Spondylolysis

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Until every child is well™

HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

Disclosures

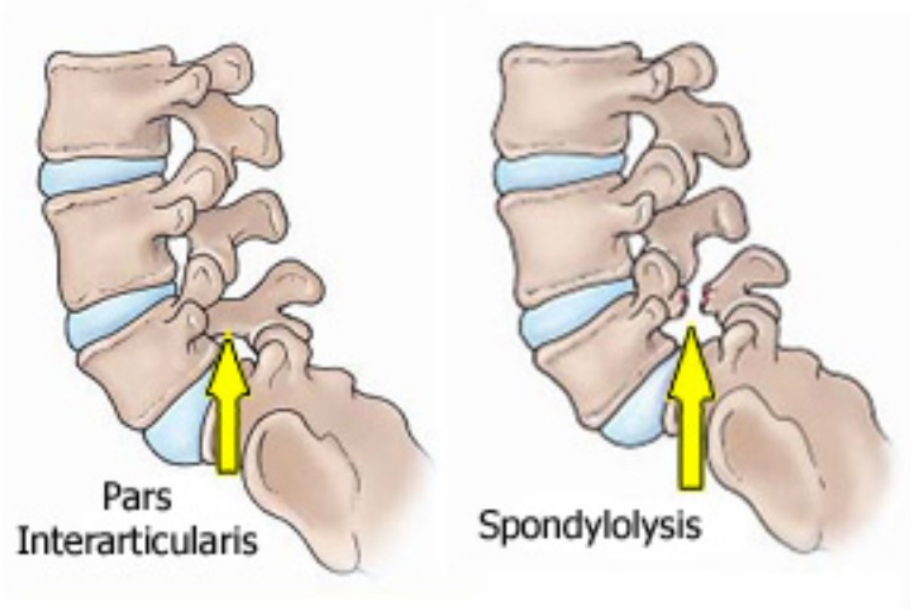
- Paid speaker and consultant:
  - Gatorade Sports Science Institute
  - Hologic
  - US Olympic and Paralympic Committee

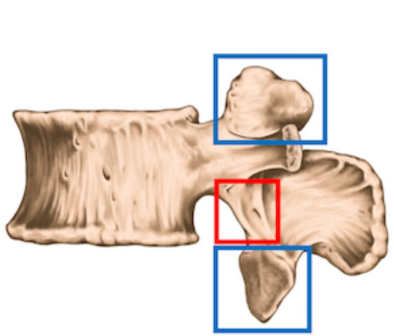
Objectives

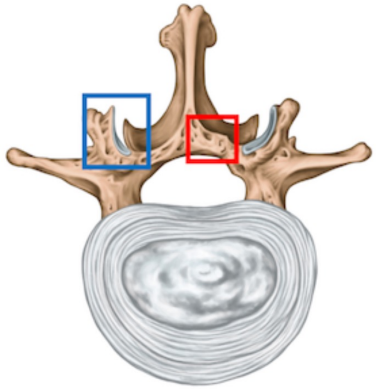
- Understand the prevalence and risk factors for spondylolysis
- Understand the diagnosis of spondylolysis, including physical exam and imaging options
- Understand the treatment approaches to spondylolysis and variations with bracing and return to play

