Lumbo Sacral Pelvic Fixation Techniques

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Disclosures

- Consultant: Novartis
- Consultant: Eli Lilly
Since all speakers have been warned to watch their presentation time

- Best strategy of performing those techniques is
- TO AVOID doing them
- See you next year!!!!

*Spinal instrumentation that involves the sacrum and the ilium could be troublesome !!!!!!
Indications of LSPF

1-Instability: L5-S1 level
   (pathologic or iatrogenic instability)

2-Trauma:
   As L5 unstable fractures, sacral fractures with spine pelvic dissociation
3-Tumours: of L5 or S.

4-When you need to correct pelvic obliquity:
   Neuromuscular scoliosis

5-When multi-segmental fixation to add to rigidity of fixation

6-Flat-back syndrome requiring corrective osteotomy of lower lumbar spine

7-Significant osteoporosis in the setting of Lumbar or LS Fusion

A lot of anatomical challenges
**Anatomy**

- Thin cortical shell
  - Except ant/sup S1
- Midline thicker than lateral
- Lateral sacral ala thick
- Pedicles are wide
- AP depth below S1 shallow (rapidly tapers)
  - Short screws
- Hardware crowding

**SP Anatomy**

- **Middle sacral vessels**
  - Converging S1 screws
- **Common iliac**: begins at L4
  - Pass along lateral surface of L5 vertebral body
  - Bifurcate at LSJ to give Int.&ext. iliac A.
  - Arteries are ventral & lateral to I. veins so not in actual contact with spine.
  - Internal iliac is close to the bony surface of ala but external is separated by psoas muscles.

- **Lumbosacral trunk** is formed by ventral braches of L4,L5 nerve roots joined by sacral nerves located on ventral surface of ala between I. veins and SIJ.
Superior gluteal artery
- Iliac screws violating sciatic notch
Colon
- S2 screws

Sympathetic chain
ALIF
- Long converging S1 screws

Why is it difficult to get fusion at LS Junction?
*Stresses at the L5 junction are so high: Why?

- The slope between L5, S1 is the steepest of all, so it has the largest load bearing along the spine, highest shear forces.
  - Thus higher rates of pseudoarthrosis

  _Largest range of motion_ (17-18 degrees of Flex. & extension)

  *Implants become so posterior to the center of gravity and axis of flexion and extension greater pullout chance.

  *Its use increase the possibility of loss of lumbar lordosis.

  *Poor bone quality, poor anchor purchase
  - BMD most important factor in fixation
    - (Zindrick et al: CORR 203, 1986)
  - Superior sacral endplate highest BMD

When you plan to do fixation to sacrum or ilium you should think of two important biomechanical concepts
**Lumbosacral Pivot point**

- It is the axis of rotation at the lumbo-sacral junction.
- Lies in the intersection of middle osteoligamentous column and L5-S1 disc.
- For constructs that cross the Lumbosacral junction: Only those devices that pass ventral to this point provide a significant biomechanical advantage regarding the rigidity of fixation.

**Fixation Options**

**Flexion Extension Axis**
Fixation Zones

- **Zone 1**
  - S1 vertebral body and cephalad margins of sacral ala
    - Converging S1 screws
    - “S” rods by Dunn and McCarthy
    - Bilateral L5/S1 transfacet screws
    - Augment with anterior support

  O’Brien et al, June 2004

- **Zone 2**
  - Inferior margins of sacral alae, S2, and area till tip of coccyx
    - Least effective-poor bone stock, anatomic constraints
    - Alar screws
    - Screw/plate option (Tacoma, Chopin, Colorado II)
    - Hooks/sublaminar wires
    - Jackson technique
Zone 3
Both Iilia
- Large, biomechanically efficient anchor
  - Galveston technique
  - Iliac screws
  - Sacral bar using Saoud & Reda method
Sacral means of fixation

Sacral Screws

- Best is the medially directed towards the promontory.
You can further augment this by S2 screw which goes lateral, so you can have two screws in S1 and one in S2 and an Iliac screw through a device and a connector.

