Degenerative Scoliosis: Epidemiology, Pathophysiology, Clinical and Radiologic Evaluation

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Disclosures

• Dupuy-Synthes Spine: Consultant, royalties
• Received research grants from Stryker Spine
• AO Spine North America Board – honorarium

Outline

• Case
• Types of adult scoliosis
• Natural history of degen scoliosis
• Clinical and Radiographic Evaluation
• Case resolution
66 year old female with LBP and leg pain

MRI

Adult Scoliosis

- Adult Idiopathic Scoliosis
  - Adolescent Idiopathic Scoliosis (AIS)
- Adult Degenerative “De novo” Scoliosis
  - Generated in adulthood
- Both conditions present as adults with:
  - LBP
  - Stenosis and leg pain
  - Cosmesis concerns, spinal decompensation
**Adult Degenerative Scoliosis (de novo)**

- Age 40 to 60 +
- Results from asymmetric disc degeneration
- Lumbar spine
- Degenerative changes within the deformity:
  - Stenosis
  - Spondylolisthesis
  - Rotatory subluxation
  - Loss of lumbar lordosis
  - Osteoporosis

**Adult Degenerative Scoliosis**

- **Etiology**
  - Asymmetric Disc degeneration
  - Facet arthrosis, capsule laxity
  - Vertebral body wedging

Cascade of Rotational Instability

**Degenerative Scoliosis**

- Thoracic kyphosis with aging
- Disc degeneration lumbar spine
- Loss of lordosis/rotation
- Coronal and Sagittal imbalance
Natural History

- Prevalence 6%-68%, 30% range
- Increases with age
- Asymmetric disc degeneration
- Most curves less than 20°
- Progress slowly
- Risks for progression: > 30° rotation, lateral translation
- Incidence of LBP no different than controls

Kobayashi et al Spine 2006
Perennou Spine 1994
Pritchett Spine 1993
DLS Development Risk Factors

TABLE 4: Result of a Cox Proportional Hazards Analysis of Radiographical Predictors for the Development of De novo Degenerative Lumbar Scoliosis

<table>
<thead>
<tr>
<th>Baseline Parameters</th>
<th>RR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>L4 size</td>
<td>1.174</td>
<td>1.025-1.346</td>
<td>0.0205</td>
</tr>
<tr>
<td>Lateral disc wedge</td>
<td>4.006</td>
<td>1.332-14.172</td>
<td>0.0313</td>
</tr>
<tr>
<td>Lateral osteophyte difference</td>
<td>22.680</td>
<td>2.819-182.461</td>
<td>0.0031</td>
</tr>
</tbody>
</table>

RR indicates relative odds; CI, confidence interval. L4 size, L4 vertebral size divided by body height (cm) and multiplied by 100. Lateral osteophyte difference is the subtraction of the length of lateral osteophytes on the affected side minus the length of osteophytes on the side contralateral to the affected side. P < 0.05 was considered significant.

Figure 1. Lateral disc wedge is the ratio of disc height on one side divided by disc height on the other side. Lateral osteophyte difference is the subtraction of the length of lateral osteophytes on the affected side minus the length of osteophytes on the side contralateral to the affected side. P < 0.05 was considered significant.

Risks for Progression

TABLE 2: Result of a Cox Proportional Hazards Analysis of Radiographical Predictors for the Progression of Pre-existing Degenerative Lumbar Scoliosis

<table>
<thead>
<tr>
<th>Baseline Parameters</th>
<th>RR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.014</td>
<td>0.003-0.594</td>
<td>0.0264</td>
</tr>
<tr>
<td>L4 size</td>
<td>0.935</td>
<td>0.917-0.955</td>
<td>0.0074</td>
</tr>
<tr>
<td>LL</td>
<td>1.387</td>
<td>1.370-1.404</td>
<td>0.0036</td>
</tr>
<tr>
<td>Sagittal angle</td>
<td>2.913</td>
<td>1.328-6.295</td>
<td>0.0076</td>
</tr>
<tr>
<td>L4 SR</td>
<td>3.577</td>
<td>1.395-9.562</td>
<td>0.0042</td>
</tr>
</tbody>
</table>

