Sports Injuries in Children & Adolescents

Andrew S. T. Porter, DO, FAAFP

University of Kansas School of Medicine - Wichita

Sports Medicine Fellowship & Family Medicine Residency at Ascension Via Christi

43rd Annual Family Medicine Winter Symposium

November 30, 2023

KU WICHITA FAMILY & COMMUNITY MEDICINE
The University of Kansas

Via Christi HEALTH

Ascension

Disclosures

- None
- Images used with permission

Sports Injuries in Children & Adolescents

- Sudden Cardiac Death (SCD)
- Back Pain in Young Athletes
- Apophyseal Injuries

Sudden Cardiac Death

- Sudden Cardiac Death (SCD)
- Leading medical cause of death in young athletes
- New research suggests incidence
  - 1 in 50,000 athlete-years in college athletes
  - 1 in 80,000 athlete-years in high school athletes
- Males & African Americans are at higher risk
  - Men’s basketball: 1 in 9,000 athlete-years

Sudden Cardiac Death

- Some data suggests that athletes may be at higher risk to experience SCD because of their increased level of physical activity that can lead to arrhythmias
- Other data suggests SCD is more common in young non-athletes vs young athletes
  - Maron, BJ. AM J Cardiol. 2016;117(8):1339-1341.

SCD

- SCD is the presenting symptom of underlying cardiovascular pathology in 50-90% of athletes
  - Significantly limits usefulness of history-based screen

SCD

- Warning symptoms
  - Exertional chest pain
  - Exertional syncope
  - Exertional near-syncope
  - Dyspnea or fatigue disproportionate to level of exertion
  - Palpitations
  - Irregular heart beats
- Family history of sudden unexplained death or SCD <50y/o
- Family history of cardiac disease known to cause SCD

SCD

- SCD in athletes <35y/o
- In most cases, structural heart disease was present
  - Hypertrophic Cardiomyopathy (HCM), anomalous origin of a coronary artery, arrhythmogenic right ventricular cardiomyopathy (ARVC), myocarditis, & coronary atherosclerosis
  - Similar findings in US, UK, and US Military
    - Maron BJ. Circulation 2007; 115:1643
    - Eckert RE. Ann Intern Med 2004; 141:829
    - Finocchiaro G. J Am Coll Cardiol 2016; 67;2108

SCD

- SCD in athletes <35y/o in Northern Italy
  - ARVC was the most common abnormality, then coronary atherosclerosis and 3rd most common cause was anomalous origin of a coronary artery
  - Northern Italy has a known higher prevalence of ARVC
    - Corrado D. N Engl J Med 1998: 339:364

SCD

- SCD during athletics also occurs in the absence of structural heart disease known as primary electrical disease
  - Long QT Syndrome
  - Short QT Syndrome
  - Brugada Syndrome
  - Catecholaminergic polymorphic ventricular tachycardia
  - Wolf-Parkinson-White Syndrome (WPW)

SCD

- SCD precipitated from trauma
  - Commotio cordis
- SCD in athletes >35y/o
  - **Coronary artery disease** is the most common cause of SCD during exercise

Table 1. Causes of Sudden Death in 387 Young Athletes*

Cause	No. of Athletes	Percent
Hypertrophic cardiomyopathy	102	26.4
Commotio cordis	77	19.9
Coronary artery anomalies	53	13.7
Left ventricular hypertrophy of indeterminate causation†	29	7.5
Myocarditis	20	5.2
Ruptured aortic aneurysm (Marfan syndrome)	12	3.1
Arrhythmogenic right ventricular cardiomyopathy	11	2.8
Tunneled (bridged) coronary artery‡	11	2.8
Aortic valve stenosis	10	2.6
Atherosclerotic coronary artery disease	10	2.6
Dilated cardiomyopathy	9	2.3
Myxomatous mitral valve degeneration	9	2.3
Asthma (or other pulmonary condition)	8	2.1
Heat stroke	6	1.6
Drug abuse	4	1.0
Other cardiovascular cause	4	1.0
Long QT syndrome§	3	0.8
Cardiac sarcoidosis	3	0.8
Trauma causing structural cardiac injury	3	0.8
Ruptured cerebral artery	3	0.8

*Data are from the registry of the Minneapolis Heart Institute Foundation (3). †Findings at autopsy were suggestive of HCM but were insufficient to be diagnostic. ‡Tunneled coronary artery was deemed the cause of death in the absence of any other cardiac abnormality. §The long QT syndrome was documented on clinical evaluation. Source: Reproduced from Maron B.J. (3) with permission of the Massachusetts Medical Society.

Hypertrophic Cardiomyopathy (HCM)

- Most common cause of Sudden Cardiac Death <35y/o
- Prevalence of 1 in 500 in general population
- Reported to cause 2-36% of SCD in athletes
  - Different studies report different rates of SCD
  - Corrado 2003 (Italy): 2%
  - Maron 2007 (USA): 36%
  - Harmon 2011 (USA): 3%

HCM

- Pathologic Features
  - Symmetric LV Hypertrophy (usually involving ventricular septum)
  - **LV wall thickness ≥ 16 mm**
    - Normal ≤ 12 mm
    - Borderline 13-15 mm
  - Non-dilated left ventricle
  - Histological analysis shows disorganized cellular architecture
    - Intramural tunneling (myocardial bridging)

HCM

- Presenting symptom of HCM is SCA in 80% of cases
- Sxs may include
  - Exertional chest pain
  - Dyspnea
  - Lightheadedness
  - Syncope

HCM

- Physical Exam
  - Harsh systolic ejection murmur that increases with valsalva & decreases with maneuvers that increase venous return
    - Cardiac exam auscultation in supine, sitting & squatting positions
    - Murmur goes away or decreases when you have them squat down

HCM

- EKG
  - Can be abnormal in up to 90% of athletes
    - T wave inversion in lateral or inferolateral leads
    - ST segment depression
    - Pathologic Q waves
    - Complete LBBB
- Echo
  - Standard to confirm diagnosis
    - LV wall thickness ≥ 16 mm
- MRI
  - Additional value in identifying segmental hypertrophy in anterolateral free wall or at apex

HCM

- Return to Play (RTP)
  - Exercise increases risk of ventricular tachycardia/fibrillation
  - Exercise is a modifiable risk factor
  - Athletes with HCM should not participate in strenuous exercise
  - Which sports?