Spondylolysis

- Fracture of the pars interarticularis

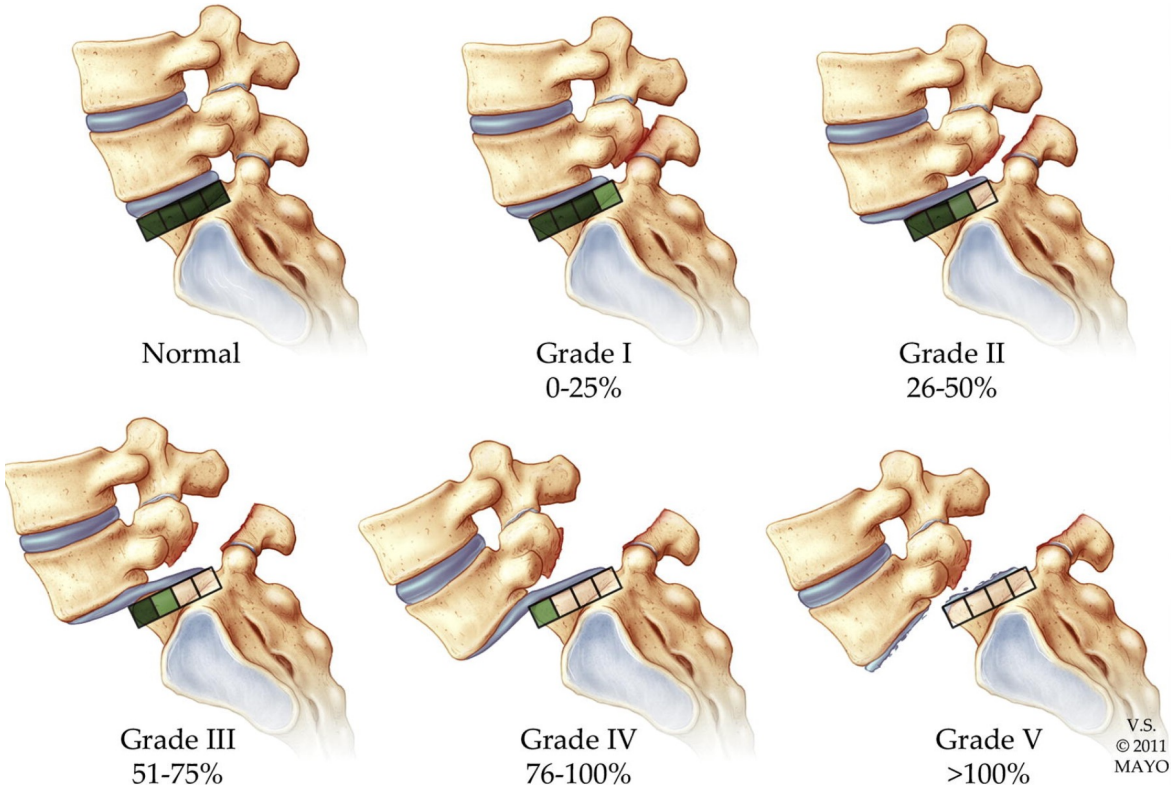






Spondylolisthesis

- Anterior slippage of 1 vertebra on its adjacent caudal vertebra



- Meyerding classification (Grades 1-5):
  - Percentage of anterior displacement

Prevalence

- 0% incidence in newborns and non-ambulatory patients
- Spondylolysis and low grade spondylolisthesis (grades 1 and 2) have been found incidentally in 2.5-3.5% of asymptomatic children receiving MRI or CT scan of abdomen or pelvis for other reasons
- 50% of Canadian Inuits
- 47% incidence in adolescent athletes with back pain

Berger R and Doyle S. Curr Opin Pediatr, 2019.
Merbs CF. Spine, 1995.
Micheli LJ and Wood R. Arch Pediatr Adolesc Med, 1995.

At Risk Populations

- Males 2-3x more likely than Females
- Whites 2-3x more likely than Blacks

- Athletes performing extension-based activity requiring repetitive axial loading over time (gymnastics, dance, diving, tennis, etc.)
  - In a study of 100 young female gymnasts, prevalence of spondylolysis was 11% (vs. 2.3% in the average young female population)

- Usually those performing chronic axial loading, but can also occur from a single acute overload injury

Bouras T and Korovessis P. Eur J Orthop Surg Traumatol, 2015.
Jackson DW, et al. Clin Orthop Relat Res, 1976.
Berger R and Doyle S. Curr Opin Pediatr, 2019.
Selhorst M, et al. Clin J Sport Med, 2017.

At Risk Populations

- 2017 Chart Review:
  - Records of 1025 adolescent athletes with LBP (mean age 15 ± 1.8 yrs)
  - 308 (30%) were diagnosed with a spondylolysis
  - Relative risk of diagnosis of spondylolysis injury in 11 sports for males and 14 sports for females
  - The risk of spondylolysis differed by sex with baseball (54%), soccer (48%), and hockey (44%) having the highest prevalence in males and gymnastics (34%), marching band (31%), and softball (30%) for female athletes

- Important to consider geographic region, type and level of athlete

Selhorst M, et al. Clin J Sport Med, 2017.