RR indicates relative odds; CI, confidence interval. L4 size, L4 vertebral size divided by body height (cm) and multiplied by 100. LL, lumbar lordosis. P < 0.05 was considered significant.
Clinical Evaluation

- Adult Degenerative Scoliosis
  - PAIN
  - LBP
  - Stenosis, radicular symptoms
- Patients with degenerative spinal disorders who happen to have Scoliosis
- Initial evaluation and non-operative treatment similar to other degenerative processes, find the pain generator

Need full length 36” films to properly evaluate deformity
Clinical Evaluation

• **Surgical Indications**
  – Progressive neurologic symptoms, rare
  – Failure of non-op treatment
    • LBP
    • Radicular pain
• **Selection of operative vs non-operative treatment of adult scoliosis (surgeons decision-making)**
  – Larger curves
  – More frequent leg and LBP
  – More episodes of severe LBP in last 6 months

Glassman et al Spine 2007

Non-operative

• Shots
• PT
• Meds

Non-operative Treatment

• The costs and benefits of nonoperative management for adult scoliosis
  • Mean treatment cost over the 2-year period was $10,815.
  • No improvement in HRQoL scores

Glassman Spine 2009
Non-operative Treatment

• No improvement in HRQoL outcome scores.  
  Bridwell Spine 2009

• Conservative care in general may be a helpful option in the care of adult deformity, but evidence for this is lacking. Unfortunately, no treatment option within conservative care has support within the literature as a preferred solution.
  Everett Spine 2007

Recent Literature

• Operative versus nonoperative treatment of leg pain in adults with scoliosis: a retrospective review of a prospective multicenter database with two-year follow-up  
  Smith et al. Spine 2009

  • non-operative patients had no significant change in ODI or leg pain (P = 0.2)
  • surgically treated patients had significant improvement in mean score for leg pain (5.4 vs. 2.2, P < 0.001) and ODI (41 vs. 24, P < 0.001).

Recent Literature

• Improvement of back pain with operative and nonoperative treatment in adults with scoliosis  
  Smith et al. Neurosurgery 2009

  • Compared with nonoperatively treated patients
  • Operatively treated patients
    - had a lower Pain score for back pain (P < 0.001)
    - Improved ODI (P = 0.001), and SRS-22 (P < 0.001).
Adult Scoliosis Surgery in Older Patients

- Adult scoliosis in patients over sixty-five years of age: outcomes of operative versus nonoperative treatment at a minimum two-year follow-up. Li et al, Wood KB, Spine 2009
- Less pain, better HRQoL outcomes than patients treated conservatively.

Deformity surgery in patients over age 60
- Major complication rate 20%.
- Patients older than 69 years had more complications.
- Comorbidities had no correlation with complication rates.
- Patients had significant improvement in ODI. Daubs, Lenke Spine 2007

Adult Scoliosis Surgery in Older Patients

- Older patients (65-85 years)
  - had greater disability preop than younger patients.
  - greater improvement than younger patients.
- despite facing the greatest risk of complications, may stand to gain a disproportionately greater improvement in disability and pain with surgery.
66 year old female with LBP and leg pain

Surgical Considerations

- Spinal Stenosis
- Scoliosis (42° lumbar)
- Coronal balance (4cm imbalance)
- Sagittal balance (5cm global imbalance with focal T/L kyphosis)
- Pelvic Incidence 52°
Surgical Considerations

- Decompression
- Instrumentation levels
- Osteotomies?
  - Pedicle subtraction
  - Ponte/Smith Petersen
  - ALIF
- What are our treatment goals?