Journal of the American College of Cardiology

Published by Elsevier Inc.

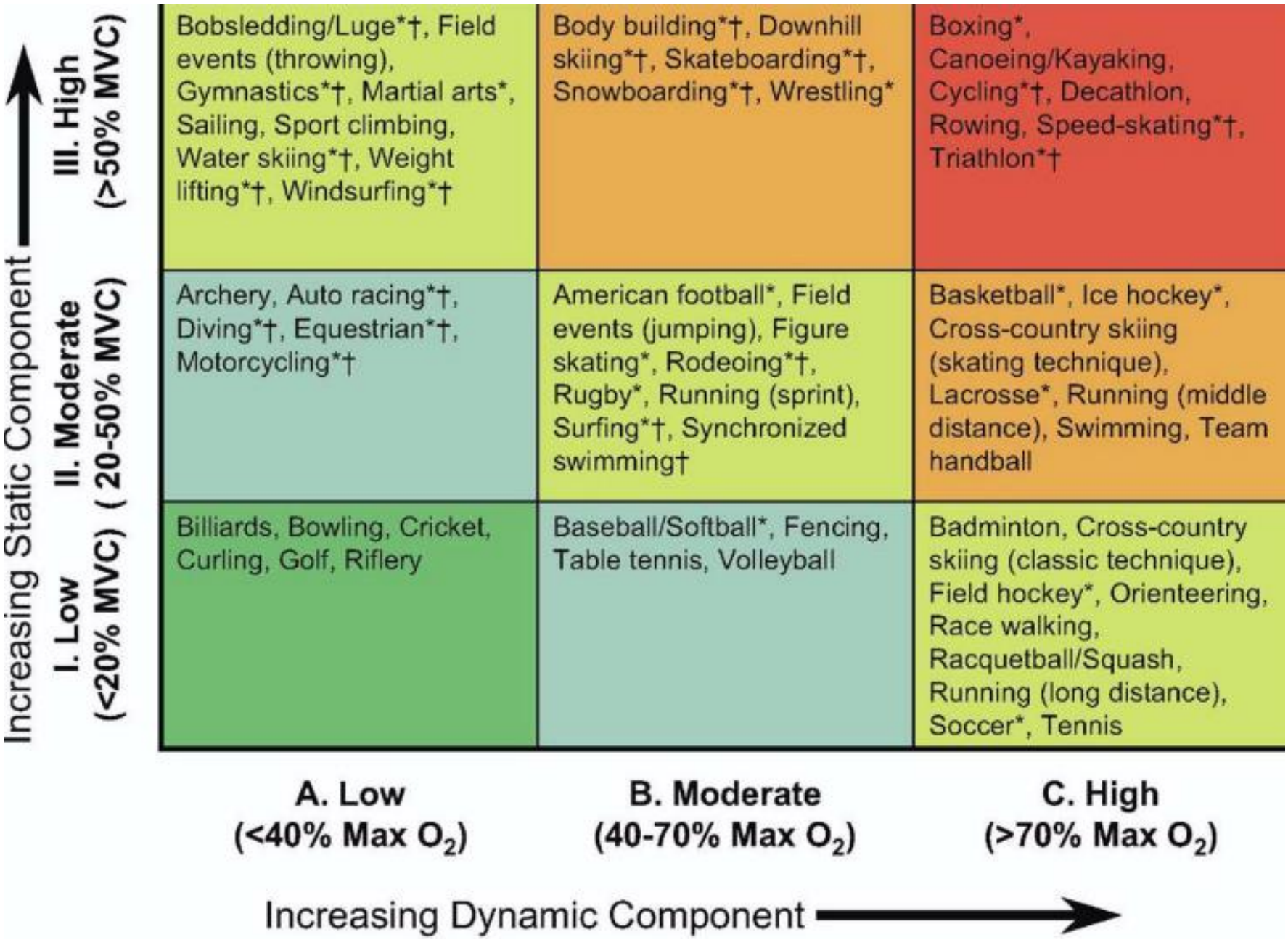
Vol. 45, No. 8, 2005
ISSN 0735-1097/05/$30.00
doi:10.1016/j.jacc.2005.02.002

36th Bethesda Conference

Eligibility Recommendations for Competitive Athletes With Cardiovascular Abnormalities

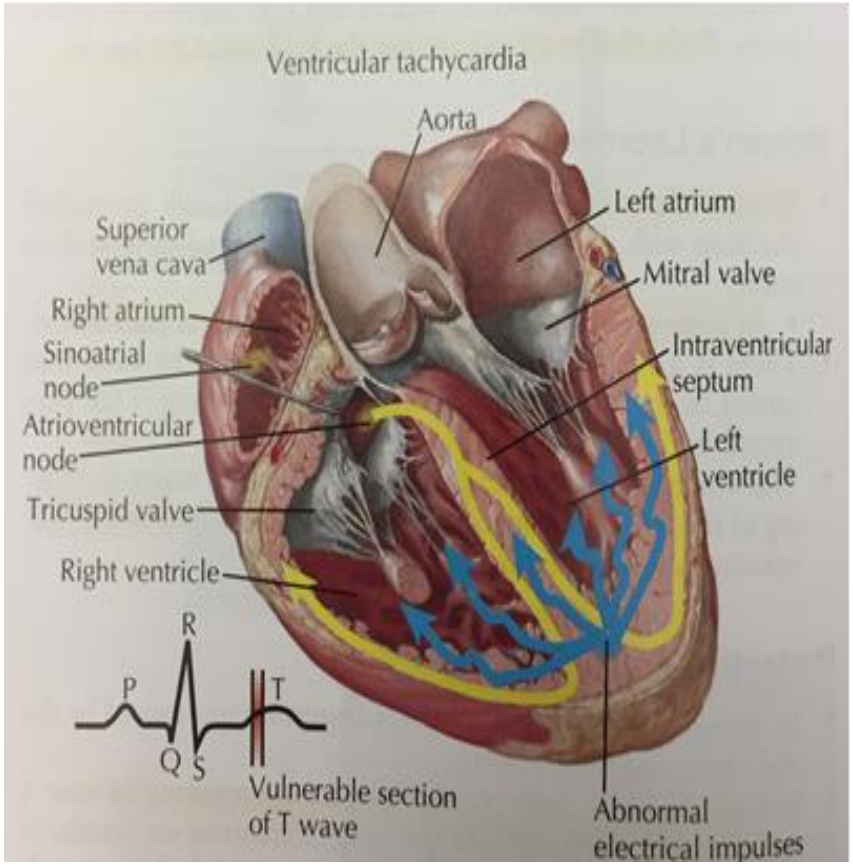
HCM – Which Sports?