Signs and Symptoms

- Typically an adolescent athlete involved in a sport involving repetitive lumbar loading in extension and rotation presents with acute or insidious onset low back pain that worsens with extension-based activities
- Lower lumbar back pain, occasionally with radiation in the buttocks and/or proximal lower extremities (neurologic symptoms are rare)
- Pain on extension, not typically with flexion, but possibly with return to neutral from flexion
- Pain is improved with rest

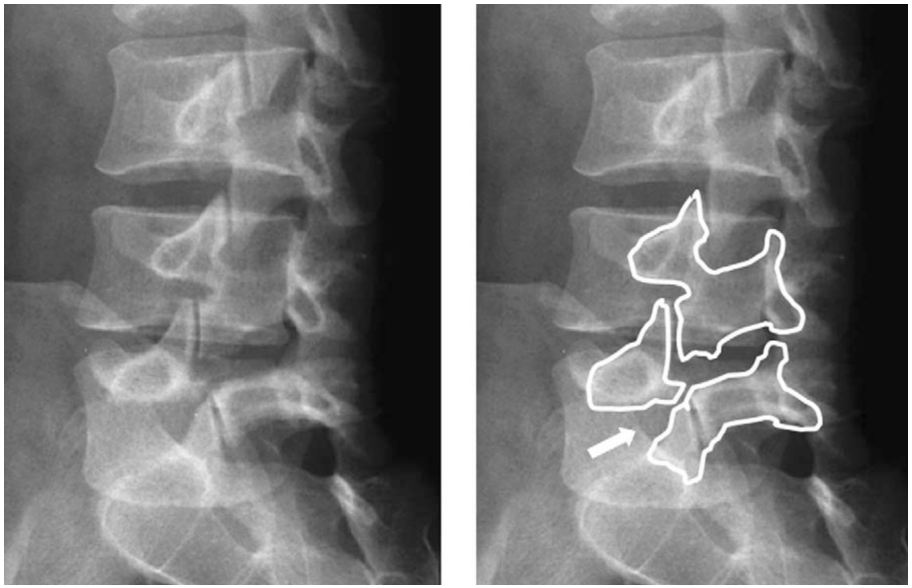
Clinical Exam

- Test for pain with back extension and flexion
- Neurologic exam
- Flexibility testing
  - extension achieved largely with hinging at one level, hyperlaxity, or poor flexibility of hamstrings and hip flexors
- Sometimes observation of hyperlordosis

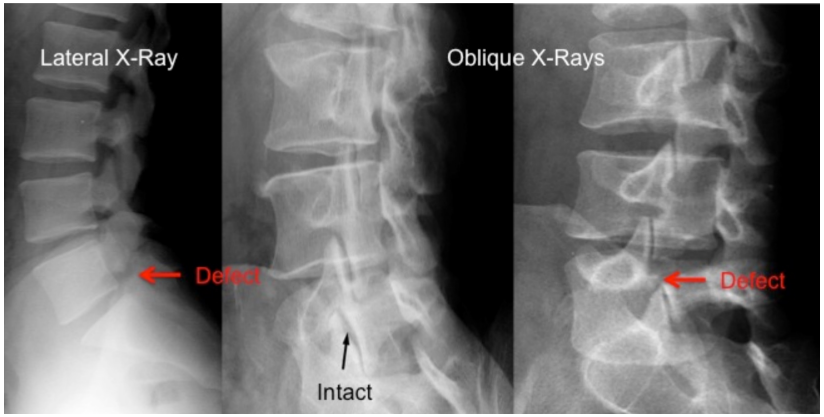
★ Stork Test

Imaging

- Plain radiographs
  - Standard of care has changed from multiple plain film views to just AP and lateral
  - "Scottie dog" on oblique view



- Study of patients with spondylolysis on x-ray showed no difference in sensitivity with AP/Lat vs. addition of Oblique view
  - (78% vs 72%, p=0.39)
- Sensitivity of 2 views compared to CT: 75%



