Choosing Levels in Adult Scoliosis

Indications to Extend Fusion to the Sacrum and Pelvis

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Disclosures

• Research/Institutional Support:
  – NIH, AO Spine, OREF, AOA
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  – Medtronic, DePuy, Stryker, Globus
• Ownership/Stock/Options:
  – Providence Medical, Simpirica
• Royalties: Medtronic

Challenges in Adult Scoliosis Surgery

• Choosing Levels
• Junctional Complications
• When can we do less?
  – When should we do more?
Surgical Strategies

• Characterized by significant variability
• Outcomes studies required for an Evidence-based approach

Overview

• The challenge of the lumbosacral junction:
  – Strain on S1 screws
  – Solid arthrodesis at L5-S1
• Biomechanics of the Pivot Point
• Techniques and Limitations
Hazards of the Junctions

- Thoracolumbar
- Lumbosacral
- Cervicothoracic

The Lumbosacral Junction

Two modes of failure:

1) Symptomatic degeneration below a long fusion to L4 or L5
2) Nonunion or Malunion at L5-S1

Preoperative Assessment

- Localization of Pain on Physical Exam
- Advanced Imaging - MRI or CT
- Dynamic Imaging
- Provocative testing
  - Facet Block
  - Discography
The Case to Fuse to L5

- Better Function
- Less complications
- Good Survival of the L5-S1 motion segment
- Revision considerations
- Leaving options open for new technologies in the future

Does the lower instrumented vertebrae have an effect on lumbar mobility, subjective perception of trunk flexibility, and quality of life in patients with idiopathic scoliosis treated by spinal fusion?

**METHODS:**
Forty-one patients (mean age, 27 y) with idiopathic scoliosis treated by spinal fusion (mean time since surgery: 135 mo) were included. Patients were assigned to 3 groups according to LIV level: group 1 (fusion to T12, L1, or L2) 14 patients, group 2 (fusion to L3) 13 patients, and group 3 (fusion to L4, L5, or S1) 14 patients. At midterm follow-up, patients completed the Scoliosis Research Society (SRS)-22 Questionnaire and Quality of Life Profile for Spine Deformities (QOLPSD), and total LBP with a numerical scale. Lumbar mobility was measured using a dual digital inclinometer.

**RESULTS:**
Group 3 (fusion to L4, L5, or S1) showed statistically significant differences relative to the other groups, with less lumbar mobility and poorer scores for the SRS subtotal (P = 0.003) and pain scale (P = 0.01). Nevertheless, LBP correlated with TF in all 3 groups; it correlated with LBP and pain scale in group 1 (r = 0.9, P < 0.0001) and pain scale in group 2 (r = 0.9, P < 0.0001).

**CONCLUSIONS:**
LBP correlated moderately with lumbar mobility, health-related quality of life (SRS-22), and spinal pain (SRS-22 pain subscore). Low vertebral mobility of fusion to the highest level of perceived TF.

**The Case to Fuse to L5**

- Better Function
- Less complications
- Good Survival of the L5-S1 motion segment
- Revision considerations
- Leaving options open for new technologies in the future
The slippery slope of extending fusion to the sacrum

- Anterior column support
- Role of iliac fixation
**L5 vs S1 Paradox**

Thoracolumbar deformity arthrodesis to L5 in adults: the fate of the L5-S1 disc.

- 61% developed advanced disc degeneration at L5-S1
- Associated with loss of sagittal balance, need for revision surgery and lower scores of SRS-24
- 18% loss of fixation at L5

Higher incidence of complications in patients fused to S1
Edwards, Bridwell et al, SRS 2003

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**Failure of Fixation at L5**

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**The selection of L5 versus S1 in long fusions for adult idiopathic scoliosis.**


**Purpose**

Determine long-term radiographic and clinical outcome of long (>T12) fusions to L5
Survivorship Analysis

5 year: 75%
10 year: 70%

If include pts considering revision
5 year: 70%
10 year: 65%
Overall: 50% at latest FU


Conclusions

• Primary long fusions to L5 associated with
  – 25% revision rate at 5 years
  – 30% revision rate at 10 years

