Sacro-Pelvic fixation: options and techniques

Khaled M. Kebaish, M.D., FRCSC
Associate Professor

Department of Orthopedic Surgery
Johns Hopkins University
Why the need for 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

- Long fusions to the sacrum
- Neuromuscular deformities
- Degenerative scoliosis
- Structural LS deformities
- High Grade Spondylololithesis
- Lumbar and sacral Tumors

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

Lumbo-sacral Pivot Point

Zones of Sacropelvic Fixation

- **Concept of 3 zones (O’Brien)**
  - **Zone I:** S1 vertebral body and cephalad margins of sacral ala
  - **Zone II:** Inferior margins of Sacral Ala, S2 to tip of coccyx
  - **Zone III:** Bilateral Ilium

- **Fixation strength improves from Zone I to Zone III.**

_O’Brien MF, Spinal Deformities, 2003._
SACRAL FIXATION EVOLUTION


- HARRINGTON HOOKS
- MOE ALAR HOOKS
- ANTERIOR GRAFTS
- LUQUE
- LUQUE GALVASTON
- ANTERIOR SACRAL FIXATION
- SACRAL SCREWS (MAGERL)
- S2 SCREWS
- MODIFIED SACRAL BAR C.D.
- SACRAL CONNECTORS
- ILIAC SCREWS
- S2 ALAR-ILIAC S2AI
Sacro-Pelvic Fixation Options

- Casting and bracing
- Sacral Sublaminar devices
  - Wires
  - Cables
  - Hooks
- Sacral pedicle screws
  - S1 pedicle screws
  - S1 and 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 (S2 AI)
Galveston Technique

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

Kostuik Trans-sacral Bar

- Updated Harrington technique
- Rod into iliac wings & S1 screws
- Longitudinal connectors
- Easy to place
- Less stable in flexion

Iliac Screws

- Most commonly used
- Fixation with screws
- Implants easier to place
- Reduction in LS motion
- More Protective of S1 than IB cages

Minimum 5-Year Analysis of L5–S1 Fusion Using Sacropelvic Fixation (Bilateral S1 and Iliac Screws) for Spinal Deformity

Kuniyoshi Tsuchiya, MD, Keith H. Bridwell, MD, Timothy R. Kuklo, MD, Lawrence G. Lenke, MD, and Christine Baldus, RN

- 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
Iliac Fixation Outcome

Table 7. Outcome of Iliac Screws

<table>
<thead>
<tr>
<th>Condition</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal (patients)</td>
<td>23</td>
</tr>
<tr>
<td>Breakage (screws)</td>
<td>7</td>
</tr>
<tr>
<td>Back-out (screws)</td>
<td>4</td>
</tr>
<tr>
<td>Iliac screws persistent (patients)</td>
<td>44</td>
</tr>
<tr>
<td>Iliac halo (patients)</td>
<td>29*</td>
</tr>
<tr>
<td>Rod breakage between S1 and iliac screw (patients)</td>
<td>3*</td>
</tr>
</tbody>
</table>

*Of the 29 patients with an iliac halo, 10 ultimately had the iliac screws removed. The 3 patients with fractured rods were a subset of the iliac screw halo group.

Table 8. Outcome of Iliac Screws: Screw Removal

<table>
<thead>
<tr>
<th>Group</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iliac screw removal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No./total yes (%)</td>
<td>18/34 (52.9)</td>
<td>5/33 (15.2)</td>
</tr>
<tr>
<td>No./total no (%)</td>
<td>16/34 (47.1)</td>
<td>28/33 (84.8)</td>
</tr>
</tbody>
</table>

Table 9. Outcome of Iliac Screws: Halo

<table>
<thead>
<tr>
<th>Group</th>
<th>No. Iliac Halo Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12*</td>
</tr>
<tr>
<td>2</td>
<td>17*</td>
</tr>
</tbody>
</table>

*Of the 29 patients who had iliac screw halos, 10 ultimately had the screws removed.