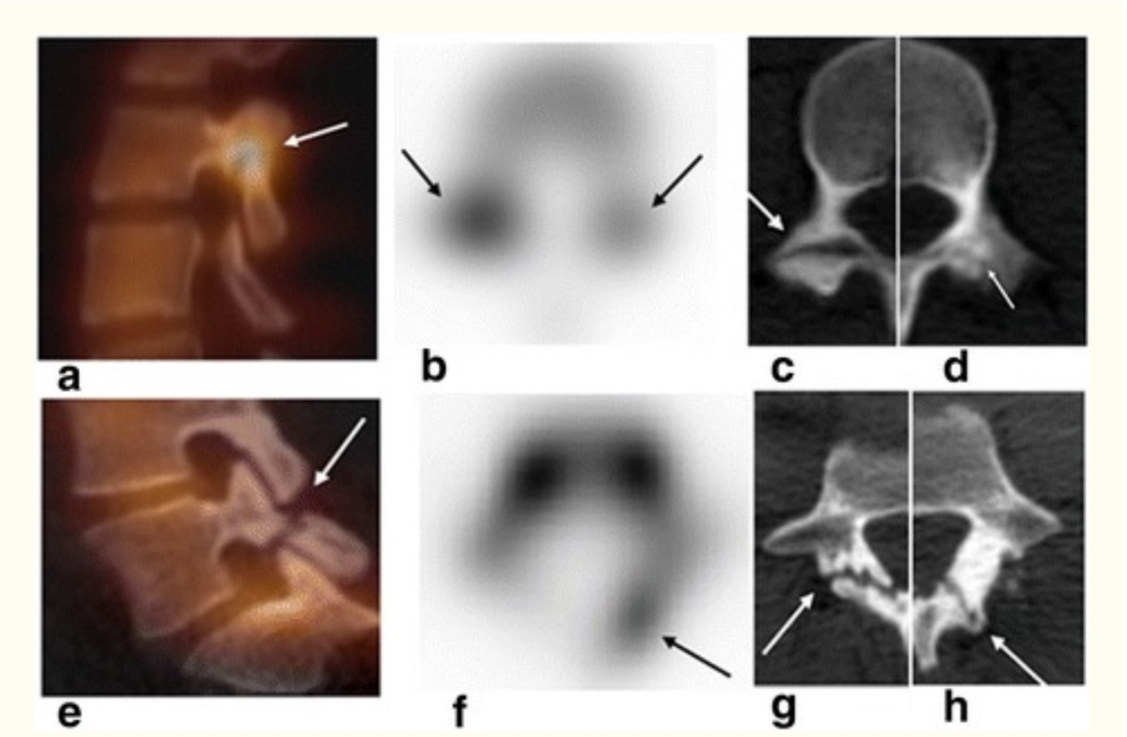
Berger RG & Doyle SM. Curr Opin Peditr, 2019.
Miller R, et al. J Peditra Orthop, 2013.

Imaging

- Bone Scintography
  - Most sensitive method for detecting active spondylolysis in adolescent athletes
  - Significant radiation

Imaging

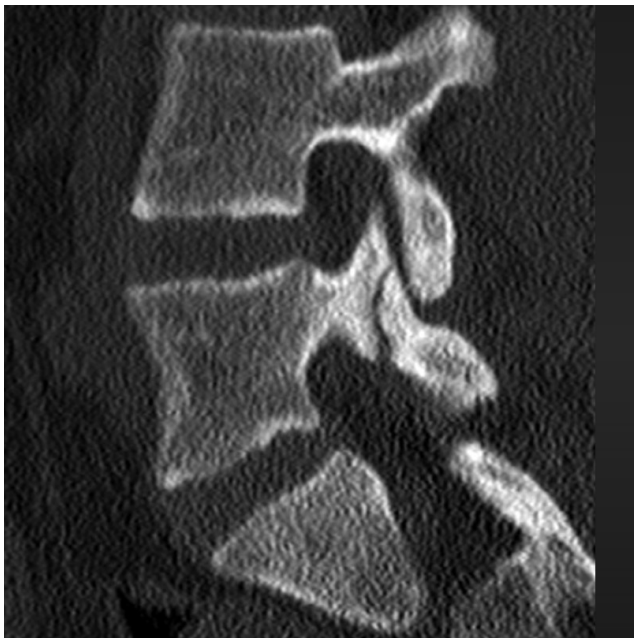
- Bone Scan + SPECT/CT (single-photon emission computed tomography/computerized tomography)
  - –Great images
  - –Even more radiation with the added CT



Matesan M, et al. J Orthop Surg Res, 2016.

Imaging

- Computed Tomography (CT)
  - Significant radiation, but can be helpful to assess chronic injuries or delayed healing



Miller R, et al. J Peditra Orthop, 2013.