- Excluded from most competitive sports
- Can possibly participate in Class 1A


Increasing Static Component
III. High (>50% MVC)
II. Moderate (20-50% MVC)
I. Low (<20% MVC)
Bobsledding/Luge*†, Field events (throwing), Gymnastics*†, Martial arts*, Sailing, Sport climbing, Water skiing*†, Weight lifting*†, Windsurfing*†
Body building*†, Downhill skiing*†, Skateboarding*†, Snowboarding*†, Wrestling*
Boxing*, Canoeing/Kayaking, Cycling*†, Decathlon, Rowing, Speed-skating*†, Triathlon*†
Archery, Auto racing*†, Diving*†, Equestrian*†, Motorcycling*†
American football*, Field events (jumping), Figure skating*, Rodeoing*†, Rugby*, Running (sprint), Surfing*†, Synchronized swimming†
Basketball*, Ice hockey*, Cross-country skiing (skating technique), Lacrosse*, Running (middle distance), Swimming, Team handball
Billiards, Bowling, Cricket, Curling, Golf, Riflery
Baseball/Softball*, Fencing, Table tennis, Volleyball
Badminton, Cross-country skiing (classic technique), Field hockey*, Orienteering, Race walking, Racquetball/Squash, Running (long distance), Soccer*, Tennis
A. Low (<40% Max O_2)
B. Moderate (40-70% Max O_2)
C. High (>70% Max O_2)
Increasing Dynamic Component

Commotio Cordis

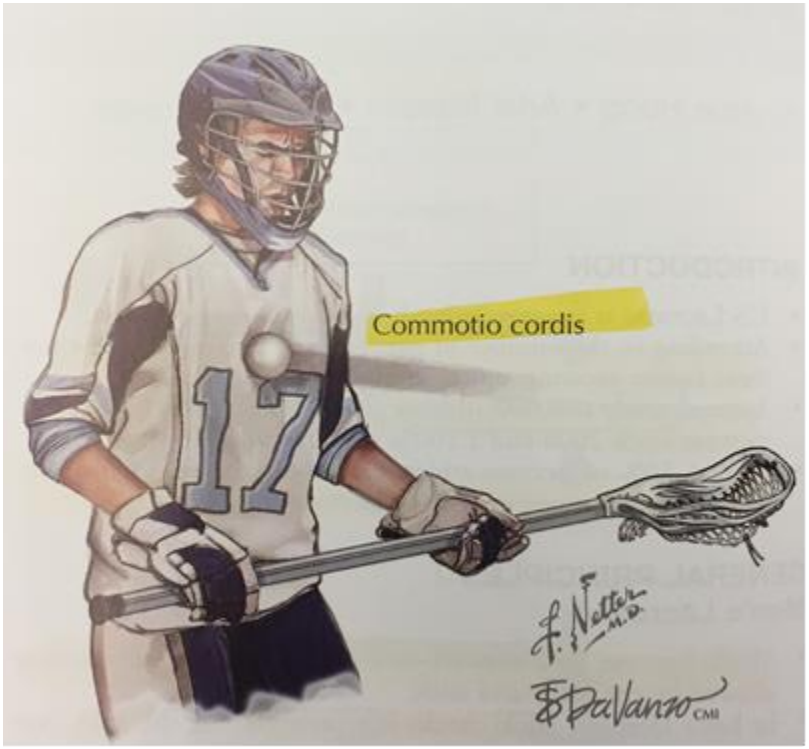
- Occurs after the chest wall is struck with a blunt object
  - During ventricular repolarization
    - Just before peak of T wave
  - Can lead to ventricular fibrillation
- Structurally normal heart