• Fusion to L5 is most reliable in patients with good sagittal balance and bone quality

Indications to Extend Fusion to the Sacrum

• Symptomatic degenerative changes at L5-S1
  – Spondylolisthesis at L5-S1
  – Stenosis requiring decompression at L5-S1

• Significant sagittal plane realignment

• Osteoporosis

• Fixed obliquity of the L5-S1 motion segment
  – Trunk translation
Sacral Fixation Considerations

- Sacrum is a poor fixation point due to the large cancellous component
- Bicortical or tricortical fixation needed
- Sacrum exposed to large cantilever forces
- Fixation to the sacrum eliminates most important sagittal compensatory mech.
- Fixation to the sacrum alters gait

Pedicle Fixation in the Sacrum

- S1 pedicle screw is the strongest fixation point
  - unicortical fixation
  - bicortical fixation
  - tricortical fixation
- S2 pedicle screw
  - short
  - weak bone

Limitations of Long Fusion to the Sacrum

- Cantilever forces for long segment constructs becomes critical when sacral fusion extends to L3 or higher
- Clinical correlation with a high incidence of symptomatic pseudarthroses in long fusions to S1
  - Kostuik 1983, 40% pseudarthrosis
  - Boachie 1991, 41% pseudarthrosis
  - Delvin 1991, 33% pseudarthrosis
  - Lenke 2004, 23% pseudarthrosis
  - Balderston 1986, 28% good result
Long fusions to the sacrum require anterior column support +/− iliac crest extension

- Cantilever forces for long segment constructs becomes critical when sacral fusion extends to L3 or higher
- Anterior interbody decrease S1 screw strain 30–40 %
- S2 fixation decreases S1 screw strain by 15%
- Iliac fixation decreases S1 screw strain by 50 to 300 %

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- Balderston 1986, 28% good result

McCord DH et al, Spine 1992

- 66 bovine specimens/10 instrumentation techniques
- Established pivot point at the lumbosacral joint at the intersection of the middle osteoligamentous column (sagittal plane) and the lumbosacral intervertebral disc (transverse plane)
Reducing Strain on Sacral Screws in Long Fusions to the Sacrum

S2 SCREW

- “Biomechanical comparison of lumbosacral fixation techniques in a calf spine model”
  Spine 2002, Lebwohl et al

- S2 screw extends fixation distal to the pivot point thus extending lever arm and providing additional support
- However, the S2 screw does not extend anterior to the pivot point and thus not as good as iliac screw fixation

Long Fusion To The Sacrum in Adult Spinal Deformity: Luque Galveston vs. Iliac Screws vs. Sacral Screws

Emami et al. Spine 2003
UCSF Spinal Disorders Service
**Iliac Bolt Fixation**

- Bolt or screw is passed into the ilium at the PSIS
- Bolt or screw is affixed directly to the spine construct
- Effective in high demand construct
- Failure rate half of traditional Galveston

**Low Profile Pelvic Fixation**

Anatomic Parameters for Sacral Alar-Iliac Fixation Versus Traditional Iliac Fixation

Taw-Li Ong, MD,* Paul D. Spernaker, MD,* Khald M. Kutani, MD,* and Elroy F. Levine, MD*

**How Many Iliac Screws?**
Study Aims and Design

Goals
Pelvic versus Sacral + ALIF
Unilateral iliac versus bilateral iliac

Methods
Seven cadavers instrumented up to L1
Multi-axial bending with pure moment
S1 screws modified with strain gauges for pullout force
L1-S1, uni-iliac, bi-iliac… with and without ALIF at L5/S1

Multi-axial bending

Unilateral versus bilateral iliac screws for spinopelvic fixation: are two screws better than one?

• 100 patients with long fusions from thoracic spine to the sacrum
  – 53 patients with 2 iliac screws
  – 47 patients with 1 iliac screw
Limitations of Iliac Fixation

- Higher incidence of perioperative complications
  - Wound infection

- Higher incidence of need for revision surgery
  - Screw removal
    - Emami A, et al.