Tsuchiya et al, Spine 2006

67 of 81 patients at 5 years
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”
Surgical Technique (S2AI)
Surgical Technique S2AI

- **Starting point:**
  - *lat & inf to S1 foramen*

- **Tap drill or Flat pedicle finder**

- **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
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
Surgical Technique S2AI
A New Low Profile Sacro-Pelvic Fixation Using S2 Alar-Iliac (S2AI) Screws in Adult Deformity Fusion to the Sacrum: A Prospective Study with Minimum 2 Year Follow-Up

Khaled M. Kebaish, MD
Ahmed Mohamed, M.B.B.Ch.
Albert Pull ter Gunne MD
Phebe S. Ko,B.S.
Richard L. Skolasky ScD
Joseph R. O’Brien MD, MPH,
Paul Sponseller, MD

Department of Orthopedic Surgery
Johns Hopkins University

IMAST & SRS 2009
Spine In press
RESULTS

- Total 52 enrolled in the study
- 46 patients 2 year clinical & radiographic F/U
- No patient were lost to follow up
- Average age: 59.8 ys (23-80)
- 45 patients had > one co-morbidity

<table>
<thead>
<tr>
<th>Gender</th>
<th></th>
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<tbody>
<tr>
<td>- Male</td>
<td>12</td>
<td>(23.1 %)</td>
</tr>
<tr>
<td>- Female</td>
<td>40</td>
<td>(76.9 %)</td>
</tr>
<tr>
<td>Age</td>
<td>59.8</td>
<td>(±13.0, 23.8-80.8)</td>
</tr>
<tr>
<td>BMI</td>
<td>27.9</td>
<td>(±5.6, 18.7-42.2)</td>
</tr>
<tr>
<td>Smoking</td>
<td>13</td>
<td>(25.0 %)</td>
</tr>
<tr>
<td>Co-morbidities</td>
<td>51</td>
<td>(98 %)</td>
</tr>
<tr>
<td>Primary procedures</td>
<td>17</td>
<td>32.7</td>
</tr>
<tr>
<td>Revision procedure</td>
<td>35</td>
<td>67.3%</td>
</tr>
</tbody>
</table>
# S2AI Fixation specific complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw Breakage</td>
<td>3</td>
</tr>
<tr>
<td>Screw Misplacement</td>
<td>1</td>
</tr>
<tr>
<td>Screw loosening</td>
<td>1</td>
</tr>
<tr>
<td>Reoperation</td>
<td>1</td>
</tr>
</tbody>
</table>
Effect on the SI Joint

- There was no evidence of SI joint fusion
- No significant change in joint space
- VAS:
  - 5 pts right SI-joint area pain (mean 4.8)
  - 4 pts left side pain (mean 5.5)

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

32 consecutive pediatric patients
2 years Follow-up
S2AI better correction pelvic obliquity
SAI patients had a lower deep infection rate compared to traditional patients
S2AI Technique

- Minimal offset from the axis of spine
- Less prominent
- One rod no connectors
- Better control of the pelvis
S2AI Technique

- Minimal offset from the axis of spine
- Less prominent
- One rod no connectors
- Better control of the pelvis
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
Spondylololithesis
Spondylololithesis
Spondylololithesis
Spondylololithesis
Lumbosacral Kyphosis

- 52 YO M, 242 Lb
- Works in a warehouse
- 8 Ms earlier, had Surgery elsewhere
- Complicated by Deep wound infection
- On suppressive Abx
Lumbosacral Kyphosis
Lumbosacral Kyphosis
Osteoporotic Deformity
Post-Op
S2AI Fixation and MIS
S2AI Fixation and MIS
Stress Fracture Of the Ilium
Stress Fracture Of the Ilium
Stress Fracture Of the Ilium
Stress Fracture Of the Ilium

Pre-op

5 months post-op
Conclusion

- Many techniques for sacro-pelvic fixation
- Evolved over the years
- High Rate of implant related problems

*S2 Alar Iliac (S2AI) :*

- *Lower Complications compared to traditional fixation*
- Effective in distal LS corrective procedures
- *No effect on the SI joint at 2 ys!

*“Low Profile Pelvic Fixation With the Sacral Alar Iliac Technique in the Pediatric Population Improves Results at Two-Year Minimum Follow-up”, P. Sponseller et al. Spine Volume 35, Number 20, pp1887-1892*
Baltimore

Thank You