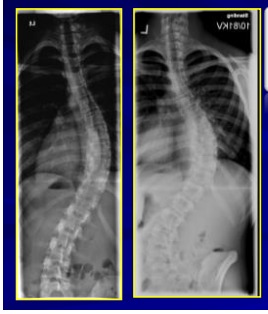
2 Years Post-op

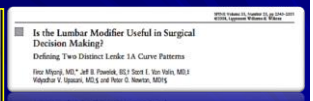
2 Years Post-op

2 Years Post-op



"Long, Swooping" Lenke 1 (Lenke '1AR')



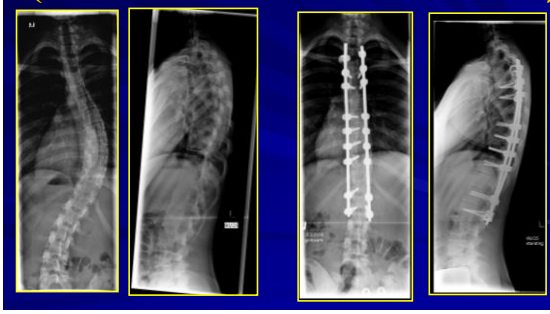


Is the Lumbar Modifier Useful in Surgical Decision Making?

Defining Two Distinct Lenke 1A Curve Patterns

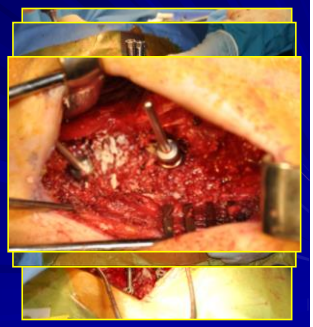
- Longer fusion to L2/L3 despite being "Lenke 1" curves…

"Long, Swooping" Lenke 1 (Lenke '1AR' – Miyanji et al. Spine 2008)



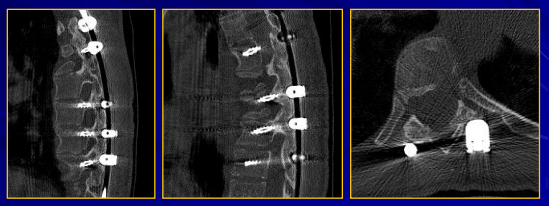
Perceived Limitations

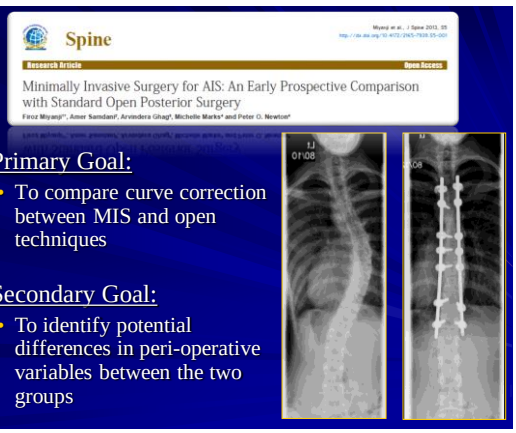
- Fusion
- Application of correction maneuvers
- Rod Passage



Perceived Limitations – 1 year post-op CT

- Fusion – facet/lamina fusion
- Model for pseud risk different than adults
- Aggressive decortication and allograft bone.



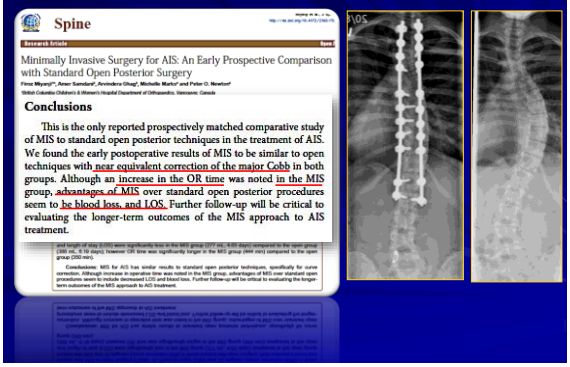


- Primary Goal:
  - To compare curve correction between MIS and open techniques
- Secondary Goal:
  - To identify potential differences in peri-operative variables between the two groups