Evidence-based approach to the use of Iliac Fixation

- Extension of fixation to ilium in:
  - Compromised anterior column support at L5-S1
    - TLIF at L5-S1
  - Revision fixation to the sacrum in a long construct
    - Above L3
  - Compromised sacral fixation
  - Incomplete correction of sagittal and coronal balance
  - Pelvic obliquity/Long thoracolumbar (c-shaped) deformity corrected
    with cantilever maneuver
  - Ankylosing Spondylitis

Conclusions

- Fixation at the lumbosacral junction is challenging and important for stable reconstructions in deformity
- High strain on the sacral screws may lead to screw loosening and nonunion
- Pelvic fixation reduces strain on the sacral screws
- Role of biologics and new technologies in limiting need for iliac fixation requires further investigation
Spino-Pelvic Parameters: How Do They Affect My Decision to Extend a Fusion to the Sacrum/Pelvis

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Disclosures

• Consultant
  – K2M, Biomet, Medtronic
• Speaker Bureau (not present, within last 36 months)
  – Depuy, Stryker
• Board Membership
  – ASI, HSS Journal

SPINOPELVIC PARAMETERS
Setting Surgical Goals

Regional
Loss of lordosis
Versus PI
PI-LL < 10°

Global
SVA
SVA < 5cm

Compensatory
Pelvic tilt
PT < 20-25°

Literature Review

• 34 consecutive adult deformity patients fused from the thoracic spine to L5
• Subsequent L5-S1 DDD developed in 66% of patients after long adult fusions to L5

Literature Review

• High percentage of patients subsequently degenerated the L5-S1 disc
• With degeneration of the L5-S1 disc, sagittal balance was frequently lost
• Prevalence of breakdown of the L5-S1 disc much greater in the “long” fusions (T4-L5) vs. the “short” fusions (T10-L5)
Literature Review

- A clinical and radiographic assessment of 232 adults
- Factors found to be significantly associated were preop thoracolumbar kyphosis of >20°, age of >55 years, arthrodesis to S1 compared to L5
- Patients with a pseudarthrosis had lower total outcome scores on SRS questionnaire
- Prevalence of pseudarthrosis following long arthrodesis was 17%. Close to 30% for fusions to sacrum.

Literature Review

- 41 patients (40 female; 1 male)
- 39 of 41 had combined anteroposterior fusion extension
- Pseudarthrosis rate was 37% (15/41)
- With sacral fixation only, the rate was 53% (8/15), with iliac fixation only 42% (3/7) and with both iliac and sacral fixation 21% (4/19; p<0.05)

Literature Review

- 54 consecutive patients who underwent elective combined anterior and posterior surgical reconstruction for acute spine deformity were studied
- Attention to sagittal balance is critical
- Luque-Galveston fixation technique has an unacceptably high rate of pseudarthrosis. Currently, the authors are using bicortical and triangulated sacral screws with anterior interbody support
- They recommend using iliac fixation, although there is a higher rate of painful implants, requiring removal

Long fixation points in the ilium that extend anterior to the axis of rotation of L5-S1 provide the most stable fixation of the lumbosacral joint.


In a spondylolisthesis model, both the iliac screws and the interbody cages at the lumbo-sacral junction protected the S1 screws, but the iliac screws were far more valuable.

Factors that Dictate my Decision to Fuse to Sacrum/Ilium

- Age
  - Bone quality
  - Degenerative changes in disc, foramen, canal
- Deformity
  - Large SVA
  - Large Coronal Decompensation
  - Large Curve Magnitude
  - Rigid vs. Flexible Deformity
  - Presence of L5/S1 Spondylolisthesis
  - Laminectomy defects at L5/S1
Factors that Dictate my Decision to Fuse to Sacrum/Ilium

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  – Bone quality
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  – Large SVA
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  – Rigid vs. Flexible Deformity
  – Presence of L5/S1 Spondylolisthesis
  – Laminectomy Defects at L5/S1