Goals of Adult Deformity Surgery

- Treat underlying degenerative condition
  - Stenosis
- Halt Progression of Deformity
- Maintain balance in the sagittal and coronal plane
- “Keep the head over the pelvis in both planes”
- Allow for efficient, less painful upright posture and ambulation
- Improve Functional Outcomes (HRQL)

Normal Sagittal Alignment

- Thoracic Kyphosis
  - T1-T12: 40°
- Lumbar Lordosis
  - L1-S1: 60°
- Thoracolumbar Junction
  - T10-L2: 0 - 2°
- 2/3 of Lordosis at L4 to S1

Lumbar Lordosis 20° > then Thoracic Kyphosis

Bernhardt and Bedwell Spine 1989
Sagittal Balance
(>5cm = imbalance)

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

Sagittal Balance and Symptoms
• 752 pts
• 352 with positive sagittal imbalance
• Kyphosis poorly tolerated in lumbar region
• Health status deteriorated with progressive increase in + sag balance over 5cm
  Glassman, Bridwell et al Spine 2005
Coronal Balance

Coronal Balance
(>4 cm = imbalanced)

Coronal Balance

• Correlation of Radiographic Parameters and Clinical Symptoms in Adult Scoliosis
  Glassman Spine 2005

• 298 pts 172 without 126 with prior sx
• 12 pts with > 4cm coronal imbalance
• Worse on pain and function SRS 22, ODI compared to those with coronal balance
• No difference in patients with prior surgery
85 patients with >4cm coronal imbalance
 23 pts with coronal imbalance alone
 62 pts with coronal and sagittal imbalance

**Results**
Outcome scores improved (ODI,SRS scores) in both groups with improvement in coronal balance
Sagittal balance still most predictive for improvement
MRI

Intraop films

Multiple SPO's, PSF T10 – Pelvis, TLIF L5-S1
Adult De Novo Scoliosis

- Incidence increasing
- Need full length films to evaluate
- Asymmetric disc degeneration key in development
- L4 tilt, L3 translation key in progression
- Evaluate and treat underlying pathology
- Maintain spinal Balance

Thank You
Meta-analysis of Adult Degenerative Scoliosis Surgical Treatment Outcomes

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Introduction

There is increasing awareness of adult degenerative or “de novo” scoliosis

Surgical treatment when indicated can be challenging and resource intense

Surgical randomized controlled trials are rare, and observational studies pose limitations due to heterogeneity of surgical practices, techniques, and patient populations.

Pooled analysis of the current literature may identify effective treatment strategies and guide future efforts at prospective clinical research.
Objective

The purpose of this meta-analysis was to synthesize existing data on the surgical outcomes for adult degenerative scoliosis.

Methods

Inclusion criteria
1) The article must include surgically treated adult patients (>18yrs) with "degenerative" or "de novo" scoliosis.
2) The article must include outcome data (post-operative vs. pre-operative).
3) Minimum follow-up is one-year.
4) English language version available.

Pooling of Data & Meta-analysis

• Data from individual studies were converted into mean changes after intervention if not reported directly.
• Pooled by outcome measures (Cobb, ODI, VAS, Coronal & Sagittal balance).
• Studies with incomplete data were excluded.
• Meta-analyses were conducted using the DerSimonian and Laird random effects model (DerSimonian and Laird, 1986).
• Heterogeneity was estimated with I$^2$ (Higgins, 2003).
• Random-effects meta-regression models were used to regress treatment effects against baseline values.

Flow diagram

Records identified through database searching:
PubMed = 250
Ovid Medline = 168
Cochrane Library = 15
Web of Science = 340
(n = 773)

Records after duplicates removed: 482
Records screened: 227
Records excluded: 205
Full-text articles assessed for eligibility: 72
54 articles reviewed in detail by collaborators
Additional full-text articles from relevant reviews assessed for eligibility:
Yadla et al = 63
Prommahachai et al = 31

Studies included in synthesis (meta-analysis) = 24
Cobb Angle correction

- 18 studies = 25 treatment effect estimates
- 9 estimates were excluded – incomplete data
- 16 treatment effects (12 unique studies, n=418 patients)
- Weighted mean difference -11.1 (95% CE: -13.9, -8.4)
- Substantial heterogeneity exists between studies ($I^2=94.4\%$).
- Meta-regression shows that the pre-up angle is statistically significantly associated with treatment effect (slope=0.6, $p=0.002$). Thus, the groups with the larger baseline (Cobb angle) means reported larger treatment effects.

