LUMBAR SPONDYLOLISTHESIS AND SPONDYLOLYSIS

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Case Presentation 1 – Lumbar Spondylolisthesis and Spondylolysis

PATIENT #1
HISTORY

- 17 yo male multisport (football, basketball and baseball) athlete at local High School
- Colleges are already recruiting him for football (quarterback) and baseball (pitcher)
- He just started training for baseball and his having difficulty pitching complaining of a sharp low back pain during the wind-up which keeps him from giving full effort
- He also complains of back pain when running for extended periods of time during conditioning drill
HISTORY

- When asked more specifically, he states that he started noticing pain towards the end of the basketball season. He also did not get much rest between football and basketball season after making the playoff.
- He denies pain at rest or during normal activity.
- When the pain is present, it is across his lower back and radiates into his buttocks but not legs.
- The expectation for the upcoming baseball season are high.
- Even Urban Meyer is concerned and leaves a message on your voicemail.
Physical exam

- This is a finely tuned athletic machine
- Strength intact
- Sensation and coordination intact
- No pain to palpation over lower back
- Pain in low back with extension of lower back
- Some pain with lateral bending
Radiologist calls back and states that the films are normal

What would you do next?
Rest?
Anti-inflammatory?
PT?
Radiologist calls and describes edema in the pedicles at L3
Case Presentation 2 – Lumbar Spondylolisthesis and Spondylolysis

PATIENT #2
HISTORY

- 55 yo male who is the father of the young athlete
- Also played competitive sports in high school but not at the same level.
- He presents with worsening back pain over the past few year. Prior to this he would complains of occasional back pain.
- He also complains of pain radiating down the lateral aspect of his right leg into his big toe. He also reports of numbness on medial aspect of right lower leg. This seems to be progressing. It is usually worse after he has been on his feet for extended periods of time.
Physical exam

- Typical middle age male with a little pot belly
- Strength intact
- Sensation and coordination intact
- Pain to palpation over lower back and paraspinous muscle
- Extension of lower back does cause worsening of low back pain as well as right leg pain
- Patrick’s test and Leg raise causes back pain but no radiculopathy
IMAGING
Spondylolysis

- Pathologic condition of a bone defect in the pars interarticularis of the vertebrae
  - “Spondylos” → vertebrae
  - “Lysis” → defect
  - Demonstrated by Lambl in 1885

- If bilateral → spondylolisthesis
  - “Listhesis” → movement or slippage
  - First noted by Belgian OBGYN Herbinaux in 1782
  - Kilian coined the term in 1854
  - Neugebauer recognized pars defect as a cause in 1888
Incidence

- Usually occurs in early childhood to late twenties
  - 3% ages 2-6 yrs
  - 6% ages 5-6 yrs
- 3-6% incidence in general population
  - 80% asymptomatic
- 13.9% incidence in symptomatic athlete
  - Wide range varying on type of sports
    - Gymnastics (up to 17%)
    - Football (lineman)
    - Weight lifting (Olympic style) (up to 23%)
    - Diving (up to 43%)
    - Wrestling (up to 30%)
Etiology

- Football lineman
  - Blocking maneuvers (Gatt et al.)
    - L4-5 forces
      - Compressive force > 8600 N
      - Sagittal shear > 3300 N
Etiology

- Weight Lifters
  - Dead lift (Cholewicki et al.)
    - L4-5 compressive force > 1700 N
Incidence

- Ethnicity and Genetics
  - 5-6% of Caucasian population
  - 3% of African-American population
  - Inuit Eskimos
    - Up to 60%
    - Positional (squatting)
  - Family 15-37%
    - Multifactorial with variable expression
- Male:Female ratio 2:1
- L5 pars defect → 85-95%
- L4 pars defect → 5-15%
Etiology

- Exact cause still being debated
- Three types
  - Subtype A – classic lytic lesion
  - Subtype B – Elongated isthmus
    - Healed fracture
  - Subtype C Acute fracture
- Congenital theory presented by Schwegel in 1859 has been debunked
  - No pars defect have been seen in neonates
  - Age of presentation
    - Bipedal posture
    - Development of lumbar lordosis
Etiology

- Current theories
  - Acquired defect
    - Injury during childhood
  - Congenital weakness in the pars
    - Genetic predisposition
    - Repetitive motion
  - Immature spine put under stress at an early age
  - Fatigue fracture
    - The pars secondary to alternating flexion and extension
      - Sagittal balance
        - Hyperlordotic individual
    - "guillotine" fracture
      - Vertebra isthmus becomes horizontal during hyperextension movements
      - L5 Isthmus b/w L4 and S1 articular process
      - Shear stress within the isthmus
Etiology

- Football lineman
  - Blocking maneuvers (Gatt et al.)
    - L4-5 forces
      - Compressive force > 8600 N
      - Sagittal shear > 3300 N
Etiology