- **Sacral Hooks**

  - Use as adjunct
    - Laminar hooks, Laminar claw
    - Alar hooks & Sacral foraminal hooks

  - Also sublaminar wires, &cables lack significant biomechanical strength as These implants are very dorsal to McCord point
“S” rods by Dunn and McCarthy

Intra-Sacral Rods
(Jackson’s Technique)


- So the rods are implanted in the area of the Sacrum buttressed by the Ilium = Strong bone with good support (Z2!)
So claimed to be a stronger construct because:

- There is interlocking effect of the construct.
- Rods are buttressed by the iliac buttress effect and passes in relat. good bone.
- Also the intrasacral position of the rod makes the construct anterior to the normal position of posterior instrumentations so = Less lever-arm forces = More resistance to pullout.
- Does not cross SI joint....
- This technique is demanding, needs specially designed inst., although its superiority than other sacral fixation methods is questionable.
Facetal Translaminar Screws

*Magerl developed the translaminar facet screws, the way they are applied now*

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**Indications**

*Conditions:

*Anterior column should be intact or supported (Cage or graft).

*Needs intact lamina.

*Can not be used alone in more than 3 levels*
- **Ilial:**

  - **Luque Fixation:** L-Rod with 90 degrees bend driven through pelvic wing with bicortical purchase:
    An obstacle to flex. & ext., post. to pivot point.

  - **Galveston Fixation:** By Allen and Ferguson:
    Luque Galveston technique
    Here the intra-iliac part of the rod is most. anterior to pivot point so more stable and not a flex. Ext. obstacle.

The rod is to be passed intercortically aimed at area 1-1.5 cm above and beyond the Sciatic notch = Strongest.

*Problems*

- Of crossing the non fused SIJ with higher rate of ilial fixation loosening = *Windshield washer or wiper effect* (Biomechanical causes plus cancellous ilium) and higher rate of SIJ arthritis and complaint.
- *This occurs also in sacrum.*
- *Instrumentation become more post. with longer lever-arm, more stresses.*
Iliac Screws

- Adjunct with various systems
- Biomechanically equal to Galveston
- Advantages
  - Improved biomechanics
  - Permits iliac crest harvesting
  - High fusion rate in long constructs

Depiction of the 2 different paths to achieve pelvic fixation from the PSIS. In Path A the screw is aimed from the PSIS to the superior rim of the acetabulum; in path B the screw is aimed from the PSIS to the anterior inferior iliac spine.
Saoud & Reda WScJ 2011
The Internal fixator
Flying buttress construct

-Iliosacral screw fixation: Actually a sacral screw but passes through ilium to increase purchase-At least 3 cortices- and gain better direction -Longer part ant. to pivot point.
MW technique

iliac screws
(7 mm) inserted
in a Galveston
manner, and

iliosacral screws
(7 mm) to
maximize
construct
strength

S2-Iliac Screw for Pelvic Fixation

- This is the technique adopted at some institutions for both adult and pediatric patients requiring spinopelvic fixation. Iliac fixation through the S2 ala provides a starting point in line with S1 pedicle screw.

- The starting point is 1-mm-2-mm lateral and 1 mm-2 mm distal to the S1 dorsal sacral foramen.

(Moshirfar et al, seminars in spine surgery 2009)
Real trajectory studied by O’Brien et al (Spine; 2009) on a cadaveric model using CT scan to evaluate instrumentation placement:

Concluded

- The average cephalocaudal trajectory was 29 degrees caudal from direct lateral.
- The average anterior-posterior angulation was 42 degrees from a horizontal line connecting the PSIS and puts nothing at risk during placement.

**Anterior constructs:**

For anterior inter-body fusion

- **Grafts or bone substitutes**: Either put in the disc space or pass fibular graft from body of L5 to sacrum (Rene P.Louis)

- **Mesh**: Filled with bone graft and almost always supplemented by posterior-pedicular type fixation.

- **Cages**: Filled with graft (Stand alone or with post. Fixation)

- **Disc space implants**: To secure and fix the two vertebrae between which anterior graft has been put: e.g. Hartshill system.
Posterior fixation with anterior interbody support (Graft, Cage, etc.) may form a good option.

Structural materials placed anterior in the interspace, increases stiffness by 18 percent versus midbody placement of 12 percent and posterior interbody placement of six percent. Polly 2000

*Dynamic (Flexible) Stabilization:

Possible modes of action:

1- Immobilization in ext. = Stability by coaptation of facet joints.
2- Relief of load from anterior annulus and endplate.
3- Post. Annular compression may close the tears and eliminate the neo-innervation and vascularization.
4- May act as a splint of the motion segment to allow tissue healing.
5- Band will relax in 4-6 mns with some regain of movements. (Gardner 1996)
**Indications:**
- Lumbar instability syndrome in young patients with failure of non-operative ttt.
- Mild deg. Spondylolisthesis.

