The extremes of Deformity Require Open Approaches - How I Do It

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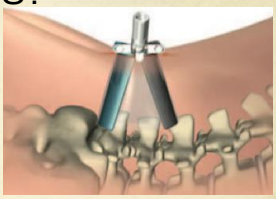
University of Wisconsin-Madison
March 24, 2014

Why Would Anyone do MIS?

- Smaller Incision
- Less Muscle Stripping
- Less Blood Loss
- Lower Infection Rate
- Improve Patient Outcomes
  - Shorter Hospital stay
  - Quicker return to Activiies
- Industry Driven
- Improve local/regional marketing of practice
- Technical/Professional challenge



Why Not do MIS?

- Potential for prolonged operative time
- Usually associated with increased radiation exposure
- Not appropriate for every case
- Less surface area of bone exposed for fusion cases
- May be difficult to repair a spinal fluid leak if one occurs
- Learning curve for surgeons (takes a few cases to develop competence)

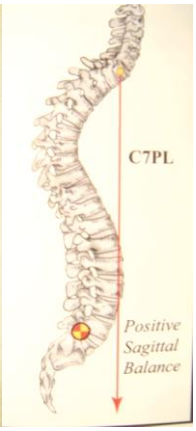
Goals Of Adult Deformity Surgery

- Stabilize and Correct Spinal deformity
- Reestablish/Maintain Spinal balance
- Obtain a Fusion
- Do so efficiently with low complication rate

Sagittal Balance and Symptoms

Glassman, Berven et al Spine 2005

- Curve type, location, magnitude
- Coronal and Sagittal balance
- SRS 22,ODI, SF-12
- Thoracolumbar curves worse function
- Positive Sagittal Balance > 5cm
  - Most important reliable radiographic predictor of health status
  - Worse pain, function, and self image



Glassman, Bridwell et al Spine 2005

- 752 pts, 352 with positive sagittal imbalance
- Kyphosis poorly tolerated in lumbar region
- Health status deteriorated with progressive increase in + sag balance over 5cm

Here We Go Again

Classification of Adult Deformity

Curve Type (Cobb angle)

Type

T: Thoracic only – with lumbar curve <30°
L: TL/Lumbar only – with thoracic curve <30°
D: Double curve pattern – at least one T and one TL/L curve, with both curves at least 30°
S: Sagittal deformity – applies to deformities with <30° coronal Cobb angle, and any of the following modifiers:
-B or C
-M or H
-P or VP

3 Modifiers

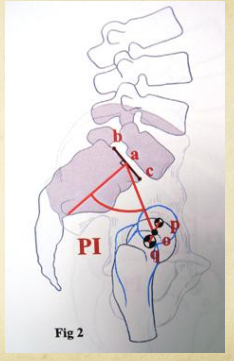
LL-PI	Pelvic Tilt	Global Balance
A: small <10°	L: PT <20°	N: SVA <4cm
B: moderate 10-20°	M: PT 20-30°	P: SVA 4-9.5cm
C: marked >20°	H: PT >30°	VP: SVA >9.5cm

Example: Type L (45°) B,M,VP

Pelvic Incidence

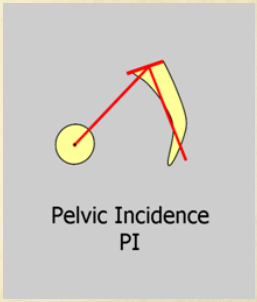
- Constant, fixed parameter
- Ave. 53.2 male, 48.2 female
- Adolescent: 49.1

O'Brien ed. Spinal Deformity Study Group "Radiographic Measurement Manual"
Legaye et al. E Spine Journal 1998
Mac-Thiong E Spine Journal 2007



LL-PI:

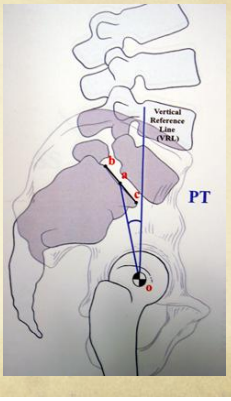
A: Small <10 degrees
B: Moderate 10-20 degrees
C: Marked >20 degrees



Pelvic Tilt

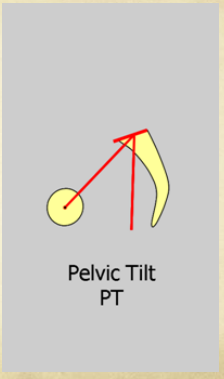
- Ave 11.9 male, 10.3Female
- Adolescent: 7.7

O'Brien ed. Spinal Deformity Study Group "Radiographic Measurement Manual"
Legaye et al. E Spine Journal 1998
Mac-Thiong E Spine Journal 2007



Pelvic Tilt:

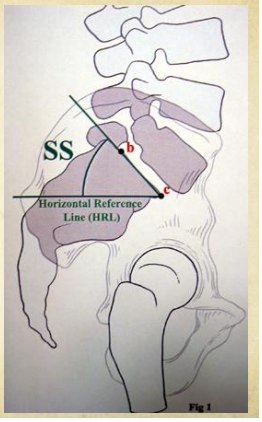
L: PT < 20 degrees
M: PT 20-30 degrees
H: PT > 30 degrees