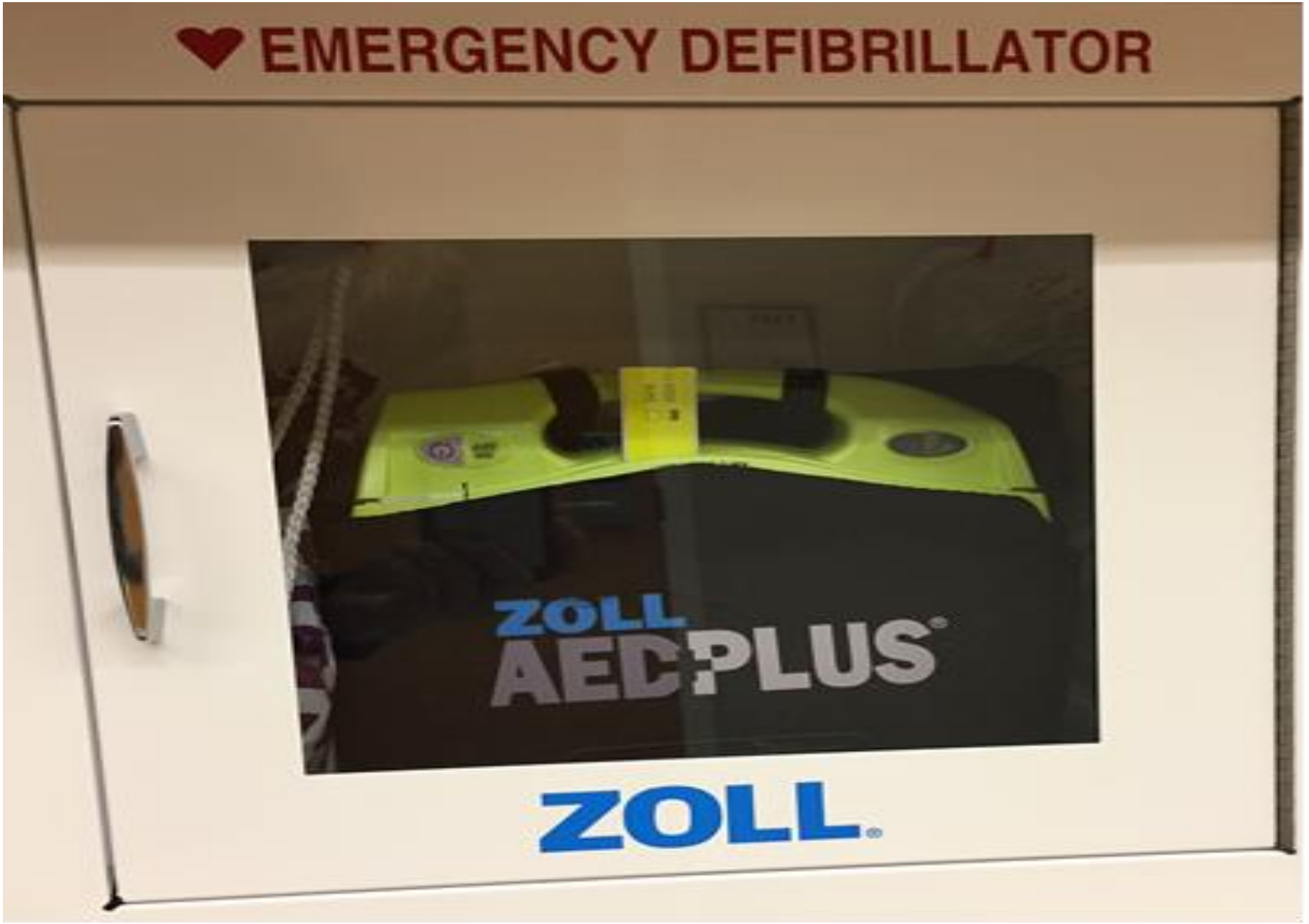


Commotio Cordis

- Instantaneous collapse after the blow
  - Can be right after the blow or after about 10 seconds

- Defibrillate STAT
  - 25% survival rate if defibrillation is within 3 minutes
  - 3% after 4 minutes
  - Animal model showed 90% survival at 2 minutes




EMERGENCY DEFIBRILLATOR
ZOLL
AED PLUS
ZOLL

Commotio Cordis

- Prevention?
  - Chest protectors
    - Have not been shown to be effective
    - Safety balls
      - In animal models have been shown to be associated with decreased arrhythmias
  - Education
    - Avoid chest shot blocking
    - Emergency Action Plan
      - AED

Myocarditis

- Acute inflammatory process involving the myocardium

- Coxsackie B Virus > 50% of time
- Echovirus
- Adenovirus
- Influenza
- Chlamydia Pneumoniae

- Lymphocytic infiltration of myocardium with necrosis of myoctyes

Myocarditis

- Sx
  - Present with flu-like illness followed by progressive exercise intolerance
  - Dyspnea
  - Cough
  - Orthopnea
    - Can lead to dilated cardiomyopathy
    - → SCD can develop in active or healed myocarditis
- P/E
  - S3 gallop
  - Edema & pulmonary rales

Myocarditis

- ECG
  - Diffuse Low voltage
  - ST & T wave changes
  - Heart block
  - Ventricular arrhythmias
- Labs
  - Leukocytosis
  - ↑ ESR
  - ↑ CRP
  - ↑ Myocardial enzymes
- Echo
  - Dilated LV, global hypokinesis, ↓ LVEF

Myocarditis RTP

- Active myocarditis
  - Should not compete
- Return to play is variable after resolution (3-6 months)
  - RTP if:
    - Ventricular systolic function returned to normal
    - Serum myocardial injury markers are normal
    - Associated arrhythmias resolved

Primary Electrical Disease

- Channelopathies
  - Diseases predisposing to potentially lethal ventricular tachyarrhythmia's
  - Characterized by abnormalities in ion-channel proteins leading to dysfunction of sodium, potassium, calcium and other ion transport across cell membranes
  - Likely that many deaths secondary to SCD with pathologically normal hearts are from channelopathies

Long QT Syndrome (LQTS)

- Most common channelopathy
- Prolonged ventricular repolarization & QT interval corrected for heart rate (QT_c)
- Six different types
  - LQTS-1, LQTS-2, LQTS-3 are most common
- Sx
  - Syncope
  - Pre-syncope
  - Family Hx of sudden unexplained death or sudden infant death