- **Current Theories**
  - Muscular imbalances
    - Tight hamstrings with weak:
      - Back extensor, abdominals, hip flexor, lateral lumbar flexor and lumbar rotator
  - Increased pars defect with young athletes
    - Greater than 30% will experience low back pain
      - Higher in some sports
        - Wrestling 59% (31%)
        - Elite gymnasts 79% (38%)
- **Causes**
  - Degenerative Disc disease
  - Spondylolysis
Progression to Spondylolisthesis

- Slippage in 1st and 2nd decade of life
  - Growth spurts
  - Individual disc laxity
- Slippage slows down in subsequent decades
  - Beutler et al. (45 yrs f/u)
    - 4% in 3rd decade
    - 2% in 4th decade
  - Disc degeneration
    - Asymptomatic ➔ symptomatic
    - Progression of slip?
Presentation

- Low BACK PAIN
  - If radiating
    - Buttocks or back of thigh
  - Can also be associated with radiculopathy
- Pain aggravated by extension
- Leg raise will not elicit radiculopathy past knee
Presentation

- Single leg extension
  - Patient standing on one leg while simultaneously extending the low back
    - Pain on side of standing leg
Presentation

- Pain elicited with combination of
  - Lateral bending toward the lesion
  - Rotation away from the lesion
- Adolescent athlete (second decade)
  - During growth spurts
  - Insidious onset
- Exaggerated lumbar lordosis
- Point tenderness on spinous process
- Neurological exam in usually normal
Imaging

- Plain X-rays
  - AP, Lateral and Oblique
    - Coned lateral (85%)
    - Oblique → plane of defect
  - flexion/extension
  - May miss pars defect
Imaging

- Bone scan
  - Activity at defect site
    - “stress reaction”
  - May be missed during early stages of fracture

- SPECT*
  - Single Photon Emission Computed Tomography
  - Most sensitive
  - Bellah et Al.
    - SPECT uptake in 39 of 71 patient were bone scan was negative
  - May show activity prior to seeing actual fracture on CT
    - May affect treatment outcome
Imaging

- CT*
  - More sensitive than plain radiograph
  - (Some believe it is the most sensitive test)
  - May miss lesion pick up by bone scan or SPECT
  - Best for following healing
Imaging
- MRI (bone edema)
  - T2 hyper-intensity
  - T1 hypo-intense
  - Missed lesion pick up by bone scan
  - Can higher powered magnets make a difference
Treatment

- Conservative (77-91%)
  - Brief period of rest
  - Activity restriction
    - 2-6 months
  - Bracing to limit hyperextension
    - 2-6 months
    - Up to 23 hours per day
- Physical therapy
  - Focus on flexion exercises
  - Musculature responsible for spine stabilization
  - Avoid extension and rotational shearing exercises
Treatment

- Conservative (77-91%)
  - Blanda et al.
    - 62 athletes
      - 52 (84%) with excellent results
      - 8 (13%) with good results
      - 2 (3%) with fair results
  - Radiographic healing
    - 78% for unilateral defect (18 of 23)
    - 8% for bilateral defect (3 of 37)
      - 8 underwent fusion for progression
  - 20 athletes with spondylolisthesis
    - 12 Grade I
    - 6 Grade II
    - 2 Grade III
    - 85% had excellent result
    - 12 underwent fusion
      - 5 with progression of slip
      - 5 with persistent pain
      - 2 with neurologic deficit
Treatment

- Conservative (77-91%)
  - Bony healing more frequent with diagnosis within one month of symptoms and proper bracing
    - Role for SPECT
  - Long term results better with bony healing
  - Non-union of a pars defect does not mean the segment is unstable
    - Patient may resume activity
      - ? Limit hyperextension
      - Muschik et al.
        - Smaller progression of slip in athlete than general population
        - Also found progression of slip during growth spurts
  - May require closer follow up
  - CT to confirm bony healing
Treatment

- Conservative (77-91%)
  - Pain Management
    - Injection
      - Conservative treatment bridge
      - Good indicator for surgical outcome
        - Persistent pain may indicate discogenic pain
  - Pharmacological
    - Hold on NSAIDS
  - Bone Stimulators
  - Pulsed Ultrasound
    - Increase blood flow
Treatment

- Operative
  - Failure of conservative treatment
    - Persistent pain over 6 months
  - Back pain independent
    - Neurologic deficit
    - Progressive slip
    - Grade III or higher
  - Fusion (loss of motion segment)
    - Posterolateral fusion
    - TLIF or PLIF
    - ALIF
  - Direct pars repair (motion preserving)
    - Buck’s screw
    - Modified Buck’s technique
    - Scott’s Wiring
    - Screw and Wire
    - Screw and hook (Moscher’s clamp)
    - MIS screw and cable (Dynesys)
Spondylolithic Spondylolisthesis

Surgical Management

H. Francis Farhadi, MD PhD
- Estimated 3 to 10% of general population
- 2/3 progress to spondylolisthesis
  - Family history
  - Occult spina bifida
  - Scheuermann kyphosis
- High grade spondylolisthesis is rare
- Activity Modification