Sacral Slope

- Ave 41.9 male, 38.2Female
- Adolescent: 41.4

O'Brien ed. Spinal Deformity Study Group "Radiographic Measurement Manual"
Legaye et al. E Spine Journal 1998
Mac-Thiong E Spine Journal 2007

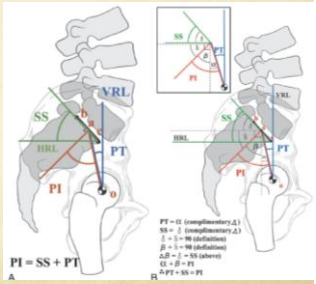


Labelle

Relationship between PI, SS and PT

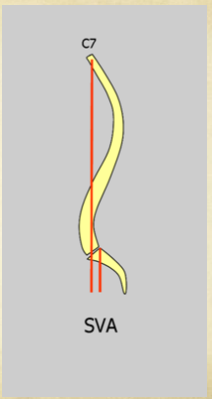
PI=SS+PT

Therefore a change in one parameter affects the other measurements and the overall alignment of the sacropelvic foundation



Global Balance:

N: SVA < 4 cm
P: SVA 4-9.5 cm
VP: SVA > 9.5 cm



Schwab

- Linear regression models demonstrated threshold radiographic spino-pelvic parameters for ODI ≥ 40 included:
- PT ≥ 22° (normal 10-11°)
- SVA ≥ 46 mm,
- PI-LL ≥ 11°

0-20% Minimal disability
20-40% Moderate disability
40-60% Severe disability
60-80% Crippled
80-100%

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Example: Type L (45°) B,M,VP

Posterioor Surgical Options:

- Posterior
  - Osteotomies
    - Ponte/Smith-Petersen
    - Pedicle subtraction
    - Vertebral Column Resection (VCR)

Sagittal Balance Corrective Procedures

- Ponte/Smith Petersen
  - Scheuermans/Thoracic Kyphosis
  - T/L Scoliosis Kyphosis
  - Disc spaces open
  - 5-10 ° per level

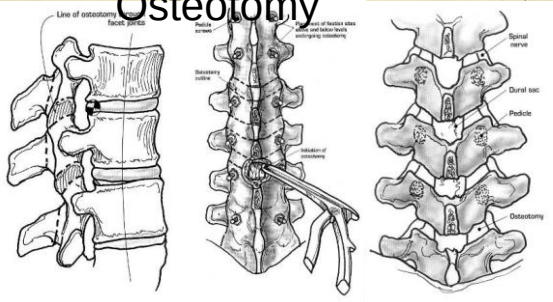
Sagittal Balance Corrective Procedures

- PSO (Pedicle Subtraction Osteotomy)
  - 30 ° to 40 ° correction
  - Global sagittal imbalance >10cm
  - Typically performed at Lumbar L2, L3, L4 level
- VCR (Vertebral Body Resection)
  - More severe Scoliosis/Kyphosis (thoracic)
  - Performed at apex of Kyphosis
  - Correction 50 ° or greater, limited by

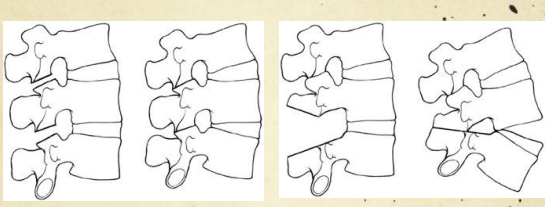
Osteotomy Selectio

Flexibilty
- Bending Films
- Dynamic radiographs
- Traction radiographs
- Bolster radiographs
- Supine radiographs
- Prone intraoperative radiographs

Ponte Osteotomy



SPO vs Ponte



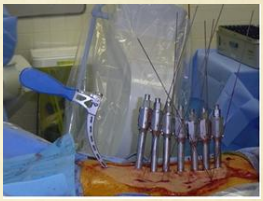
Ponte SPO

Ponte Osteotomy

In Scheuermann's Kyphosis

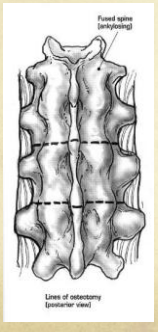
MIS Challenge

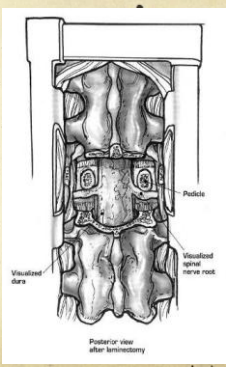
- Requires Boney Resection over multiple levels
- Requires facet Fusion over the rest
- Not much muscle Sparing by the time you are done