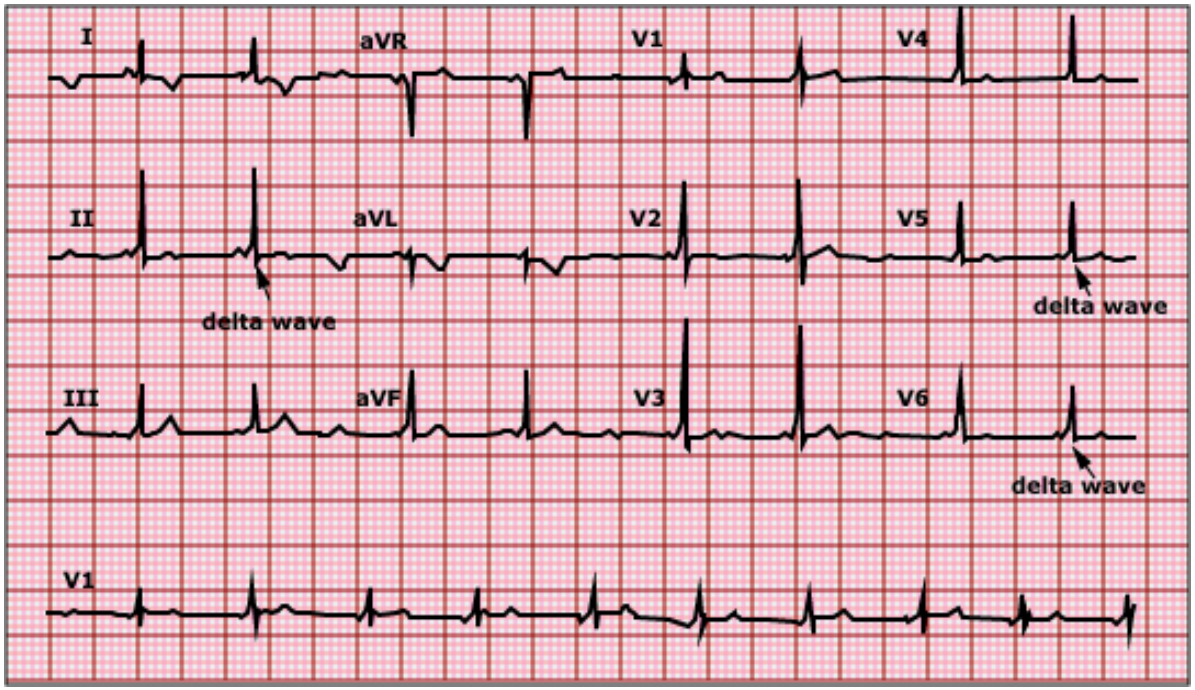
LQTS

- ECG
  - $QT_c \geq 470$ ms in males
  - $QT_c \geq 480$ ms in females
- RTP
  - Decisions guided by heart rhythm specialist
  - Can consider class IA sports

Wolf-Parkinson-White Syndrome (WPW)

- Approximately 1% of ECGs will show changes consistent with WPW
  - Only a small subset will go on to develop the associated arrhythmias associated with WPW
- Pathologic Features
  - Tachyarrhythmia caused by accessory pathway that directly connects the atria & ventricles & bypasses the AV node
  - Arrhythmias
    - Atrioventricular tachycardia
    - A-Fib
    - A-Flutter
- Sx
  - Palpitations, syncope, near-syncope

WPW - ECG



- Slurring of QRS upstroke (delta wave)
- ECG can also show PR < 120 ms & QRS > 120 ms

WPW

- Once diagnosed, risk stratify with exercise stress testing
- RTP
  - High Risk Pathways
    - Catheter or surgical ablation with normal repeat EP studies or 2-4 weeks without sxs can undergo subsequent RTP
  - Low Risk Pathways
    - RTP without ablation is reasonable

Back Pain in Young Athletes

- Different than adult general population
  - Pain more likely secondary to:
    - Sprain, strain, contusion, or fracture
    - Facet Syndrome
    - Spondylolysis or Spondylolisthesis
    - Disc Herniations
    - Scheuermann's Disease
    - Congenital Anomalies (Scoliosis)
    - Osteomyelitis
    - Sacroiliac Joint Dysfunction
    - Rheumatologic Condition (Ankylosing Spondylitis)
    - Tumor (Osteoid Osteoma, Osteochondroma)
- Back pain is less likely Mechanical/Non-specific (facet, SI, OA, sprain/strain) etiology

Back Pain in Young Athletes

- Risk Factors
  - Strength
  - Flexibility
  - Imbalances (e.g., Hip Extensors)
  - Functional Deficits
  - Growth Spurts
  - Abrupt increase in intensity or duration of training
  - Improper Technique
  - Poor Equipment
  - Leg Length Discrepancies

Back Pain in Young Athletes

- Gymnasts/Divers
  - Interspinous process bursitis or stress fx
- Swimmers (esp. butterfly) & weightlifters
  - Scheuermann's kyphosis
- Wrestlers, ballet dancers, gymnasts, divers, pole-vaulters, football, & swimmers
  - Spondylolysis