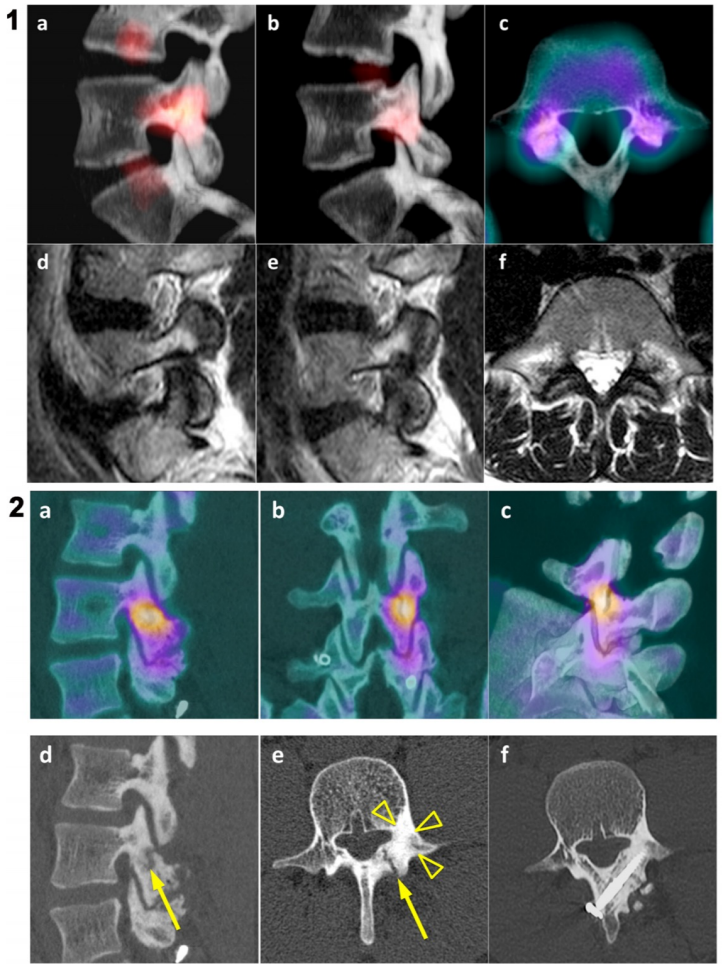
Imaging

- Magnetic Resonance Imaging (MRI)
  - –Considered most appropriate test by some
  - –Compared to CT, has 80-95% sensitivity and no radiation

Kobayashi A, et al. Am J Sports Med, 2013. Masci L, et al Br J Sports Med, 2006.

Imaging

- Boston Children's Hospital/ Harvard
  - –Usually skip the plain radiographs
  - –Start with an MRI
  - –Consider CT much later for better characterization
  - –Really can't figure out the cause of pain, maybe consider SPECT Bone Scan
    - Rarely add additional CT images



Kobayashi A, et al. Am J Sports Med, 2013. Masci L, et al Br J Sports Med, 2006.

Treatment

- Rest from sports
- Physical therapy
- Bracing or not bracing

Boston Overlapping Brace

Boston Transitional Brace

Rehabilitation

- Flexibility- hamstrings, glutes, and hip flexors
- Core strength
- No extension or twisting
- Various progression protocols

Rehabilitation

- RTP based on Timing of Physical Therapy Referral
  - Retrospective chart review
  - Medical charts of 196 adolescent athletes (mean age = 14.3 ± 1.8 years) with an acute spondylolysis
  - Aggressive referral group (<10 weeks) vs. conservative referral group (>10 weeks) were compared
  - Median days to full RTP for aggressive referral group (115.5 days, interquartile range 98-150 days) vs. conservative referral group (140.0 days, interquartile range 114.5-168 days) were significantly different (*P* = 0.002).

Selhorst M, et al. Clin J Sport Med, 2017.

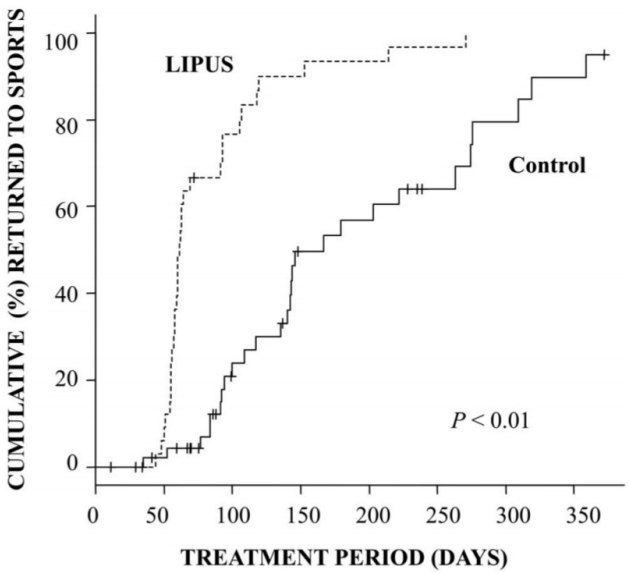
Other Options- US?