Coronal balance

- 5 studies reported coronal balance = 8 estimates n=197 patients.
- The pooled mean change was 7.7 (4.9, 10.5) mm. Study estimates were heterogeneous ($I^2=79.0\%$).
- Significant association between coronal balance at baseline and the change after intervention (slope=0.3, $p=0.002$)

Sagittal Balance

- 4 studies reported change in sagittal balance = 6 treatment n = 176 patients.
- Estimates were heterogeneous ($I^2=89.2\%$).
- Study estimates range from -30 to -36 mm.
- The overall estimate of the change in sagittal balance was 4.6 (-11.4, 20.5) mm.
- There was no significant association between baseline sagittal balance and mean change after intervention.

Note: verification needed on method of measuring sagittal balance using C7 plumb line.
• 4 studies reported pain before and after intervention using the Visual Analog Scale (VAS) scale, N = 147
• All studies reported an improvement in pain, range -0.7 to -6.1 units.
• Pooled mean change = 3.2 (-4.5, -0.7) units.
• The baseline value was strongly associated with the change in pain level (p<0.0001), with those studies with the worst baseline values showing the greatest benefit of treatment.

NOTE: Weights are from random effects analysis

<table>
<thead>
<tr>
<th>Study</th>
<th>Mean change in VAS (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tsai 2011</td>
<td>-3.24 (-4.50, -1.98)</td>
</tr>
<tr>
<td>Scheufler 2010</td>
<td>-4.60 (-5.33, -3.87)</td>
</tr>
<tr>
<td>Keorochana 2010</td>
<td>-4.70 (-5.06, -4.34)</td>
</tr>
<tr>
<td>Ploumis 2010a</td>
<td>-6.04 (-7.10, -5.02)</td>
</tr>
<tr>
<td>Ploumis 2010b</td>
<td>-0.60 (-0.73, -0.47)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>Mean change in ODI (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheufler 2010</td>
<td>-33.30 (-36.85, -29.75)</td>
</tr>
<tr>
<td>Wu 2008</td>
<td>-32.20 (-40.75, -23.65)</td>
</tr>
<tr>
<td>Glassman 2009</td>
<td>-24.30 (-29.02, -19.58)</td>
</tr>
<tr>
<td>Li 2009</td>
<td>-27.40 (-35.30, -19.50)</td>
</tr>
<tr>
<td>Cho 2007</td>
<td>-46.00 (-50.39, -41.61)</td>
</tr>
</tbody>
</table>

NOTE: Weights are from random effects analysis

• The Oswestry Disability Index (ODI) was reported in 9 studies, 11 estimates
• One study (Glassman, 2009) did not report the baseline value of ODI and was excluded
• Strong heterogeneity was observed between studies (I²=96.0%), however all studies showed a decrease in ODI after intervention, range from -16 to -46.
• The pooled mean change in ODI was -27 (-34, -20). Association between baseline and mean change (p=0.056) was not statistically significant.

Conclusion

• Literature review yielded 24 studies reporting pre and postoperative data of the surgical treatment of adult degenerative scoliosis.
• There were no RCTs
• Despite significant heterogeneity, meta-analysis showed significant improvement in Cobb angle, coronal balance, and VAS after surgical treatment of adult degenerative scoliosis.
• Standardized outcome measures needed for prospective study.
Thank you
Department of Orthopaedic Surgery

Presents Degenerative Scoliosis
When and Where to Operate
Monday, March 11, 2013

Harry N. Herkowitz, MD
Chairman, Department of Orthopaedic Surgery
Beaumont Health System, Royal Oak, Michigan
Professor and Chairman, Department of Orthopaedic Surgery
Oakland University William Beaumont School of Medicine
Rochester, Michigan

DEGENERATIVE LUMBAR SCOLIOSIS

- Lateral Curvature of the Spine Developing in a Straight Spine Due to Degenerative Arthritis
- Develops After Skeletal Maturity
- Apex L2-L4
- Curve Greater Than 10°

ADULT SCOLIOSIS PREVALENCE

- Adult scoliosis in general population
  - Prevalence 2% - 32%
- Adult scoliosis in elderly
  - 40% - 68%
CLINICAL SYMPTOMS

- Low back pain
- Neurogenic claudication
  - Spinal Stenosis
- Radiculopathy
  - HNP
  - Spinal Stenosis
    - Central
    - Foramen
- Pedicle Kinking
- Lateral Listhesis