• Spino-Pelvic Parameters
  – High PT
  – High PI

High PT

• PT will be very difficult to correct without fusion to S1 and Iliac Fixation in Adult Spinal Deformity

High PI

• “Guillotine Effect” of Fusion to L5 on L5/S1 Disc Space
  – High shear stresses
Substantial sagittal imbalance, back pain, inability to ambulate

Cantilever to “Dial In” Pelvic Anteversion

Case

- 79M with bilateral leg and back pain
  - 10% back, 90% leg pain
    - 50% Left, 50% Right
  - Exacerbated by standing/walking
  - Improved with sitting, lying down (some positions)
  - No bowel/bladder symptoms
  - Subjective weakness/numbness when ambulating
  - Failed PT/Injections
Exam

- Marked Positive Sagittal Balance
- Can only stand for a short period of time
- Static Motor Exam intact
- Sensory exam normal
Questions

- Osteotomy? Can you do PCOs? Or will this need a PSO?
  - If PSO, what level?
  - If PCO, what level(s)?
- Is an Interbody necessary?
  - Lateral? Transforaminal? Anterior?
- Choice for UIV? Lower or Upper Thoracic?
- Iliac Fixation?
- Will you need Biologics?
Do We Always Have To Go To The Sacrum? Are There Select Circumstances Where We’d Be Better Off Stopping At L5?

Case following Courtesy of Dr. Keith H. Bridwell MD

Frail Almost 70-Year-Old Female. Bilateral Leg Pain And Weakness, Left Greater Than Right.

Good Sagittal Parameters!
Large Calcified Disc Herniation at T11-T12 on the Left Side

Stenosis at L3-L4

4 Year Follow-up
Balance Risks/Benefits

- Large PI-LL mismatch
- Large PT
- Large PI (natural anatomy)

- Need fusions to Sacrum/Ilium
- Pseudo Risk
L5-S1 FUSION OPTIONS
APPROACH, INTERBODY SUPPORT, & GRAFT OPTIONS
Jason W. Savage, MD
Cleveland Clinic
Center for Spine Health
9/8/2015

DISCLOSURES

• Consultant: Stryker Spine

• Editorial Board: JSDT

• Off-label use of BMP

OUTLINE

• Approach
  – Anterior
  – Posterior

• Interbody Support
  – ALIF/PLIF/TLIF/OLIF
  – Advantages/Disadvantages
  – Is it necessary ???

• Graft Options
  – Bone vs. PEEK vs. Metal
  – BMP
GOALS OF SURGERY

- Restore regional lordosis
- "Fix" the fractional curve
- Achieve a solid fusion

Up to 25% pseudarthrosis rate at L5-S1

ANTERIOR APPROACH

- **Advantages**
  - Access to disc space
  - Large structural graft
  - Lordosis

- **Disadvantages**
  - Unfamiliar and separate approach
  - Complications

POSTERIOR APPROACH

- **Advantages**
  - Provides interbody support
  - Single approach/procedure

- **Disadvantages**
  - Inferior disc "prep"
  - Graft extrusion
  - Nerve root irritation
  - Fusion ???
Anterior lumbar interbody fusion in comparison with transforminal lumbar interbody fusion: implications for the restoration of foraminal height, local disc angle, lumbar lordosis, and sagittal balance

Patrick C. Briel, M.D., Tyler R. Kooi, M.D., Brian A. O’Shannessy, M.D., Patrick Sucker, M.D., Sean Saleh, M.D., Stephen Ono, M.D., and John C. Lee, M.D.

- Retrospective
- 32 ALIF vs. 25 TLIF
- Foraminal Height
  - 18.5% vs. 0.4% (p<0.01)
- Segmental Lordosis
  - 8.3 vs. -0.1° (p<0.01)
- Regional Lordosis
  - 6.2° vs. -2.1° (p<0.01)


Transforminal Versus Anterior Lumbar Interbody Fusion in Long Deformity Constructs

A Matched Cohort Analysis

Ian G. Doanward, MD, Lawrence C. Leke, MD; Keith H. Brackwell, MD; Benj T. O’Soo, MD; Garthyn E. Steber, BS; Joshua M. Pahy, MD; Matthew M. Kang, MD; Brenda A. Siler, MA; and Linda A. Kuehen, BTH