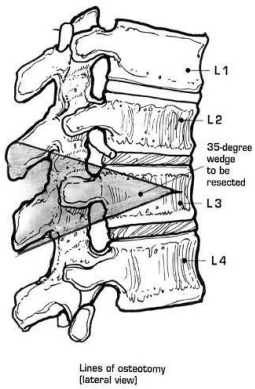


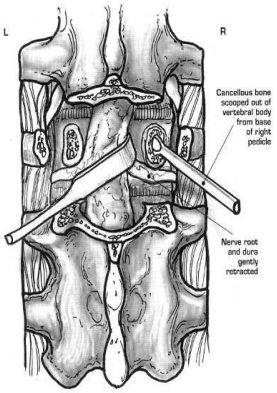
Osteotomy

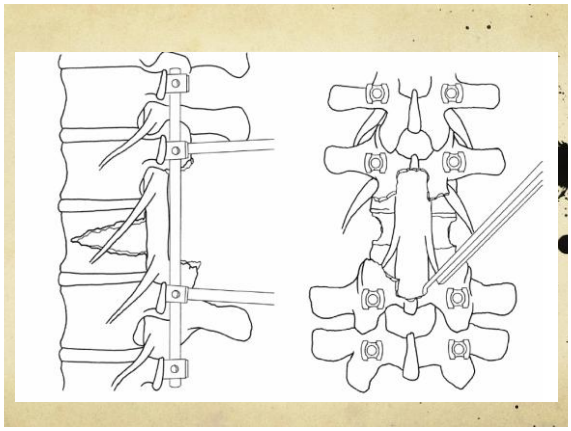
30 – 40 Degrees of Correction

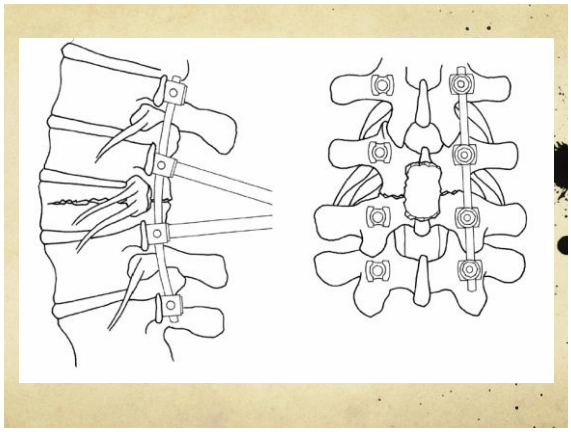


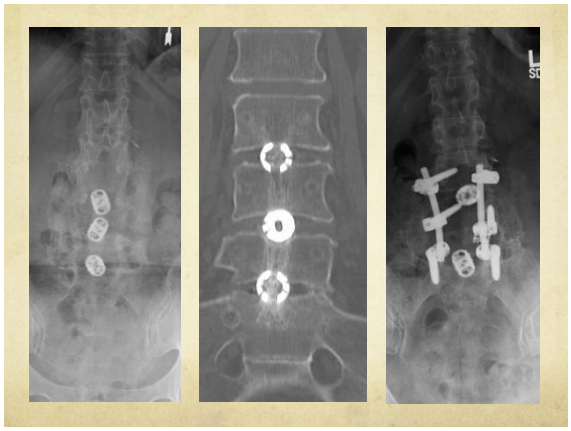


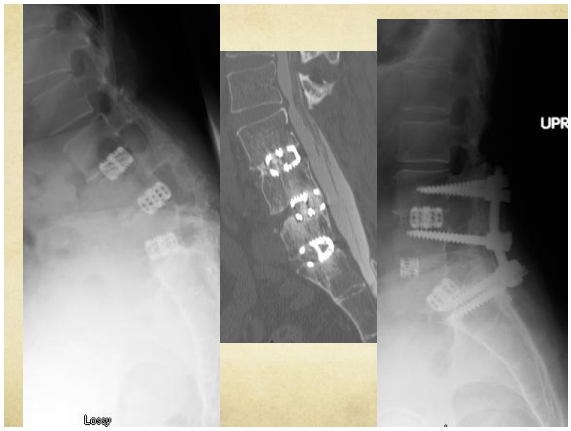












MIS Considerations - Perhaps

- Mini open at level of osteotomy
- Perc. Screws and rod elsewhere
- But – Why
- Revision surgery
- Muscle Sparing?
- Radiation

Vertebral Column Resection, Indications: The Classic

- Fixed spinal deformity in the coronal plane.
  - Spine must be shortened and translated.
- Pain, progression, neuro deficit, functional decline and cosmesis

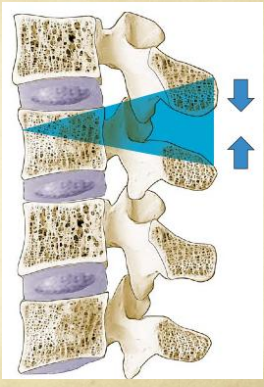
Vertebral Column Resection and Arthrodesis for Complex Spinal Deformities

Oheneba Boachie-Adjei and David S. Bradford

Journal of Spinal Disorders
Vol. 4, No. 2, pp 193–202
© 1991 Raven Press, Ltd., New York

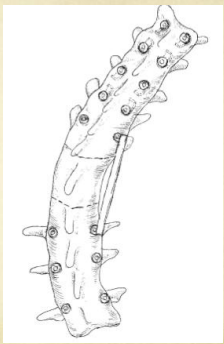
An Evolution

- Expanding utilization of the PSO has led to the next step:
- The Dorsal vertebral column resection (VCR)
- Advantages:
  - Neuro elements more readily identified.
  - Can titrate the resection
- Perhaps increased risk to anterior vasculature