**Contraindications:**
- Symptomatic pseudo from previous surgery
- Osteoporosis
- Spodylolisthesis more than grade 1.

**Advantages:**
- More physiologic, no adjacent segment overload and degeneration, no need for graft.

**Disadvantages:**
- This stabilization in extension is not suitable if there is any foraminal stenosis not to lead or increase radicular symptoms, expensive, not yet sure of long term results.

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**AxiaLif**

![AxiaLif Diagram]
Which is better biomechanically and clinically

Very difficult question to answer: results in literature may make you even more confused.

- Biomechanically: What makes constructs more rigid and gives better correction and higher fusion rate??
- Clinically: what gives better clinical outcome
- Both

*McCord et al 1992 (spine) stated the importance of lumbosacral pivot Point

WITH *Zhu et al 2000 (Spine) medially directed sacral screws in the direction of the promontory (BM)
**Lebwohl et al 2002 (Spine):** Iliac distal fixation was more effective than any secondary fixation point. (BM)

**Adrian et al, (BM)**

Lumbo-sacro-pelvic Fixation Using Iliac Screws improve biomechanical strength and seems to provide acceptable clinical result.

**TUMIALAN & MUMMANENI (Neurosurgery) 2008**
LONG-SEGMENT SPINAL FIXATION USING PELVIC SCREWS

CONCLUSION: Pelvic screw fixation is a safe and effective technique (BM&C)

AGAINST *Stovall et al 1997 (Spine): sacral foraminal hooks good adjuncts

**Saer et al 1990 (Spine):** Two staged procedures with non-instrumented LS fusion then posterior segmental instrumentation with Galveston type iliac fixation lead to best clinical results.

**Tolo et al, 2005 (JBJS):** Galveston pelvic fixation was associated with satisfactory results and with less complications than generally reported in the literature.

**only 1 study, 1990 to date has directly compared sacral and iliosacral screw fixation to the Galveston technique in neuromuscular patients. This biomechanical study by Camp et al showed higher pullout strength of Cotrel-Dubousset rods secured to the pelvis using the Galveston technique compared to either sacral or iliosacral screws

AGAINST **Emami et al 2002 (Spine):** Luque – Galveston unacceptable high rate of Pseudoarthrosis = Not recommended for use.
Chi-Ho Wong S2 alar-iliac fixation technique provides superior pullout strength (BM)

- Sponsellar et al (SRS 44th annual meeting):
  S2 Alar iliac screws in Paediatric population improved results at 2 years F.U
  - Moshirfar et al, seminars in spine surgery 2009) concluded

- Use of the S2 iliac technique may be a viable option in minimally invasive thoracolumbar deformity surgery.

- Kustuik et al 1998(Spine): Anterior fixation statistically increased stiffness.

- Khan et al, 2009(Orthopaedics): studied Outcomes of Combined Anterior and Posterior Surgery in Lumbar Degenerative Scoliosis:
  effective method. However, clinical outcomes were characterized by a 35% rate of complications and need for revision surgery
MW construct in fusion for neuromuscular scoliosis

- Arlet et al. utilized “MW Construct” good results
- Carroll et al, ESJ 2007: study reveals superior correction of coronal deformity and pelvic obliquity using the MW construct in a limited number of patients with neuromuscular scoliosis.

Conclusion

- Literature suggests that
  - Medially directed S1 screws
  - Iliac screws & Internal fixator
  - MW constructs
  - Combined anterior and posterior fusion
  - S2 iliac screws

Might be better with no specific order

NO CONSENSUS
Conclusion

- Use LSPF only when it is really indicated.
- Your aim when you do LSPF is fusion in balanced and well aligned position, which is not only the matter of adequate fixation but most importantly, decortication and grafting of the surfaces intended for fusion (Transverse processes, facets or interbody): biologic enhancement

- When you do that with Reasonable fixation method you most probably achieve fusion.

- Use the method you are familial with and what works well in your hands.

"Failure of a construct is almost always a failure of the surgeon not the construct"
Thank You

www.egyptspine.com
www.worldspinalcolumn.org