- Retrospective
- ALIF vs. TLIF in ASD
- 42 pts in each group
- Segmental lordosis
  - 6.9° vs. -2.6° (p<0.0001)
- Regional lordosis
  - 11.5° vs. 7.9° (p<0.29)


NO DIFFERENCE IN RATE OF PSEUDARTHROSIS

INTERBODY GRAFT OPTIONS

• Provide structural support
  – Function is primarily mechanical
• Require “other” bone graft substitutes to achieve bony fusion
• Implant material is important
  – Limit subsidence and stress shielding
  – Bone integration

INTERBODY GRAFT OPTIONS

• Femoral Ring Allograft
  – “Biological Cages”
  – Natural elasticity
  – Potential for incorporation
• PEEK
  – Elasticity less than cortical bone
  – No potential for incorporation
• Titanium
  – Elasticity is much greater than bone
  – Radiopaque

SYSTEMATIC REVIEW (12 Retrospective Studies)

– 609 ALIFs, 631 TLIFs

Fusion Rates

– 88.6% vs. 91.9% (p=0.23)
– Disc height (2.71mm)
– Segmental lordosis (2.35deg)
– Lumbar lordosis (6.33deg)
Radiographic Analysis of PEEK Cage and FRA in Adult Spinal Deformity Fused to Sacrum

Zongnian Yao, MD,* Min Da, MD,* Jun Miao, MD,† Guorui Li, PhD,† and Kirkham R. Wood, MD

• Retrospective review
• ALIF with PEEK (N=27) vs. RFA (N=14) at L5-S1
• X-ray evaluation
• Fusion Rates
  – 94.9% vs. 84.2% (p<0.05)
• Improved foraminal height and segmental lordosis with PEEK

Comparison of fusion rates following transfemoral lumbar interbody fusion using polyetheretherketone cages or titanium cages with transpedicular instrumentation

Osamu Nonnur – Takashi Assmmy – Yuuki Yama – Hideki Imahechi – Hiroki Yasuoka – Akira Koizuma

• Single level TLIF with local autograft
• Titanium (N=23) vs. PEEK (N=25)
• Fusion Rates
  – 100% vs. 75% at 2 years (p=0.016)
• Vertebral osteolysis was seen in 60% of PEEK non-unions

INTERBODY GRAFT OPTIONS

• Expandable Cages
• “Surface Enhanced”
• Silicone Nitrate
• Tantalum
• 3D Printing
• Nanotechnology
The world of biologics

Courtesy of Wellington K. Hsu, MD

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Improving the Clinical Evidence of Bone Graft Substitute Technology in Lumbar Spine Surgery

<table>
<thead>
<tr>
<th></th>
<th># Studies</th>
<th># Patients</th>
<th># Fused</th>
<th>Rate (%)</th>
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<tr>
<td>ICBG</td>
<td>23</td>
<td>1389</td>
<td>1103</td>
<td>79%</td>
</tr>
<tr>
<td>Local Autograft</td>
<td>8</td>
<td>714</td>
<td>637</td>
<td>89%</td>
</tr>
<tr>
<td>Allograft alone</td>
<td>4</td>
<td>269</td>
<td>141</td>
<td>52%</td>
</tr>
<tr>
<td>BMA</td>
<td>2</td>
<td>40</td>
<td>34</td>
<td>85%</td>
</tr>
<tr>
<td>BMP</td>
<td>3</td>
<td>213</td>
<td>201</td>
<td>94%</td>
</tr>
<tr>
<td>Ceramics</td>
<td>16</td>
<td>697</td>
<td>603</td>
<td>87%</td>
</tr>
<tr>
<td>DBM</td>
<td>3</td>
<td>192</td>
<td>171</td>
<td>89%</td>
</tr>
<tr>
<td>PRP</td>
<td>4</td>
<td>209</td>
<td>154</td>
<td>74%</td>
</tr>
</tbody>
</table>