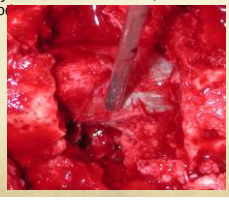
Technique

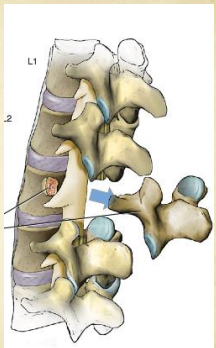
- Mark planned resection with burr
- Plan for resultant angle of correction
- Decompress neural elements longer than planned resection to



Technique

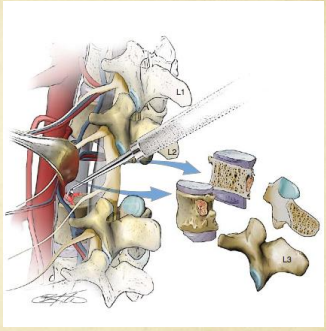
- TEMPORARY ROD FOR STABILIZATION
- Remove lateral fusion mass
- Isolate pedicles and resect to their base
- Identify boarders of resection, discs or mid bo





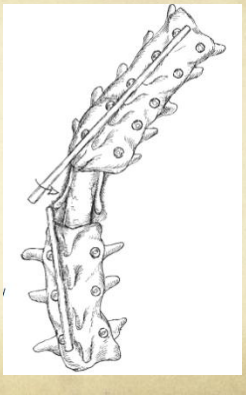
Technique

- Bluntly dissect the lateral cortex. Identify segmental vessels
- Decancellate, Decorticate and resect discs
- Posterior cortex last



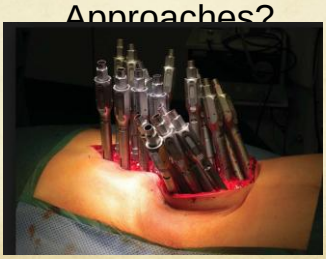
Deformity Correction

- Shorten and Translate
- DO NOT DISTRACT
- Prefer Two rod convex technique
- Can convert to solid rod once cancave side fixed
- GOAL IS TO HAVE ANTERIOR COLUMN ABUT



48 yo female with a solid fusion which is out of balance in both the sagittal and coronal planes

Do Any of these Procedures lend themselves to MIS Approaches?



Essential Problem with MIS in Adult Deformity:

- Advantages are minimized
- Incision
- Muscle sparring

- Disadvantages are Maximized
- Technical Challenges
- Previous Hardware
- Radiation
- Fusion

Perhaps: When spine is solidly fused and out of balance a hybrid approach can be utilized

MIS Deformity Correction

Mark Dekutoski, MD
CORE Institute
Phoenix, AZ

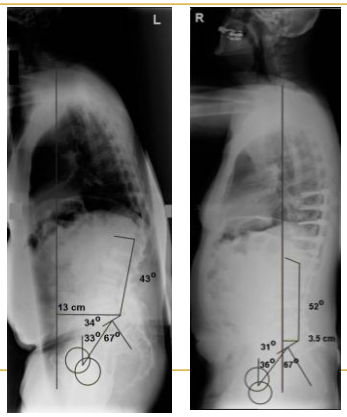
ACCME Conflicts….

To 2012
1) Medtronic Longitude – Perc Trauma developer/ Royalties, Consulting to Mayo Foundation
2) MBD Self Funded CME Travel >25K per year
3) MBD Self funded Research Support >30 k per year
4) Frmr Employer – Research Education Fellowship Royalties – Most Medical Device Companies

Ongoing 2013 to date
CORE Excellence - CoManagement Hospital/Industry/Payor Across Muskuloskeletal Care
Education – Medtronic DePuy
Research – AO Foundation

Off Label Use: Most of Cases!! Physician Directed Care-Informed Patient

- Only On Label use:
  - Interbody Fusion – Lateral Access
    - Above L5
    - One to two levels
    - w/ Post Instrumentation
  - Posterior Instrumentation
    - w/ Fusion



MAS Approaches to Deformity

- Anterior Release and Interbody Fusion
- Posterior Facet Fusions/Pontes
- Posterior Instrumentation/Reduction

MBD Submitted to SRS, Accepted Spine

AIF/LIF cohort

- 33 cases of degenerative scoliosis treated with LIF were reviewed.
- • 23 patients underwent additional ALIF procedures L5 +/- L4

102 lumbar

79 thoracic LIF

26 patients had an additional Ponte osteotomy

All of the patients had posterior fixation with pedicle screws.

.

PreOP to PO Change

	ALIF/LAT	PSF	
Sagital Vertical Aligment	-1.1 ± 3.6	0.3 ± 4.6	0.29
Lumbar Lordosis	5.8º ± 16.1º	-1.6º ± 12º	0.036
Pelvic Tilt	-5.2º ± 12.8º	-0.5º ± 9º	0.06
Sacral Slope	1.6º ± 13º	-1.5º ± 10.8º	0.33

Correction of sagittal plane deformity is the primary goal of surgery for adult degenerative scoliosis.