- Low Intensity Pulse Ultrasound (LIPUS) & Brace & PT vs. Brace & PT
  - 1.5-MHz oscillation frequency, 1-kHz pulsed frequency, 30-mW/cm2 spatial intensity, and a duration of 20 minutes.
  - The median number of LIPUS treatments was 27 (interquartile range, 18-35); at least 3 days a week

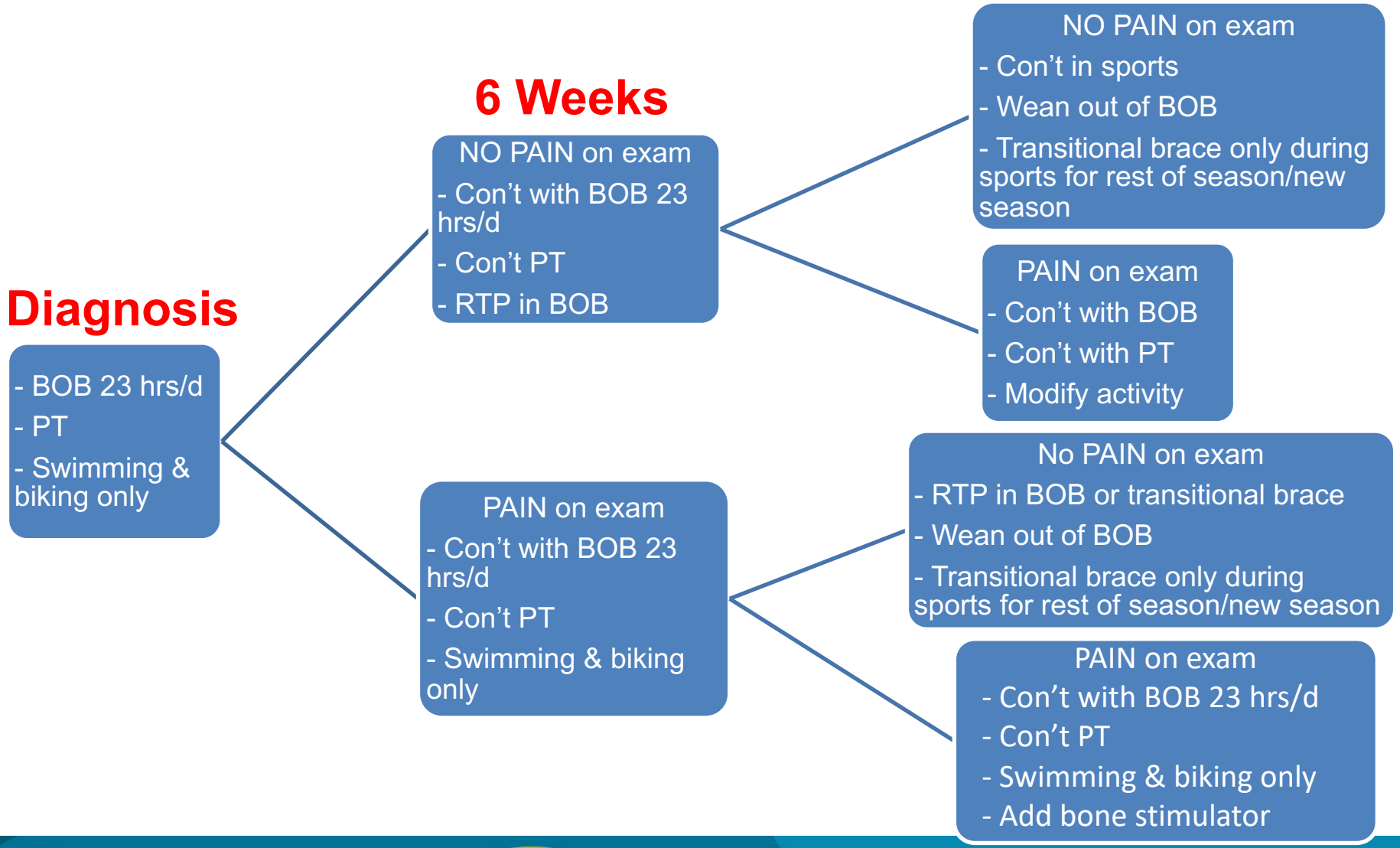
- The median RTP was 61 days (95% CI: 58-69 days) in the group treated with LIPUS vs. 167 days (95% CI: 135-263 days) in the control group ($p < 0.01$)