Case #1

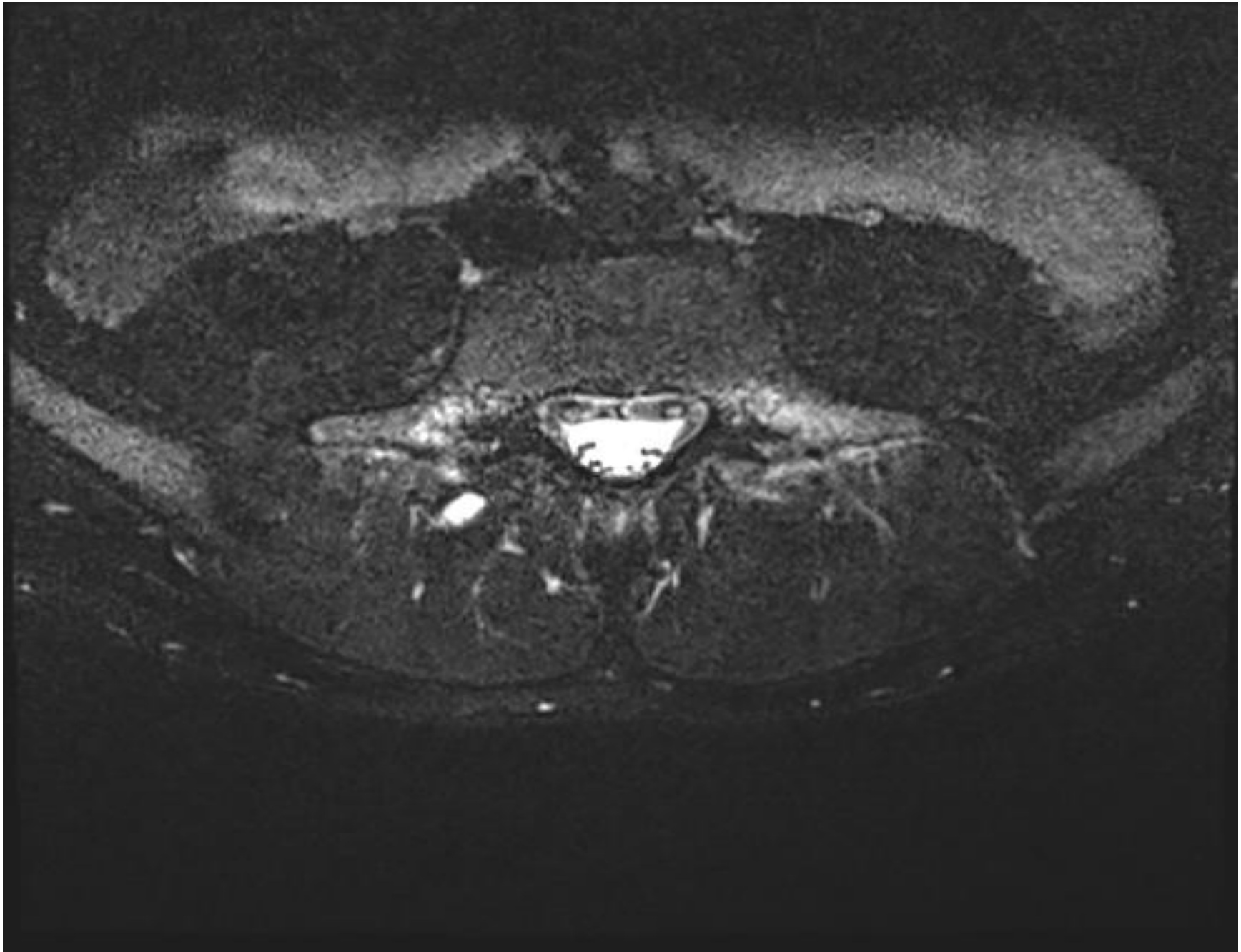
Subjective

- 15-year-old male high school basketball athlete
- C/O right and left low back pain
- Denies any radiating symptoms
- Only has pain with back extension
- No fever or chills or other systemic symptoms
- Has tried modalities, stretching, strengthening, NSAIDs & Acetaminophen all without relief
- No history of back pain
- No pain with flexion

Case #1

Exam

- Only reproduction of pain was with back extension and stork test
- Normal exam otherwise



What is this?