- Lumbar lordosis and focal lordosis over the levels treated was significantly increased in the AIF/LIF cohort but not in the PSF cohort.
- The change in focal lordosis was achieved significantly more at the LIF levels in comparison to the AIF levels.
- AIF/LIF cohort showed a greater correction of sagittal deformity in comparison to the PSF cohort which showed no significant changes in any sagittal or spinopelvic parameters.

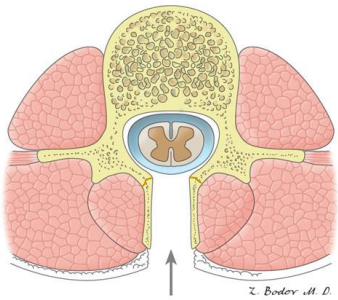
Lumbar Spinous Process Splitting Laminoplasty: A Novel Technique for Minimally Invasive Lumbar Decompression

JSDT Accepted

From the Department of Spine Surgery at the Mayo Clinic Rochester MN 55905

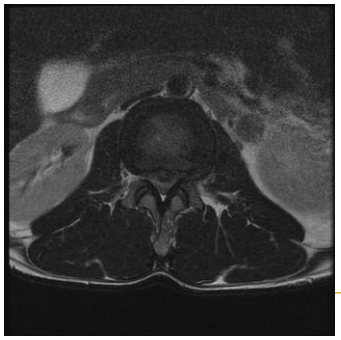
1-Ahmad Nassr, M.D.
2-Charbel D. Moussallem, M.D.
3-Bradford L. Currier, M.D.
4-Michael J. Yaszemski, M.D., Phd
5-Paul M. Huddleston, III, M.D.
6-Peter S. Rose, M.D.
7-Mark B. Dekutoski, M.D.

Illustration of the Technique



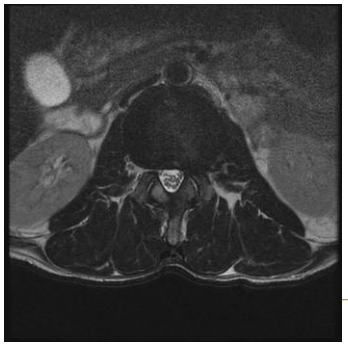
Banczerowski P, Vajda J, Veres R Neurosurgery.2008 May;62(5 Suppl 2):ONS432-40; discussion ONS440-1.

Pre-operative Lumbar MRI



Pre-operative MRI showing L2-L3 stenotic level

Post-Operative Lumbar MRI



Post Operative MRI showing adequate decompression with evidence of bony union and intact L2 spinous process

Conclusion

The Spinous Process Splitting Laminoplasty is a novel technique that allows for a midline exposure and decompression of the lumbar canal while offering the advantages of decreased paraspinal muscle injury and preservation of the multifidus attachment to the bony spinous process for healing

Complication rates with this procedure are infrequent and justify further study into its use. Wile our experience with this novel technique is increasing we never reported epidural hematomas after using drains in all cases

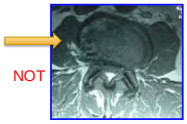
Approach Overview

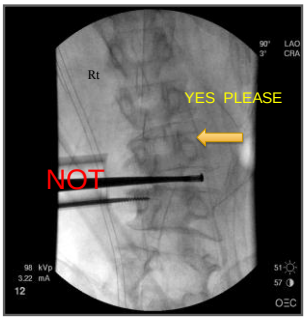
Day One:
MAS L5 (+/-L4)
Structural Graft
LIF/Fusion on Convexity to UEV

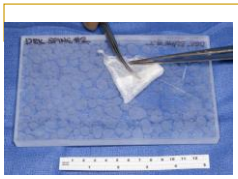
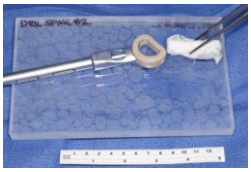
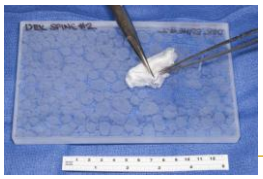
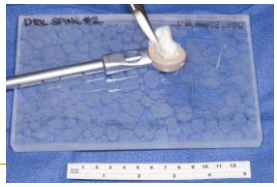
Lateral Interbody Fusion

Trans-Psoas Technique

- Convexity is more Posterior
- Concave – Not!!!
- Plexus is more Anterior
  - C Kim 2009





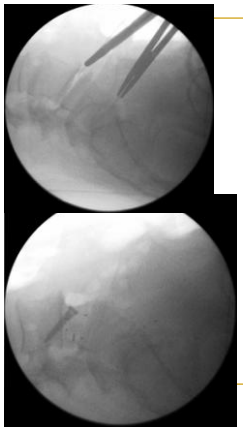
Approach Overview

Staged: Two to Four Days
Post ML Incision
Muscle Dilating
Screws/Rod

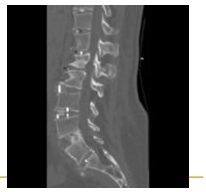
Facetectomy for Release
Facet Fusions if no ant Fusion