Results

	MIS		OPEN			
Demographics						
Gender M:F	2:14		1:15			
Lenke Class (n)	1(8); 2(5); 3(2); 4(1)		1(9); 2(2); 3(3); 4(1); 6(1)			
	Mean	**SD**	**Mean**	**SD**		
Age (yrs)	16.8	1.2	16.4	1.2		
BMI	21	3	22	4		
Risser	4.5	0.5	4.5	0.5		
Pre Op Major Cobb	56	5	56	8		
Primary Outcome	**Mean**	**SD**	**Mean**	**SD**	**95% CI Lower**	**95% CI Upper**
Post-Op Major Cobb	20	8	18	4	-2.4	7.2
Post-Op Thoracic Kyphosis (T5-T12)	21	9	17	5	-1.7	9.4
Percent Curve Correction	63%	13	68%	8	-0.12	0.04
Secondary Variables	**Mean**	**SD**	**Mean**	**SD**	**95% CI Lower**	**95% CI Upper**
OR Time (min)	444	89	350	76	34.8	154.0
EBL (ml)	277	105	388	158	-207.8	-14.1
LOS (days)	4.63	.96	6.19	1.68	-2.6	-0.6

Conclusions


Spine

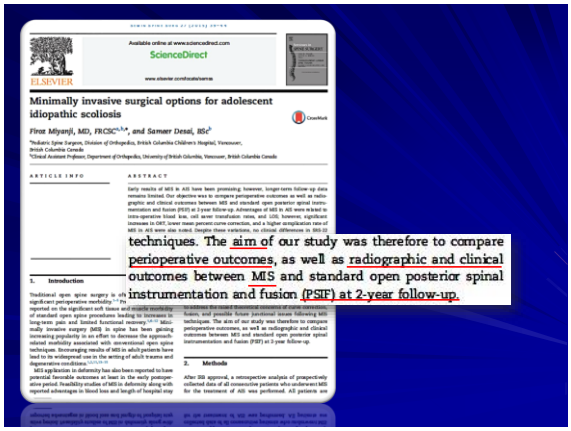
Minimally Invasive Surgery for AIS: An Early Prospective Comparison with Standard Open Posterior Surgery

Conclusions

This is the only reported prospectively matched comparative study of MIS to standard open posterior techniques in the treatment of AIS. We found the early postoperative results of MIS to be similar to open techniques with near equivalent correction of the major Cobb in both groups. Although an increase in the OR time was noted in the MIS group, advantages of MIS over standard open posterior procedures seem to be blood loss, and LOS. Further follow-up will be critical to evaluating the longer-term outcomes of the MIS approach to AIS treatment.

Perceived Limitations

- Prospective and long-term studies are *critical* to evaluate possible limitations and to demonstrate the true clinical benefits of minimally invasive surgery in the setting of deformity



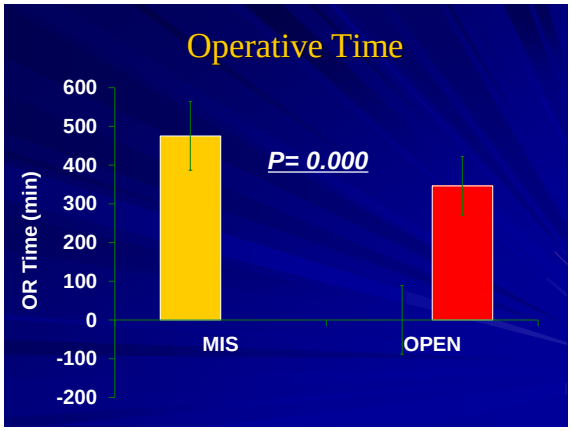
Minimally invasive surgical options for adolescent idiopathic scoliosis

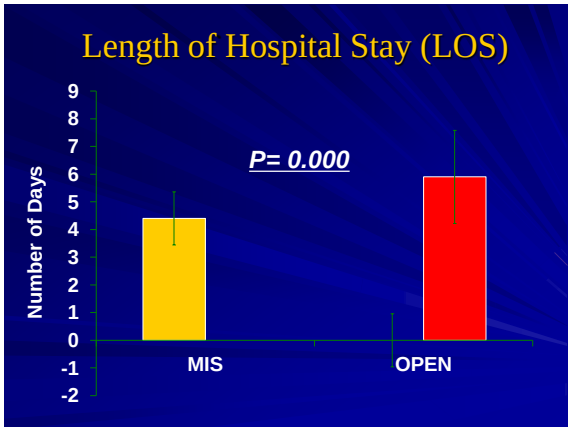
techniques. The aim of our study was therefore to compare perioperative outcomes, as well as radiographic and clinical outcomes between MIS and standard open posterior spinal instrumentation and fusion (PSIF) at 2-year follow-up.