Diagnosis of Spondylolysis

Stress fracture of the Pars Interarticularis

- Caused by overuse injury of a hyperextension &/or rotation motion

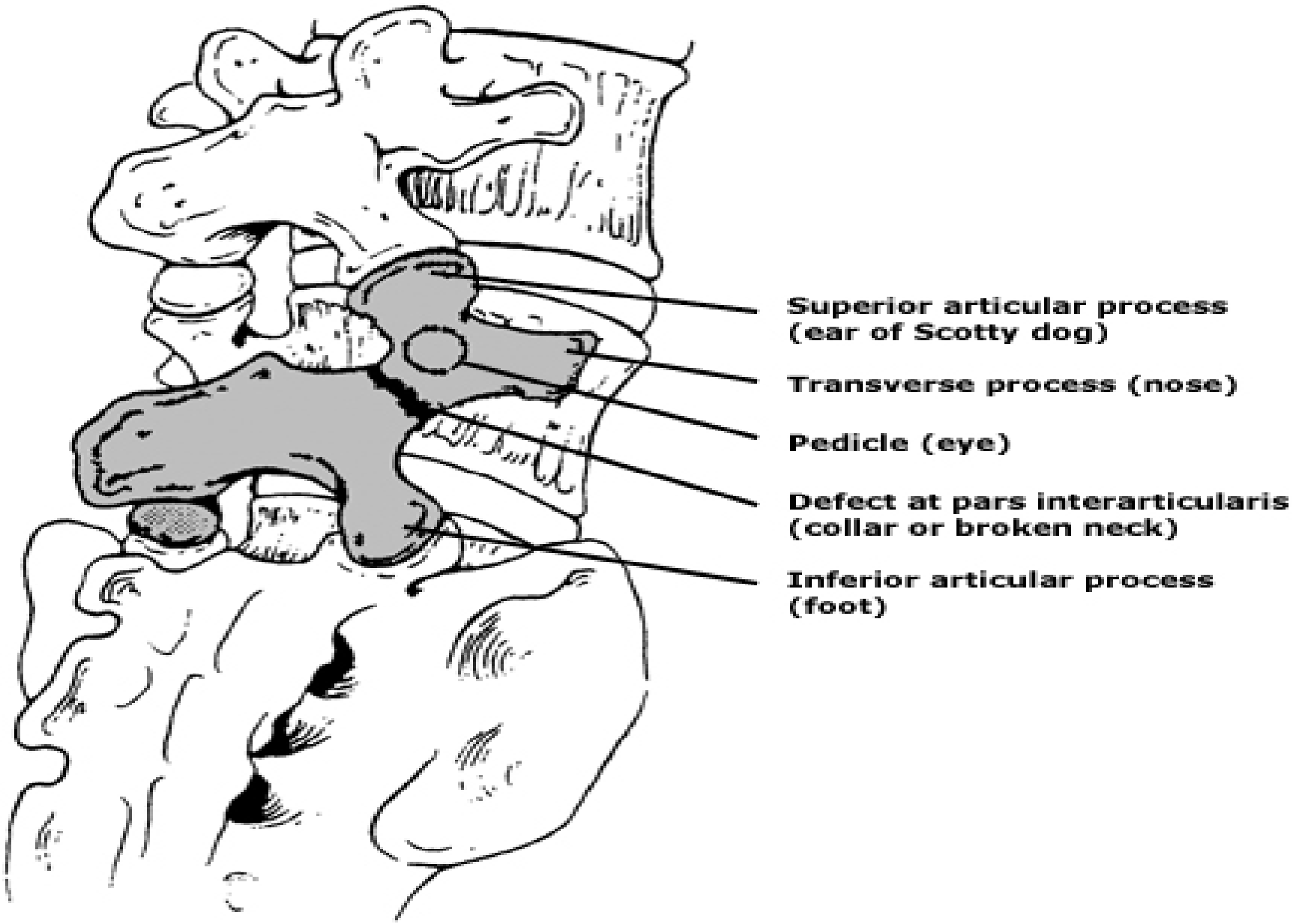
Diagnosis of Spondylolysis

Epidemiology

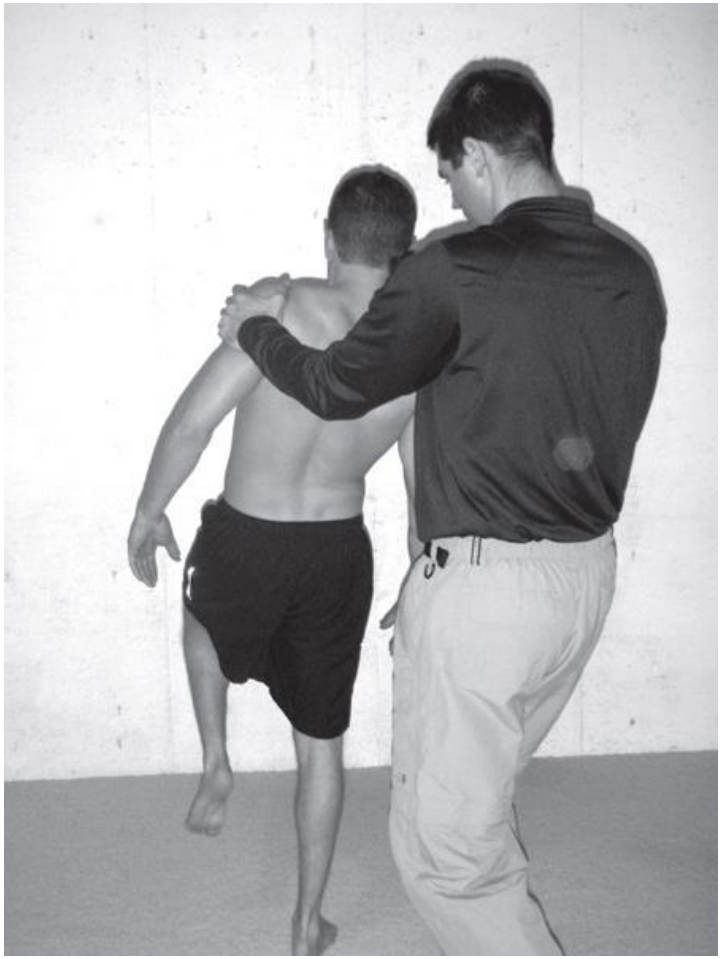
- Gen. population prevalence is 4-6%
- One study showed 46% prevalence in kids under 18 with low back pain
- L5 is most common level, followed by L4
- Bilateral pars defects most common
- 2 levels at once is not common

Diagnosis of Spondylolysis

- Increased incidence in ballet, gymnastics, diving, soccer, & football linemen


Superior articular process
(ear of Scotty dog)
Transverse process (nose)
Pedicle (eye)
Defect at pars interarticularis
(collar or broken neck)
Inferior articular process
(foot)

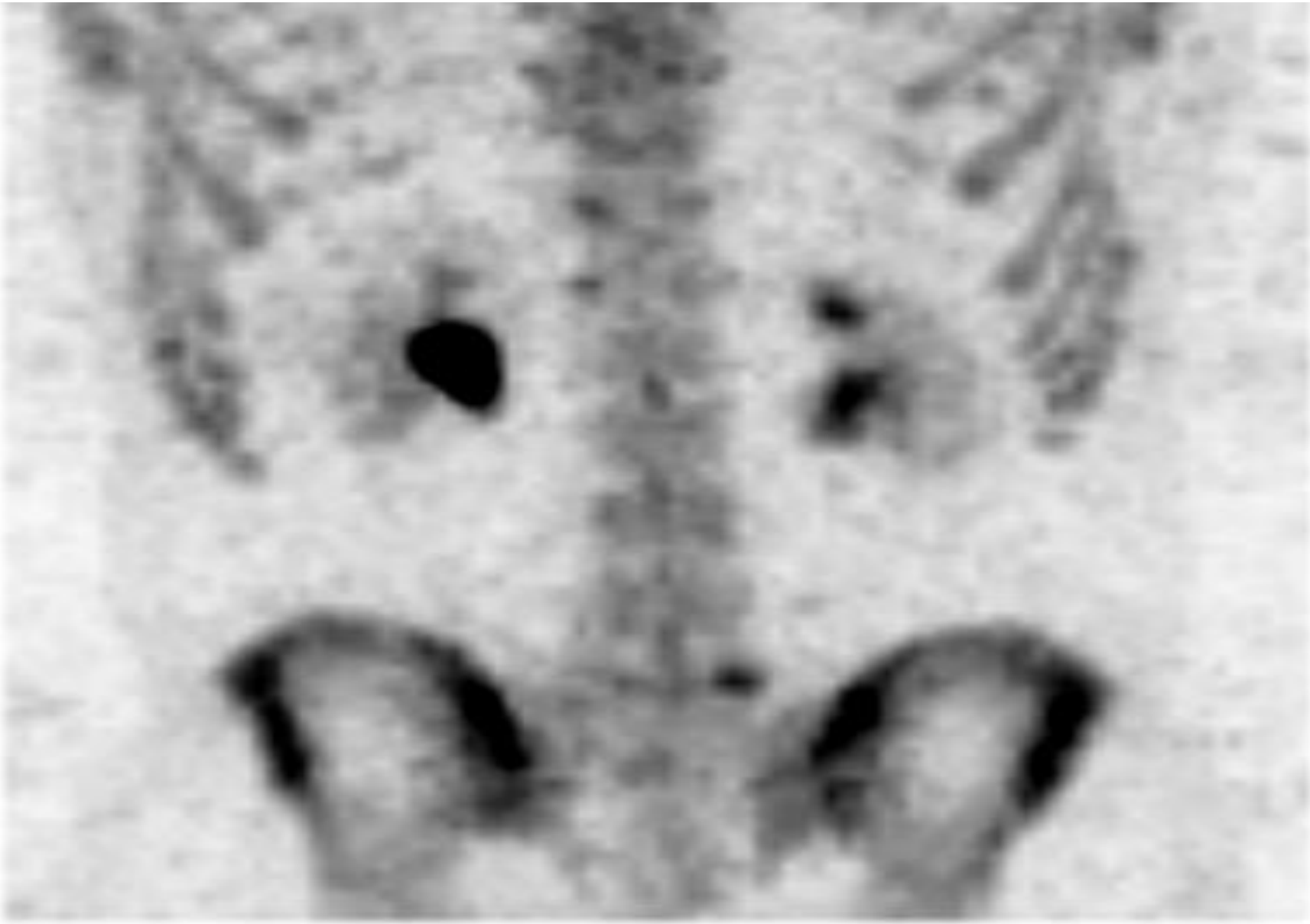
Stork Test



- History of deep LBP exacerbated by extension
- Stork Test (unilateral extension test) positive