IDIOPATHIC SCOLIOSIS

Table 4. Probability of Progression Based on Curve Magnitude and Age

<table>
<thead>
<tr>
<th>Curve Magnitude at Detection</th>
<th>Age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10–12 (%)</td>
</tr>
<tr>
<td>&lt; 10°</td>
<td>25</td>
</tr>
<tr>
<td>10–20°</td>
<td>50</td>
</tr>
<tr>
<td>20–30°</td>
<td>90</td>
</tr>
<tr>
<td>&gt;30°</td>
<td>100</td>
</tr>
</tbody>
</table>


DEGENERATIVE LUMBAR SCOLIOSIS

Curve Progression

- Higher in curves over 30°
- Average 3° per year
- Smaller curves progress less
- Progression unpredictable

TREATMENT GOALS

- Decreased pain back and/or leg
- Improve neuro deficit
- Balanced spine
- Improved quality of life

SPINAL BALANCE

- Sagittal Imbalance More Common Than Coronal Imbalance
- Measure from Plumb Line Center of C7 Body to Center of S1: Sagittal Balance
- Measure from Plumb Line Center of C7 to Pelvis on AP Film: Coronal Balance

SAGITTAL BALANCE

- Correlation with symptoms
- 73 adults with adult scoliosis
- Measured coronal and sagittal balance
- Sagittal Imbalance > 6cm correlated with an increased ODI
- Coronal Imbalance did not correlate
- Conclusion: adult scoliosis over age 50 with sagittal imbalance led to high ODI

Pelvic Incidence

Formula for predicting correction needed with PSD

\[ \text{PI} + \text{LL} + \text{TK} = 45 \]

Increased Pelvic Incidence = Increase incidence of spondylolysis / spondylolisthesis

Weight Loss

NSAID

Physiotherapy

Bracing?

Aerobic Fitness

Epidural Injection

Address Osteopenia

204 Patients

HRQOL measures
  - ODI
  - SRS-22
  - SF 12

No significant change in HRQOL measures at 2 years

Glassman S, et al.
SPINE 2010
OSTEOPENIA

Definition: Age related loss of bone mineral density (BMD)
Prevalence: overall 43%

Effect on Spine:
- Increased risk of fracture
- Weakens fixation of spinal implant

Diagnosis
- T-score: the number of standard deviations below the mean BMD for young white adult women
- Z-score: Number of S.D. below age matched controls

Surgical Strategies
- Larger Screws
- Bone Cement
- Go through anterior cortex
- Pack bone in screw hole
- Expandable screws

OSTEOPOROSIS / OSTEOPENIA

Adult Scoliosis
- 176 Females treated surgically
- T-Scores and Z-Scores
- BMI, surgical outcome, fusion and curve magnitude

Yagi, M and Boachie-Adjei, O
SPINE 2011
OSTEOPOROSIS / OSTEOPENIA

Adult Scoliosis

• BMD similar in scoliosis patients and general population
• Bone fusion not influenced by osteopenia
• No correlation between BMD and curve magnitude, fusion, and complications

Yagi, M and Boachie-Adjei, O
SPINE 2011

GOALS OF SURGERY

• Reduce pain
• Alleviate Neural Compression
• Restore Balance
• Improve Quality of Life

INDICATIONS FOR SURGERY

• Disabling back pain
• Progressive deformity
• Sagittal or coronal / imbalance
• Static or progressive weakness
• Radiculopathy or neurogenic claudication
DECISION TO OPERATE
AFFECTED BY:

- Advanced age
- Variable life expectancy
- Osteopenia
- Medical comorbidities
- High complication rate
- Loss of functionality

RISK-BENEFIT ASSESSMENT OF SURGERY: ADULT SCOLIOSIS

- Older patients – baseline
  - Greater disability
  - More severe back and leg pain
  - Worse health status

Smith J, et al.
SPINE 2011

RISK-BENEFIT ASSESSMENT OF SURGERY: ADULT SCOLIOSIS

- Older patients: 2 year follow-up

Outcome measures for disability, health status and back/leg pain similar to younger age group