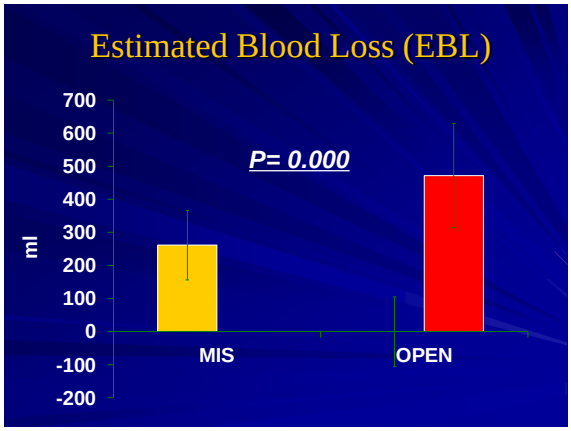
Results

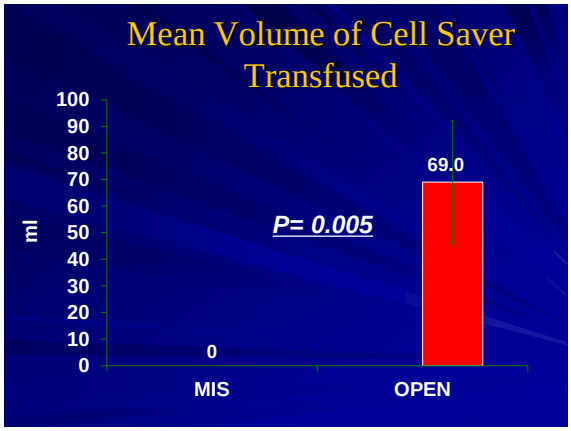
Patient Demographics	MIS (n=23)	PSIF (n=23)
Gender M:F	3:20	4:19
Lenke Class (n)	1: 20 2: 2 4: 1	1: 12 2: 8 3:3
Mean Age (yrs)	16.8±0.40 (14-20)	16.4±0.28 (13-19)
Mean Weight (kg)	59.1±1.74 (43-72)	56.4±1.57 (44.6-76.2)
Mean Preop Major Cobb (°)	56.7±1.62 (45-77)	58.1±1.57 (46-71)
Mean Preop Lat (T5-T12)	20.5±2.08 (-2-39)	22.6±3.38 (-4-54)
No. of Fusion Levels	10.2	12.2

Peri-op Outcomes

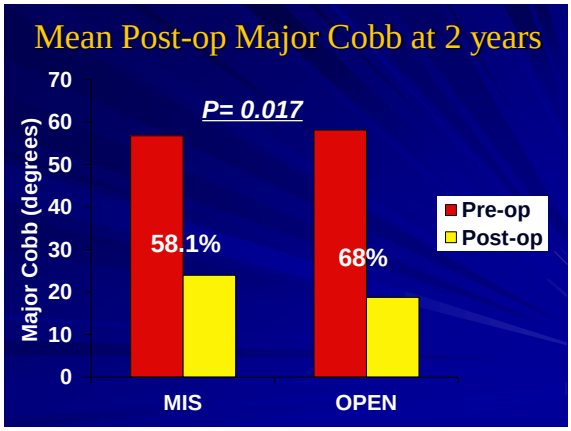

Operative Time
OR Time (min)
600
500
400
300
200
100
0
-100
-200
P= 0.000
MIS
OPEN


Length of Hospital Stay (LOS)
Number of Days
9
8
7
6
5
4
3
2
1
0
-1
-2
P= 0.000
MIS
OPEN