- Retrospective Study
- ALIF in ASD
  - ICBG (N=32) vs. BMP (N=23)
- Fusion Rates
  - 71.9% vs. 95.7% (p=0.057)
- Follow-up
  - 4.9 vs. 2.7 years

Cleveland Clinic

Spine 2009;34:2205-2212.
The Fate of L5–S1 With Low-Dose BMP-2 and Pelvic Fixation, With or Without Interbody Fusion, in Adult Deformity Surgery

Prokopis Annes, MD,* Daniel S. Brode, MD,* William R. Spiller, MD,* Michael D. Dubs, MD,† and Brandon D. Lawrence, MDP

**Retrospective Case Series**

**L5–S1 Interbody fusion vs. PLF**

**Conclusion.** The use of low dose of BMP-2 at the L5–S1 level in combination with sacroepic fixation achieved satisfactory fusion rates in adult deformity surgery. No additional benefit was encountered by adding an interbody cage.

**Fusion Rates**

- 97% vs. 96% (p=1.0)


**MY ALGORITHM AT L5–S1**

- **ALIF**
  - Sagittal plane deformity (mostly from L4-L5 and/or L5-S1)
  - Adjacent segment pathology below a previous fusion (i.e. AIS)
- **TLIF**
  - De novo scoliosis with "tall" disc or spondy
  - Fractional curve
- **PLF alone**
  - De novo scoliosis with collapsed disc

**CASE EXAMPLE**

Courtesy of Doug Orr, MD
Case Example

Historically high rate of pseudarthrosis at L5-S1
Iliac Fixation, 360°, and Biologics have improved fusion rates
ALIF improves disc height, segmental lordosis, and LL better than TLIF
Likely no difference in fusion
Still a lot of questions ???

Conclusions

Thank you
Sacroplevic Fixation Options, Techniques and Complications

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DISCLOSURE

- Depuy Spine Consultant, Royalty
- K2M Consultant
- Orthofix Consultant

WHY PELVIC FIXATION?

- S1 Pedicles capacious & short
- Sacrum bone is osteopenic
- Failure rate of S1 Screws Up to 44%
- Inadequate as the only means of fixation in long fusion

Camp et al, Spine 1990
INDICATIONS FOR PELVIC FIXATION

Expected significant biomechanical stresses

- Long fusions to the sacrum
- Definition: > 4 levels
- Osteoporosis

Sacral Fracture
Sacro-Pelvic Fixation Options

- Casting and bracing
- Sacral Sublaminar devices
  - Wires
  - Cables
  - Hooks
- Sacral pedicle screws
  - S1 pedicle screws
  - S2 Pedicle screws
- S1 Alar screws

- S1 and Alar screw blocks
- Dunn-McCarthy S-Rod
- Jackson intra-sacral rod
- Kostuik sacral bar
- Galveston technique
- Iliac Screws
- Sacral Alar Iliac screws (S2AI)

LUMBO-SACRAL PIVOT POINT

- "Axis about which the lumbo-sacral region rotates"
- Middle of osteo-ligamentous column at L5-S1
- Implants ventral to this point provide an effective moment arm to resist flexion & improve fixation strength

**GALVESTON TECHNIQUE**
- Most commonly used in NM Spinal deformities
- Inexpensive
- Difficult to get the correct angle
- Loss of correction
- Windshield wiper effect

Jackson Technique
- S1 pedicle screws
- Rod placed in S1 screw and into sacral ala
- Not crossing the SI joint
- Technically difficult
- Biomechanically weaker than iliac fixation

Iliac Screws
- Commonly used
- Fixation with screws
- Implants easier to place
- Reduction in LS motion
- More Protective of S1 than IB cages
67 patients (81 initial cohort)
5 years Follow-up
Iliac screws removed in 23 pts
7 broken screws
Screws halos in 29 pts
No SI joint arthritis

Woojin et Al. paper 46, IMAST 2011
67 of 190 patients
Iliac screws
Minimum 2 ys follow-up
34.3 % failure
11.9 Major failure