TABLE 1. Demographic Data and Patient Characteristics (n = 82)

Parameter	LIPUS (n = 35)	Control (n = 47)	*P*
Age (mean ± SD), y	14.6 ± 2.1	15.0 ± 1.6	0.55*
Sex, n (male, female)	35, 0	45, 2	0.33†
Height, cm	166.9 ± 9.5	167.4 ± 8.7	0.87*
Weight, kg	59.4 ± 10.1	57.4 ± 13.4	0.36*
Body mass index, kg/m^2	21.2 ± 2.3	20.3 ± 3.8	0.17*
Location of spondylolytic lesion			
Level, n			0.55†
L2	1	0	
L3	4	6	
L4	7	13	
			0.76†
			0.39†
		3.1	0.51*



Follow-up and Return to Play at Boston Children's Hospital



Return to Play

- 2019 Systematic Review:
  - 14 trials (592 participants) were included
  - 8 studies reported conservative treatment outcomes
    - 92% (n = 492) return to sports at any level, and 89% (n = 185) returned to their pre-injury level of sports
    - Average time to RTP was 4.6 months
  - 7 studies reported surgical treatment outcomes
    - 88% (n =100) return to sports at any level, and 81% (n = 103) returned to their pre-injury level of sports
    - Average time to RTP was 6.8 months

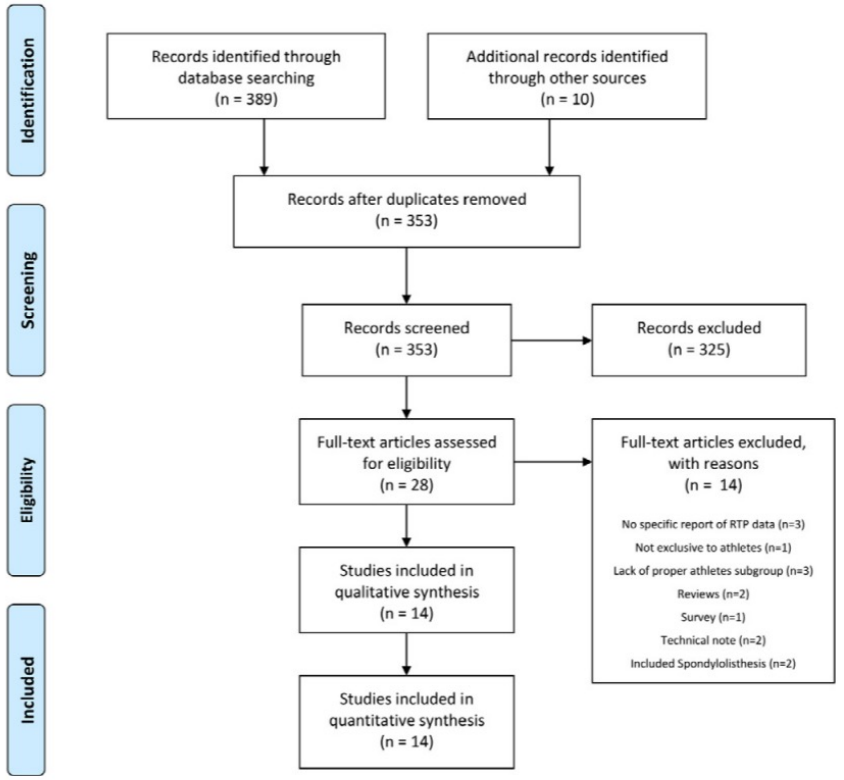


Fig. 1. PRISMA flow chart describing the screening strategy for included studies and resons on excluded studies.

Grazina R, et al. Phys Ther Sport, 2019.

Controversies and Areas for Further Research

- Imaging: Radiographs vs. Bone Scan vs. SPECT/CT Bone Scan vs. CT vs. MRI?
- Bracing: Yes or No and How long?
- Physical Therapy: When and what?
- Other Activity: When and what?
- Return to Play: When to initiate and duration of progression back?

THANK YOU!

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