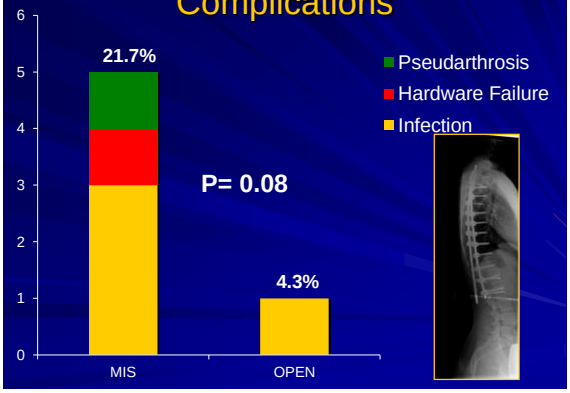

Estimated Blood Loss (EBL)
ml
700
600
500
400
300
200
100
0
-100
-200
P= 0.000
MIS
OPEN



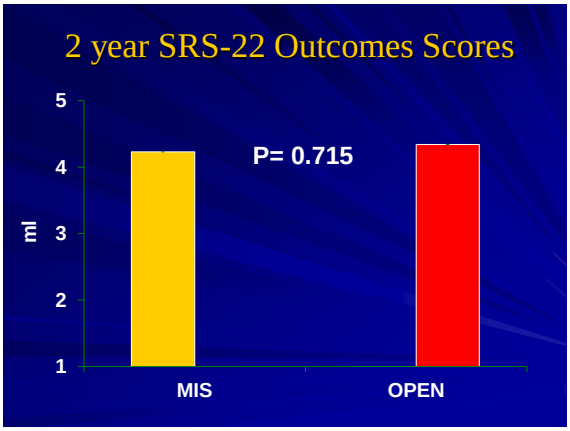
2-yr Follow-up



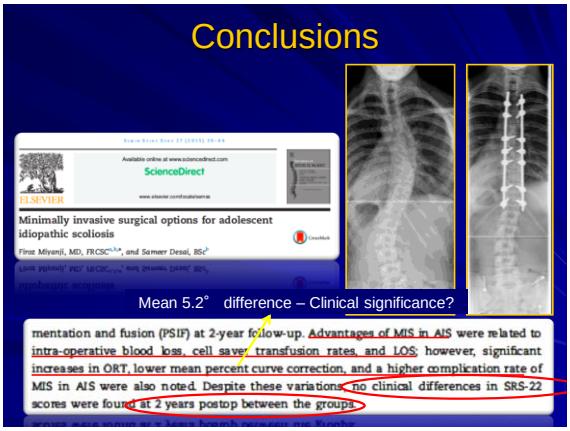
Complications



2 year SRS-22 Outcomes Scores

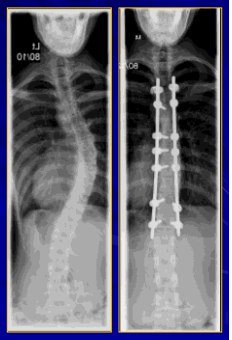


Conclusions



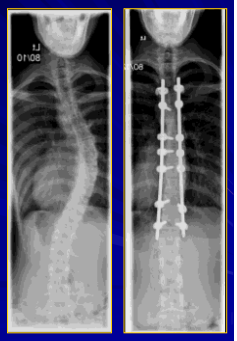
Summary

- **Steps:**
  - **Exposure**
  - **Grafting**
  - **Screw Placement**
  - **Deformity Correction**
- **Fusion level selection should follow "traditional rules"**
- **Consider HFT for 'stiff' curves**
- **Start with flexible Lenke 1A/B curves**



Summary

- **MIS *very feasible* in deformity**
- **Correction is *NOT* significantly compromised**
- **Advantages include blood loss, transfusion rates, and LOS**
- **At 2 years SRS functional outcome scores equivalent to open techniques**



Thank You

RUSH UNIVERSITY MEDICAL CENTER
RUSH MEDICAL COLLEGE • COLLEGE OF NURSING • COLLEGE OF HEALTH SCIENCES • THE GRADUATE COLLEGE

EMERGING TRENDS IN MIS DEFORMITY SURGERY

Richard G. Fessler, MD, PhD
Professor
Department of Neurosurgery
Rush University Medical Center