S2 Alar - Iliac S2AI
"SAI"
Surgical Technique
How it all started?
Surgical Technique S2AI

- Starting point: *Midway between S1 & S2 foramina*
- 2.5 mm drill from pelvic set
- Trajectory: 45° to floor
  - 20-30° caudal
  - "Varies w. pelvic obliquity & Sacral tilt"
  - *Aim for the AIIS*
- Confirm bony end point with a probe
Surgical Technique S2AI

- Screw path just above sciatic notch
- Fluoroscopy is helpful
  - Iliac oblique, Tear drop
Surgical Technique S2AI
- Screw path just above sciatic notch
- Fluoroscopy is helpful
  Iliac oblique, Tear drop
- Diameter 8-10 mm
- Length 80-100

Biomechanics
- Biomechanical properties equivalent to Iliac screws
  Stress-strain & load to failure
Outcomes and Complications of Sacro-Pelvic Fixation Using S2 Alar-Iliac (S2AI) Fixation in Adult Deformity patients: A prospective Study with 2-Year Follow-up

Khaled Kebaish, MD
Mostafa El Dafrawy, M.D
Hamid Hassanzadeh, M.D
Philip Neubauer, M.D
Roosevelt Offoha, BS
Eric Tan, M.D
Paul Sponseller, MD
Department of Orthopaedic Surgery
Johns Hopkins University

RESULTS

- 146 patients were included
- 2 year clinical & radiographic F/U
- 2 patient were lost to follow up
- Average age: 59 ys (21-80)
- 35% of patients had > one co-morbidity

S2AI Fixation specific complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Number</th>
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<tbody>
<tr>
<td>Screw Breakage</td>
<td>8 (5 pts)</td>
</tr>
<tr>
<td>Screw Misplacement</td>
<td>2</td>
</tr>
<tr>
<td>Minimal Screw loosening (+2mm)</td>
<td>13 patients</td>
</tr>
<tr>
<td>Reoperation</td>
<td>4</td>
</tr>
<tr>
<td>Total screws (6%)</td>
<td></td>
</tr>
</tbody>
</table>

- Screw Breakage: 8 patients (5 patients)
- Screw Misplacement: 2 screws
- Minimal Screw loosening (+2mm): 13 patients (16 screws)
Sacropelvic Fixation Using the S2 Alar-Iliac (S2AI) Screw in Adult Deformity Surgery: A Prospective Study with Minimum 5-Year Follow-Up

Sophia A. Strike, MD; Hamid Hassanzadeh, MD; Floreana Naef, MD; John Carrino, MD; Paul D. Sponseller, MD; Richard Skolasky, ScD; Khaled M. Kebaish, MD

S2AI FIXATION COMPLICATIONS

- 109 S2AI screws placed
  - Six broken screws (four patients)
  - > 2 mm lucency: 20 screws
  - No pseudoarthrosis at L5-S1
  - No SI joint degeneration

Effect on the SI Joint

- There was no evidence of SI joint fusion
- No significant change in joint space
- No significant SI joint area pain

Corlett EN, Bishop RP. Ergonomics 1976
Concerns of Fusion Across SI Joint

Anatomic studies
- Minimal motion in pediatric cadavers
- No motion in adult cadavers
- 75% auto fused in adults over 50 years


Adult Scoliosis

- 71 YO M
- Retired Physician
- Severe Back Pain and Rt Buttock
- Used to be very active now Limited by his symptoms
- No Prior Rx
62 y.o. Female
Degenerative on Idiopathic

Spondylolysis
Spondylolisthesis

Sacral Fracture
DISCUSSION

- Implant fractures were only seen with smaller diameter screws (7mm)
- Recommend using Larger screws (>8mm)
- Loosening > 2mm very rare
- Reoperation and removal are infrequent
Conclusion

- Many techniques for PELVIC FIXATION
- High Rate of implant related problems
- S2 Alar Iliac (SAI) technique easy & safe
- Lower Complications
- Effective in distal LS corrective procedures
- No effect on the SI joint at 5 yrs!
- *Can be done through an MIS approach*
THANK YOU