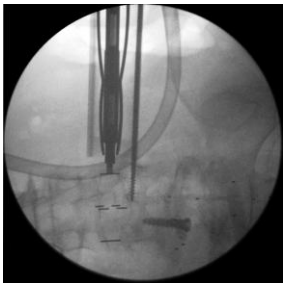
Coronal Shift
Mod. Pelv Incidence
First Seen 2007
Education
Bone Metabolic Eval
Aerobic Fitness



Gain 10mm L5 S1
Foramen
Ten Degrees

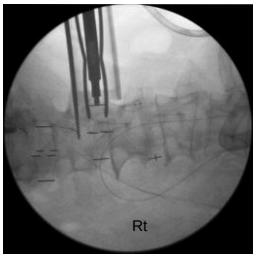


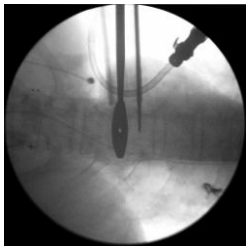
L45 From Right - Convexity



STD Jackson Table …
Rotate Bed to get Horizontal and Vertical Flouro

L2 and Above From Left - Concavity



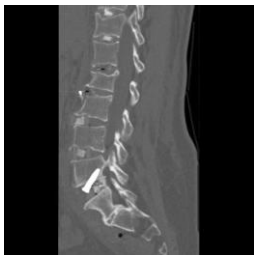


Graft Delivery…Don't leave it in the Iliopsoas!!!!!!

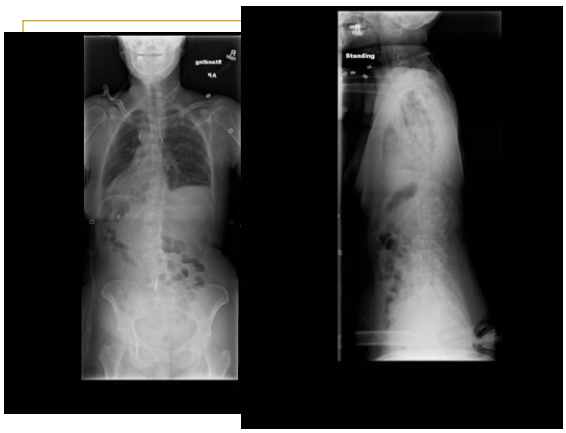
Disc Fusion Technique

- Annular Release – Cobbs/Dilators
- Subtotal Disc Removal
- Punctate Bleeding
- Fastidious End Plate Preservation
  - IMAST, CNS 2010 –Fogelson, etal
  - Settling Resorption with Endplate Violation
- ~~Avoid Disc Shavers!!!!! -~~

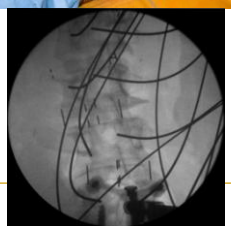
L2 SPACER – REVERSED LORDOSIS

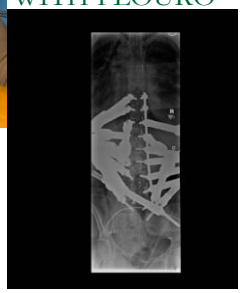


Graft Delivery!!! Avoid Spillage into Psoas

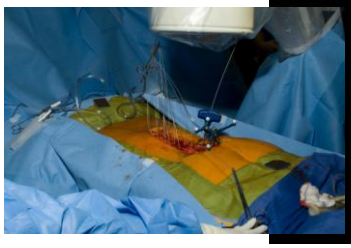


NAVIGATION WITH FLOURO





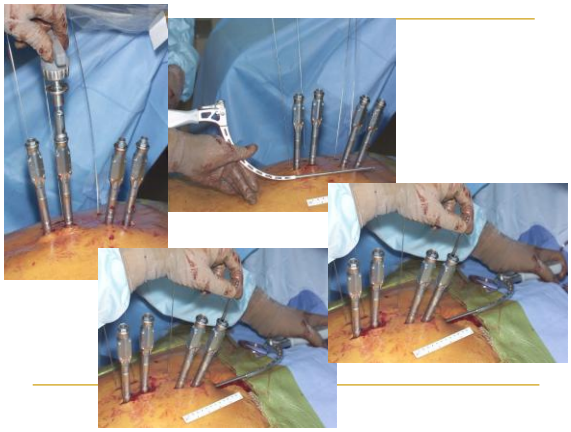
Facetectomies Then Screws, Pass Rods Adjust FS XR



Percutaneous Screws/Rods

- Multiple Levels
- Steerable Rod
- Screw Tower Reductio

- Sequential Reduction
- Translation, Derotation, Compression/Distraction



Iliac Screws

Pass rod Cephalad to Caudad
Out past S1 Screw

Hand Rod Benders to increase lordosis
End Ventral/down bend to reduce rod prominence

Caution for Patient Safety!!