- NSAIDs

- Exercise regimen – reduction of lumbar lordosis, Rx of hip flexion and hamstring contracture

- Bracing

- Greater than 2/3 to 4/5 of patients with grade 1 or 2 slips have successful symptom relief and return to previous activity level
Operative Management

- Growing children with slip greater than 50%
- Radiologic evidence of progressive displacement
- Persistent back +/- leg pain not relieved by conservative measures
- Neurologic deficit
Fusion

- In situ, uninstrumented, posterolateral fusion with autologous bone graft
- Supported by single-center retrospective case series
  - > 80% good outcomes
  - 1.3 to 3.1% risk of neurological complications (SRS)
Surgery Versus Conservative Management in Adult Isthmic Spondylolisthesis
A Prospective Randomized Study: Part 1

Hans Moller, MD, and Rune Hedlund, MD, PhD

Study Design. A prospective randomized study was performed.

Objective. To determine whether posterolateral fusion in patients with adult isthmic spondylolisthesis results in an improved outcome compared with an exercise program.

Summary of Background Data. In spondylolisthesis, satisfactory results have been reported with both surgical and conservative management. The evidence for treatment efficacy, however, is weak because prospective randomized studies are lacking.

Methods. In this study, 111 patients were randomly allocated to an exercise program (n = 34) or posterolateral fusion with or without transpedicular fixation (n = 77). The inclusion criteria were lumbar isthmic spondylolisthesis of any grade, at least 1 year of low back pain or sciatica, and a severely restricted functional ability in individuals 18 to 55 years of age. Pain and functional disability were quantified before treatment and at 1- and 2-year follow-up assessments by visual analog scales (VAS).

Results. The 2-year follow-up rate was 93%. The functional outcome, as assessed by the Disability Rating Index and the pain reduction, was better in the surgically treated group than in the exercise group at both the 1- and 2-year follow-up assessments (P < 0.01). In the longitudinal analysis, the mean Disability Rating Index and pain improved in the surgical group (P < 0.0001). In the exercise group, the Disability Rating Index did not change at all, whereas the pain decreased slightly (P < 0.02).

Conclusions. Surgical management of adult isthmic spondylolisthesis improves function and relieves pain more efficiently than an exercise program. [Key words: exercise, functional outcome, isthmic spondylolisthesis, low back pain, physiotherapy, lumbar spinal fusion, prospective randomized clinical study]

The presence of isthmic spondylolisthesis in patients with CLBP may positively modify the treatment effect of fusion vs. multidimensional supervised rehabilitation with respect to pain and function.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Diagnosis</th>
<th>Study name</th>
<th>SD in means and 95% CI</th>
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<tbody>
<tr>
<td>Pain</td>
<td>(-) IS</td>
<td>Brox et al 2003</td>
<td>0.29 (-0.22, 0.80)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fritzell et al 2001</td>
<td>0.70 (0.41, 0.99)</td>
</tr>
<tr>
<td></td>
<td>(+) IS</td>
<td>Möller &amp; Hedlund 2000</td>
<td>2.31 (1.79, 2.84)</td>
</tr>
<tr>
<td>Function</td>
<td>ODI</td>
<td>Brox et al 2003</td>
<td>0.13 (-0.38, 0.64)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fairbank et al 2005</td>
<td>0.18 (-0.05, 0.42)</td>
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<tr>
<td></td>
<td></td>
<td>Fritzell et al 2001</td>
<td>0.50 (0.21, 0.79)</td>
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<tr>
<td></td>
<td>GFS</td>
<td>Brox et al 2003</td>
<td>0.25 (-0.27, 0.75)</td>
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<td>Fritzell et al 2001</td>
<td>0.59 (0.30, 0.88)</td>
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<td></td>
<td>DRI (+) IS</td>
<td>Möller &amp; Hedlund 2000</td>
<td>3.03 (2.45, 3.62)</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; DRI, Disability Rating Index; GFS, General Function Scale; IS, isthmic spondylolisthesis; ODI, Oswestry Disability Index; VAS, visual analog scale.
PLIF/TLIF Approach
2-Level MIS TLIF Closure
Surgical treatment of lumbar spondylolisthesis with spondyloysis

Safdar Khan, MD
Case History - KL

- 51 y/o man with long standing history of back and right leg pain
- Leg pain worse than back pain (80:20)
- Also c/o ‘start-up pain’
- Leg pain radicular in character, L5 root dermatome
- No weakness on clinical exam
- No bowel/bladder issues
Case History - KL

- Clinical impression: Isthmic spondylolisthesis L5-S1 with stenosis causing right L5 radiculopathy

- Non operative management first!
- PT, injections, medications

- Failed 6-8 weeks of conservative care
- Goals of surgical treatment?
Case History - KL

- Now 1 year s/p L5-S1 posterior spinal fusion with decompression and interbody fusion

- Excellent outcome – pain free, back to work, no back or leg pain
Discussion and Questions