Smith J, et al.
SPINE 2011
SURGICAL TREATMENT: COMPLICATIONS OLD VERSUS YOUNG

- Minor complications: 4x
- Major complications: 5x

DECISION TO PURSUE SURGERY IN ELDERLY WITH SCOLIOSIS

- 139 patients
- Age greater than 60 years
- Surgical versus nonsurgical Rx
- Assessed with ODI, SF12, SRS-30


PATIENTS OPTING FOR SURGERY

- Patients electing for surgery have poorer quality of life
- ODI – severe disability
- X-ray not critical
- Health status and disability are critical

**ADULT SCOLIOSIS**

**Leg Pain**
- Nonoperative versus operative treatment
- Significant improvement in ODI and NRS score in operative group
- Laminectomy improved leg pain scores


**DEGENERATIVE SCOLIOSIS WITH STENOSIS**

**INDICATIONS FOR FUSION**
- Progressive Deformity
- Sagittal or Coronal Imbalance
- Degenerative or Lateral Listhesis
- Flexible Curve
- Intractable Back Pain

**FUSION PRINCIPLES**
- Decompress all levels of stenosis
- Restore balance
- Fuse from neutral vertebrae to neutral vertebrae
- Do not stop at thoracic apex
- Screws at each level
PRE-OP PLANNING
IMAGING

- CT Scan
  - Surgical Planning
    - Pedicle size and position
    - Deformity assessment

- MRI
  - Assess neural compromise
  - Assess intradural pathology

SURGICAL OPTIONS
DEGENERATIVE LUMBAR SCOLIOSIS
WITH SPINAL STENOSIS

- Decompression only
- Decompression with limited fusion
- Decompression with fusion entire curve
- Anterior fusion
- Anterior and posterior fusion
- Osteotomy
- MIS
DEGENERATIVE LUMBAR SCOLIOSIS
Posterior Procedures

DECOMPRESSION
LIMITED FUSION WITH ASD
DECOMPRESSION WITH FULL FUSION

DEGENERATIVE SCOLIOSIS WITH STENOSIS

• (21) Group I – Decompression Alone
• (43) Group II – Decompression with 1-2 Levels Fused
• (20) Group III – Decompression with Full Curve Fusion

Transfeldt, E. et al.
SPINE, 2010

Group I
• Complications 10%
• Revision Surgeries 10%
• Patient Satisfaction 64%

Group II
• Complications 40%
• Revision Surgeries 33%
• Patient Satisfaction 73%

Group III
• Complications 56%
• Revision Surgeries 37%
• Patient Satisfaction 75%
DECOMPRESSIVE LAMINECTOMY WITHOUT FUSION
• Stiff Lumbar Spine
• Static Curve
• No Significant Axial Symptoms
• No Imbalance

DECOMPRESSIVE LAMINECTOMY WITH INSTRUMENTED FUSION LIMITED
• No Imbalance
• 1-2 Levels of Stenosis
• Degenerative or Lateral Listhesis

DECOMPRESSIVE LUMBAR LAMINECTOMY WITH FULL CURVE FUSION
• Progressive Curve
• Flexible Curve
• Spinal Imbalance
• Significant Stenosis at Curve Apex
• Prior Decompressive Surgery
• Adjacent Level(s) Involvement (prior fusion)
WHEN TO Fuse TO Sacrum

- L5-S1 spondylolisthesis
- Previous L5-S1 laminectomy
- L5-S1 stenosis
- Oblique take off L5-S1
- Severe L5-S1 DDD

WHEN TO USE LLIAC Screws

- Long fusions for balance
- Revisions for loosening
- High grade spondylolisthesis
- Sub optimal bone quality

ANTERIOR Fusion

- Poor bone quality
- High risk of pseudarthrosis
- Fixed deformity
WHEN TO DO OSTEOTOMY

- Fixed Sagittal or Coronal Imbalance
- Revision Fusion with Imbalance
- PSO vs. Smith Peterson
  - PSO for Larger Correction