The surgical technique shown is for illustrative purposes only. The technique(s) actually employed in each case will always depend upon the medical judgment and experience of the Surgeon and OR Team exercised before and during surgery as to the best mode of treatment for each patient. See package insert for FDA labeling limitations.

WHAT ARE THE LIMITS OF MIS APPROACHES TO CORRECTION OF DEFORMITY?

Richard G. Fessler, MD, PhD

Raqeeb Haque, Gregory M. Mundis Jr., Yousef Ahmed, Tarek Y. El Ahmadieh, Michael Wang, Praveen Mummaneni, Juan Uribe, David Okonkwo, Robert Eastlack, Neel Anand, Adam Kanter, Frank LaMarca, Behrooz Akbarnia, Paul Park, Virginie Lafage, Jamie Terran, Christopher Shaffrey, Eric Klineberg, Vedat Deviren, **ISSG**

RUSH

ISSG INTERNATIONAL SPINE STUDY GROUP

DISCLOSURE

- Royalty
  - DePuy, Stryker, Medtronic
- Professional Organizations
  - Chairman, Drugs and Devices Committee AANS/CNS
- Editorial Board
  - Neurosurgery, Neurosurgical Reviews, JSDT, Spinal Surgery, Operative Neurosurgery, Internet Journal of Minimally Invasive Spinal Technology, Pan Arab Journal of Neurosurgery, Journal of Craniovertebral Junction and Spine, The Scientific World Journal
- In Queue Innovations
  - Co-founder and CSO

INTRODUCTION

- Open correction of adult deformity remains the gold standard
- However, over the last several years less invasive techniques have developed to accomplish this
  - MIS
  - HYB
- A large body of data has accumulated over the past decade which suggests that less invasive surgery offers multiple potential advantages to open surgery
- Limitations of MIS depend upon what is meant by limitation
  - Radiographic correction
  - Clinical outcome

ADVANTAGES OF MIS

- Less pain and pain meds (Fessler and Khoo, 2002; O'Toole et al., 2006)
- Less blood loss (Khoo et al, 2002)
- Lower infection rates (O'Toole et al., 2009)
- Less ICU (Eichholz et al, 2006)
- Less hospitalization (Khoo et al, 2002)
- Less physiologic stress (Huang et al, 2005)
- Fewer complications (Rosen et al, 2007)
- Higher fusion rates (Christie et al. submitted)
- Less muscle atrophy (Bresnahan et al, in press)
- Equivalent decompression of neural elements (Bresnahan, et al., submitted)
- Preservation of normal motion (Bresnahan et al, 2009)
- Preservation of normal biomechanics (Smith et al., submitted)

RECENT DIRECT COMPARISON

- Compare the radiographic and clinical outcomes between three surgical techniques for adult spinal deformity
  - OPEN (OPEN)
  - Minimally Invasive (MIN)
  - Hybrid OPEN/MIS (HYB)

METHODS

- **Retrospective review of prospectively collected databases**
- **Inclusion criteria:**
  - **Age ≥ 45yrs**
  - **Lumbar Cobb ≥ 20 degrees**
  - **Minimum 1 year f/u**

METHODS

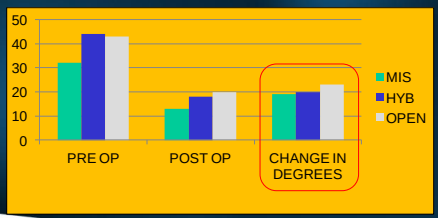
- OPEN
  - Open correction of scoliosis using posterior technique for osteotomy and instrumentation
- MIS
  - Combination of LLIF/TLIF/facet fusion with percutaneous posterior instrumentation
- HYB
  - Combination LLIF/TLIF with OPEN posterior instrumentation

METHODS

- **Radiographic parameters**
  - **Major coronal Cobb angle**
  - **Sagittal vertical axis (SVA)**
  - **Lumbar lordosis (LL)**
  - **Pelvic incidence (PI)**
  - **Pelvic tilt (PT)**
- **Clinical parameters**
  - **Oswestry (ODI)**
  - **Visual Analog Scale (VAS)**