CATEGORIES

RUSH UNIVERSITY

- DEVICES
  - Hyperlordotic cages
  - Patient specific pre-contoured rods
  - "Growing" rods for MIS
- BIOLOGICS
  - Non-BMP fusion augmentation
- TECHNIQUE
  - Expandable disc space distractors
  - Sectioning the ALL
  - Technique for bending rods into lordosis
- PLANNING
  - Computer programs for optimal correction

2

DEVICES

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- HYPERLORDOTIC CAGES

Recent modifications

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- 65 yo male with 20 years of worsening back pain s/p L2-4 laminectomy 6 years ago
- Unable to stand or walk for more than a few minutes; failed PT, injections, chiro, meds

Scores	
NRS - (1) Neck	0
NRS - (2) Arm	0
NRS - (3) Back	8
NRS - (4) Leg	0
ODI	62
SF-12 Mental Health	43.86
SF-12 Physical Health	30.11
SRS30- Satisfaction with management	3
SRS30-Function/Activity	2.4
SRS30-Mental health	3.6
SRS30-Pain	2.6
SRS30-Self Image/Appearance	2.83
SRS30-Total	2.87
VR-12 Mental	47
VR-12 Physical	31.32
VR6D	0.57

Courtesy of John O'Toole

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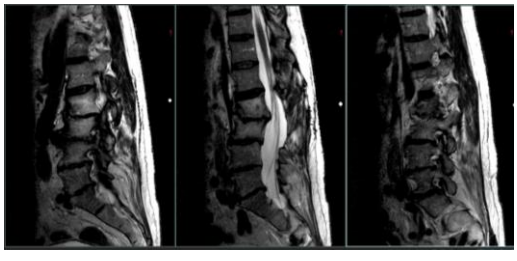

T2 sagittal

RUSH UNIVERSITY

- Stage 1:
  - L5S1 ALIF with 15 degree cage
  - R L2-5 LLIF (10 and 20 degree cages at L23, 45)
    - L3-4 ALL release with 30 degree cage
- Stage 2:
  - L3-4 MIS posterior osteotomies
  - L2-S1 percutaneous screws w/ navigation

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Pre to postop PRO scores

RUSH UNIVERSITY

- Has severe knee arthritis affecting VAS leg and ODI

Scores		
NRS - (1) Neck	0	0
NRS - (2) Arm	0	0
NRS - (3) Back	8	3
NRS - (4) Leg	0	3
ODI	62	68
SF-12 Mental Health	43.86	36.9
SF-12 Physical Health	30.11	37.16
SRS30- Satisfaction with management	3	4.33
SRS30-Function/Activity	2.4	2.43
SRS30-Mental health	3.6	3.8
SRS30-Pain	2.6	3
SRS30-Self Image/Appearance	2.83	3
SRS30-Total	2.87	3.13
VR-12 Mental	47	40
VR-12 Physical	31.32	38.75
VR6D	0.57	0.53

DEVICES

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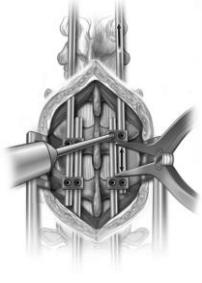
- PATIENT SPECIFIC PRE-CONTOURED RODS

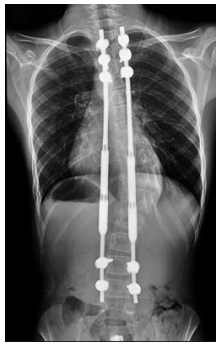
UNiD
THE PATIENT SPECIFIC ROD

DEVICES

RUSH UNIVERSITY

- GROWING RODS FOR MIS





BIOLOGICS

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- NON-BMP BONE GROWTH AUTMENTATION
  - Protein
  - Calciumphosphosilicate

P-15 PROTEIN

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TECHNIQUE: EXPANDABLE DISTRACTORS and CAGES

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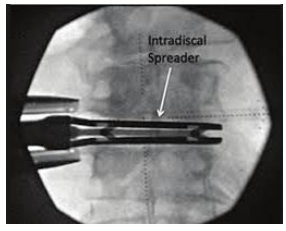
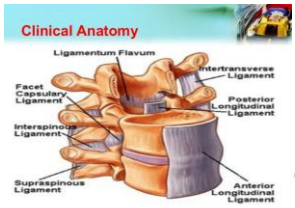
LORDOTIC