CASE: Pedicle Subtraction Osteotomy for Fixed Sagittal Plane Deformity

SUMMARY

- Surgery for Degenerative Lumbar Scoliosis With and Without Stenosis is Increasing
- Population is Aging and Staying Much More Active
- Surgical Indications are usually tied to Quality of Life Issues
- The Risk/Benefit Ratio Must Be Well Understood
- Outcomes are Favorable in 70% of Cases
- Complications are Significant
THANK YOU

Royal Oak, Michigan

Department of Orthopaedic Surgery
Minimally Invasive Surgery in the Treatment of Degenerative Lumbar Scoliosis:

Frank M. Phillips, MD
Professor, Orthopaedic Surgery
Rush University Medical Center
Chicago, IL USA

DISCLOSURES

• Royalties: Nuvasive, DePuy
• BODs: Baxano, Theracell

Degenerative Scoliosis in the elderly: What are we treating?

• Stenotic symptoms in 95%; low back pain in 50% of patients
• Mean curve 28° (9/segment)
• Lateral listhesis in 85% (L3-4 most common)
• Flat back in 48%
• Myelographic defects within curve (concavity & convexity) and outside curve (L5-S1)

Grubb Spine 1992
Degenerative Scoliosis: Who are we treating?

- Elderly
- Co-morbidities
- Poor nutritional status  
  - poor healing
  - prominent subcutaneous hardware
- Osteoporotic bone  
  - poor fixation

Surgery can make patients worse.

Surgical reconstruction: Degenerative Scoliosis:

Literature Complications

MEDICAL AND SURGICAL COMPLICATION RATES 40 to 60%

Degenerative Scoliosis: Treatment Goals

Treat stenotic symptoms without creating or allowing progressive deformity
- Patients seldom present because of deformity!

Avoid larger than necessary surgery in elderly, frail patients

Maintain/restore spinal balance.
Do not treat x-rays
**XLIF for scoliosis: Why is it appealing**

- If reduces posterior assault - will reduce morbidity
- Potential for higher fusion rates with acceptable morbidity

**Requirements:**
- Restore spinal balance
- Achieve fusion
- Eliminate need for direct decompression

- Stand-alone XLIF
- Supplemental percutaneous posterior fixation

**XLIF Degenerative Scoliosis**

*Phillips, Pimenta IMAST 2005*

- Prospective case series of 39 patients with degenerative scoliosis with neurogenic claudication and back pain
- XLIF was performed at 1 to 4 lumbar levels (mean 2 levels) + posterior instrumentation
- Mean operative time was 125 minutes; <50cc EBL
- Mean LOS was 1.4 days

**XLIF for degenerative scoliosis**

- Patient lateral decubitus (concavity up)
- Table break to assist in scoliosis correction
- LIF with complete disc space mobilization from concavity
- Indirect decompression
  - Mundis, Akbari, Phillips Spine 2010
LIF for Scoliosis

- SOLAS Degenerative Study Group
- Multi-center, prospective observational study
- 107 pts
- Avg age ~ 68.4 yo
- Degenerative scoliosis
- 82.7% back + leg pain

XLIF Scoliosis: Morbidity Data

Average OR time:
- 177.9 min per case
- 57.9 min per level

Average blood loss:
- 50-100cc (Mode)

Average hospitalization (3.8 days):
- Unstaged: 2.9 days
  Range: 1-16; Median: 2
- Staged: 8.1 days
  Range: 3-16; Median: 8
- Time to ambulation: 1.2 days

5 (4.7%) received a transfusion
3 (2.8%) required an ICU stay
1 (0.9%) required rehabilitation services

LIF for Scoliosis: Results

Significant improvement (p<0.01) for all clinical outcomes from preoperative to 24 months.

24 MONTH PATIENT SATISFACTION
- 85% of patients were satisfied with their procedure
- 85% of patients would repeat their procedure
XLIF: Supplemental pedicle screws?