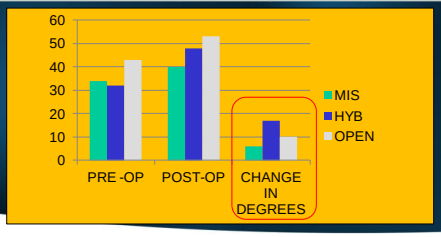
RESULTS

		MIS	HYB	OPEN
COBB ANGLE	PRE-OP	32.1*	44.3	43.2
	POST-OP	13.1*	17.7	20.4
	Δ	18.8	26.6*	22.8



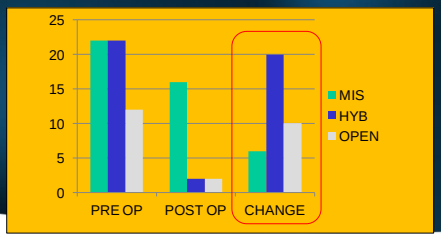
RESULTS

		MIS	HYB	OPEN
	PRE-OP	33.8	31.9	42.7
LORDOSIS	POST-OP	39.4	48.5	53.2
	Δ	5.8	17.4*	10.5



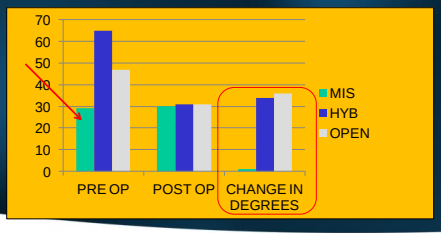
RESULTS

		MIS	HYB	OPEN
	PRE-OP	21.6	22.0	12.3
PI-LL	POST-OP	16.1	2.1	2.0
	Δ	5.5	20.6*	10.2



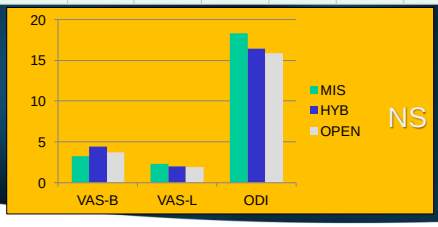
RESULTS

		MIS	HYB	OPEN
	PRE-OP	29	65	47
SVA	POST-OP	30	31	31
	Δ	1*	34	36

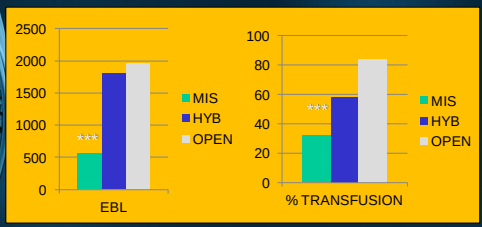


RESULTS

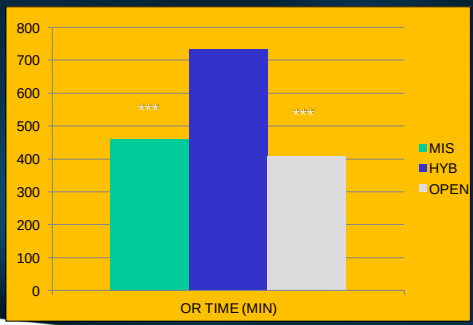
		MIS		HYB		OPEN	
		MEAN	SD	MEAN	SD	MEAN	SD
Δ	VAS-B	-3.2	2.1	-4.4	3.3	-3.7	3.0
PRE to	VAS-L	-2.3	3.8	-2.0	3.9	-1.9	3.8
POST	ODI	-18.3	17.0	-16.4	13.9	-15.9	17.4



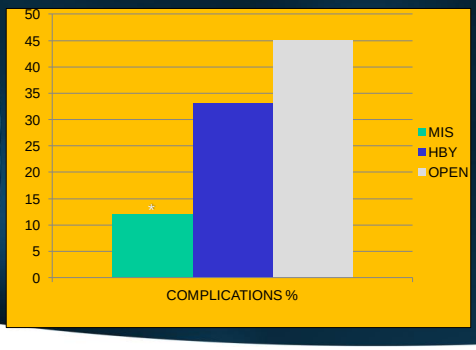
EBL AND TRANSFUSION

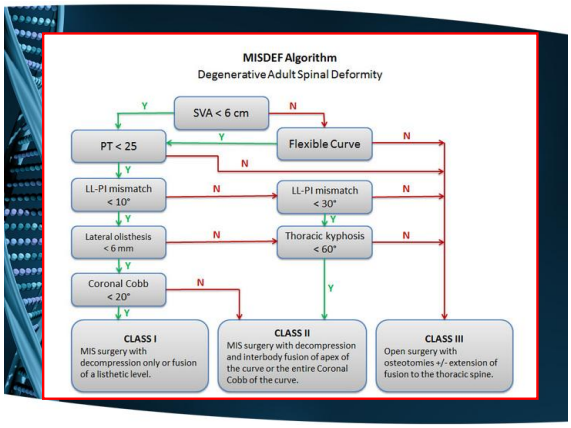


OR TIME



COMPLICATIONS





SUMMARY AND CURRENT LIMITATIONS

- RADIOGRAPHIC CORRECTION
  - MIS, HYB, AND OPEN CORRECTION OF CORONAL DEFORMITY WERE ROUGHLY EQUAL
    - There appears to be minimal limitation of MIS here
  - HYBRID AND OPEN CORRECTION OF SAGITTAL DEFORMITY WERE SUPERIOR TO MIS
    - MIS appears to be limited to
      - sagittal correction of less than 10 cm sagittal imbalance
      - LL - PI < 30°

SUMMARY AND CURRENT LIMITATIONS

- CLINICAL OUTCOME
  - PAIN AND FUNCTIONAL SCORES WERE EQUAL BETWEEN THE GROUPS
    - There appears to be no limitation here
  - MIS SURGERY HAD LESS EBL, TRANSFUSIONS, AND COMPLICATIONS
    - There appears to be significant benefit to MIS here

CONCLUSION

- MIS techniques appear to be a viable option for correction for selected cases of adult spinal deformity
- Limitations will also result from experience of physician in MIS techniques
- Current limitations may be solved as the technology for MIS deformity advances

THANK YOU