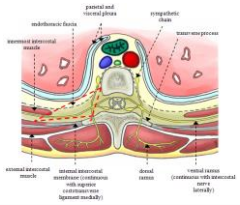
MIS



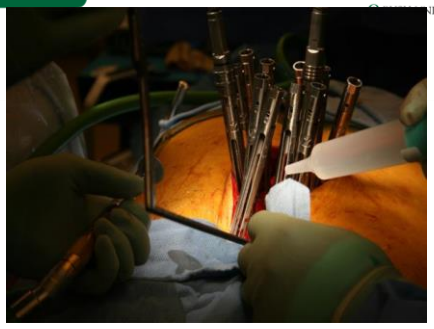
TECHNIQUE: CUTTING ALL

RUSH UNIVERSITY





TECHNIQUE FOR BENDING RODS



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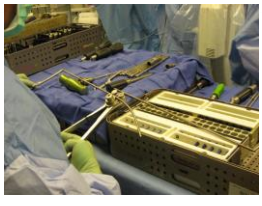
Haque, R., Fessler, R.G.: "Push-Through" Rod Passage Technique for the Improvement of Lumbar Lordosis and Sagittal Balance in Minimally Invasive Adult Degenerative Scoliosis Surgery.
Journal of Spinal Disorders and Techniques, 2014.



PUSH THROUGH AND BEND INTO LORDOSIS

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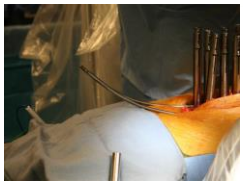
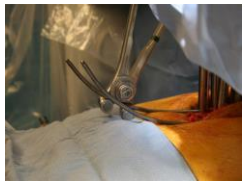

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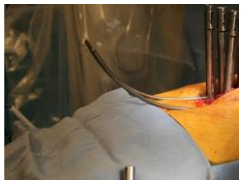


EMERGING TRENDS: WHERE ARE WE GOING?

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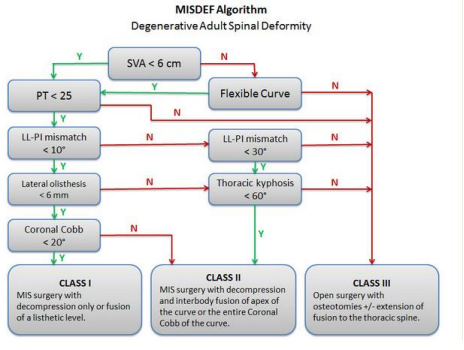

16 Y/O FEMALE

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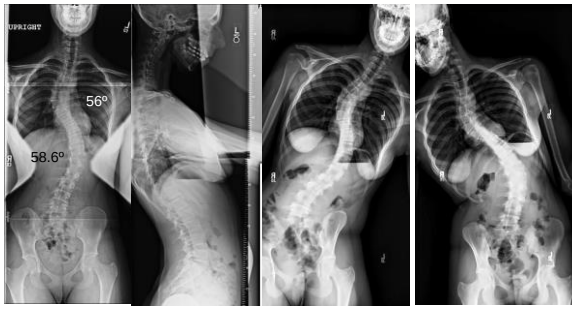

Coronal balance: 28 mm; Sagittal balance: -113 mm;
PI=39.4; PT=0; SS=29; LL=43

POST MIS CORRECTION

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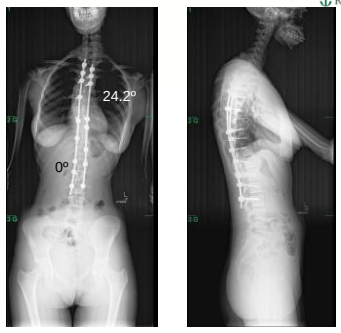

Coronal balance: 26mm; Sagittal balance: 0 mm
PI=52.3; PT=24.4; SS=26.1 LL=30.9

PLANNING

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- SURGIMAP

EOS

PLANNING

GOAL: EMERGING TRENDS

RUSH UNIVERSITY

- All deformity correction performed through MIS technique!

THANK YOU