68 yo male with LBP and claudication
L2-5 minimally invasive XLIF, percutaneous screws placed lateral decubitus
3.5 hrs; EBL + 50cc, DC home Day 2

8 weeks

XLIF Results: Cobb Correction

Total Population
- Pre-op coronal Cobb: 26.1±11.6° (range: 10° - 65°)
- Post-op coronal Cobb: 16.5±10.4°
- Average correction: 8.2°

Supplemental Fixation-Dependent Correction of Cobb after XLIF
- Greatest correction magnitude achieved in patients with bilateral posterior pedicle fixation (12.7° v. 41.5%)
- Least correction magnitude seen in patients without supplemental fixation (2.6°, 9.8%)
- Greater correction observed in open vs. percutaneous bilateral pedicle screws (25.7% vs. 50.1% correction, p=0.020).

XLIF Results: Lordosis

- 45.2% of patients were hypolordotic at baseline (L1-S1 lordosis < -40°) with an average lordosis of -27.1° corrected to -38.2°
- Correction of lordosis was not significantly different between fixation groups (p=0.298) - a function of XLIF!
- The incidence of anterior construct subsidence was significantly affected by supplemental fixation ($\chi^2$, p=0.008) - 50% in "stand-alone"
Weakness

36 patients (33.6%) reported weakness after surgery
- transient in 86%

Weakness was correlated to surgery time (p=0.03) but not any other factor including level.

XLIF Scoliosis: MIS vs. Open Complications

• Incidence of complication: 19.2% MIS versus 37.9% OPEN posterior instrumentation (p=0.0450)
• Incidence of major complications: 5.8% MIS versus 20.7% OPEN posterior instrumentation (p=0.0405)
• The strongest independent predictor of complications was the total number of levels treated per patient (p=0.0004)
• All reoperations (3) and deep wound infections (3) were associated with open posterior instrumentation procedures.

Nerve Surveillance: What I've learned

• Critically important - reliable, reproducible
• Early results using varied systems noted high incidence of neural complications (Knight et al.) - not all systems are the same!
• Need feedback while traversing the Psoas and when docked
• If retractor moves - re-check nerves
• Likely most common cause of neuropraxia is prolonged retraction of plexus against transverse process (duration important!!!!)
LIF: INDIRECT DECOMPRESSION?


21 XLIF cases without supplemental fixation or direct decompression
- Prospective single-site study; compared pre- and post-op x-ray and MRI
- 24% increase in foraminal area
- 13.5% in foraminal height
- 33.1% increase in central canal diameter (sagittal)
- 8.4% in central canal area (axial)
- 37.9%/46.3% in right and left subarticular diameters

All radiographic metrics of indirect decompression were statistically significantly increased after treatment with XLIF (p<0.05)

Case example # 2
DPA, Female, 49 years old, Neurogenic Claudication, Back (VAS=10) and Leg Pain (VAS = 10)

LIF: Technique Pearls
- Minimize Psoas trauma and bleeding
  - Single penetration, no wanding of retractor
  - Open retractor “just enough” for access
  - Be aware of segmental vessels (pedicle level)
- Do not violate ALL
  - Instability - anterior implant migration
- Do not violate end-plates during preparation or implant insertion
- Do not over-distract
- Widest, longest implant
78 yo female, 2 prior lamis with radiculopathy and LBP
- MRI - severe foraminal stenosis

- L1-5 XLIF
  - EBL< 50cc
  - Surgery 130 mins
  - Ambulated POD #1 - no radiculopathy
  - Refused posterior fusion
  - DC home POD #2

68 F presented with back and R>L leg pain with pitched forward posture
Traditionally: T10-L5 fusion?
Post L1-L5 XLIF

Mobilized POD #1
Resolution of neurogenic symptoms
Able to stand upright

Staged percutaneous posterior instrumentation

Degen Scoliosis: Strategy FMP (since 2009)

- 1st stage LIF
- Mobilize patient in brace
  - Assess for ongoing neurogenic symptoms
  - Full length films to assess for alignment

  Good alignment, no claudication

  Yes  No

  Percutaneous bilateral pedicle screw-rod construct  Laminctomy as needed
  Open pedicle screw -rod construct

Yes
Degenerative Scoliosis Surgery

- No cookbook recipe. Customize to patients expectations, medical morbidity
- Ensure neural decompression - direct (MIS)/indirect
- Posterior instrumented fusion improves deformity correction, reduced subsidence
  - Higher morbidity with open fixation
- XLIF reasonable strategy when anterior interbody support desired