Spondylolysis – Imaging

- Plain Film (oblique views – 30% are positive)
- CT Scan
- SPECT scan
  - Bone Scan with CT 3 dimensional cuts
- Bone Scan
- MRI
  - T2 Fat Sat Views in all planes with thinly sliced stacked axial's



Diagnosis of Spondylolysis

- History (deep pain in low back, exacerbated by active or passive extension, particularly on one leg)
- Stork Test (unilateral extension test) - Pain will be on side of weight bearing
- Plain Film (oblique views – 30% are positive), CT, SPECT scan
  - MRI - requires a high-definition scanner & appropriate sequences

Spondylolysis – Treatment

- Month 1
  - Warm and form extension blocking back brace 23/24 hours per day + REST
- Month 2
  - Brace during the day & with rehab
  - Rehab consists of core strengthening and lower extremity flexibility

Spondylolysis – Treatment

- Month 3
  - Gradual return to activity
  - Continuing core strengthening & flexibility
  - Wear brace with activity
- I recommend wearing the brace for 1 year or longer with activity & sometimes longer depending on severity of injury

Treatment of Spondylolysis

- Activity restriction until patient asymptomatic
- Gradual return to activity (usually 6-12 weeks)
- Core/lumbar strengthening & flexibility
- +/- bracing
  - Most literature supports bracing
- Trial of return to activity after pain free period (Duration is variable but reasonable at 6-12 weeks)
- A **healed** injury is a pain free injury which may include bony union or asymptomatic fibrous non bony union

Spondylolisthesis

- Bilateral spondylolysis with anterior slippage of the vertebral body on the adjacent vertebral body
  - Stress injury to Pars Interarticularis
  - NFL/NCAA 1% of both professional & collegiate football players have spondylolisthesis
  - Not contraindication to playing football
    - Caveat: May predispose to pain & may lead to further worsening of anatomic changes
  - Pathologic forces have been demonstrated in blocking linemen (loaded extension of Lumbar Spine)

Back Pain in Young Athletes

- Spondylolysis: nondisplaced fracture of the pars interarticularis

- Spondylolisthesis: forward displaced spondylolysis

  Bilateral spondylolysis with anterior slippage of the vertebral body on the adjacent vertebral body

Case #2

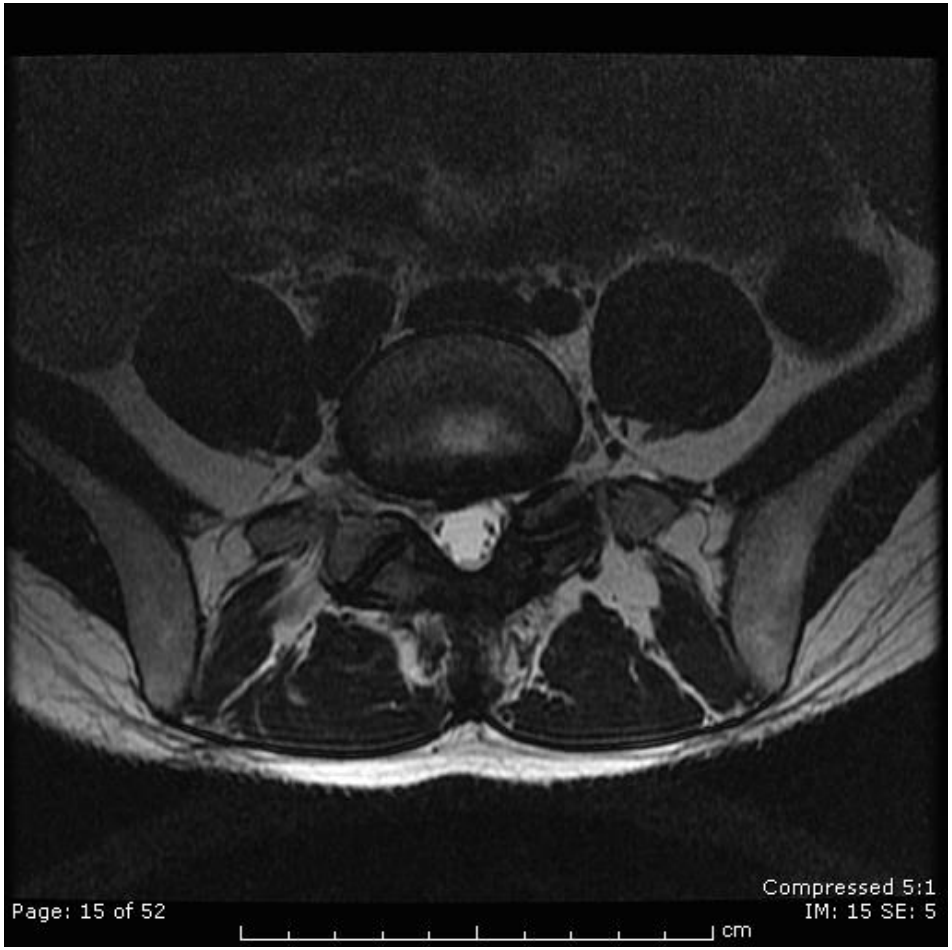
Subjective:

- 18yo Collegiate VB setter presents with low back pain for 2-3 weeks
- Started after lifting some furniture & moving a couch
- C/O sharp pain which begins in the right lower back & does radiate to right buttocks/hamstring
- + Numbness in right hamstring
- Pain is worse with flexion, denies any bowel or bladder dysfunction

Case #2 – Exam

- Point tender in the L4/L5 on the right side
- Pain with flexion
- NO pain with extension
- Stork test negative
- Straight Leg Raise & slump test positive on right with radicular pain down right leg
- Strength & sensation is normal in right & left legs

What is the condition?



Back Pain in Athletes

- Disk Herniation
  - Persistent midline lumbar pain
    - Also consider chronic instability secondary to a fracture of vertebral body or posterior elements
  - Mechanism of injury is often flexion-based component with rotation component
  - Pain may radiate to buttocks, posterior thigh, or down the leg

Disc Herniation

- **Straight Leg Raise Test**

  Detects tension on the L5 or S1 nerve roots

  Positive if pain is present in the posterior leg that radiates below the knee (usually done supine)

  Reproducing back pain alone does not indicate significant nerve root tension

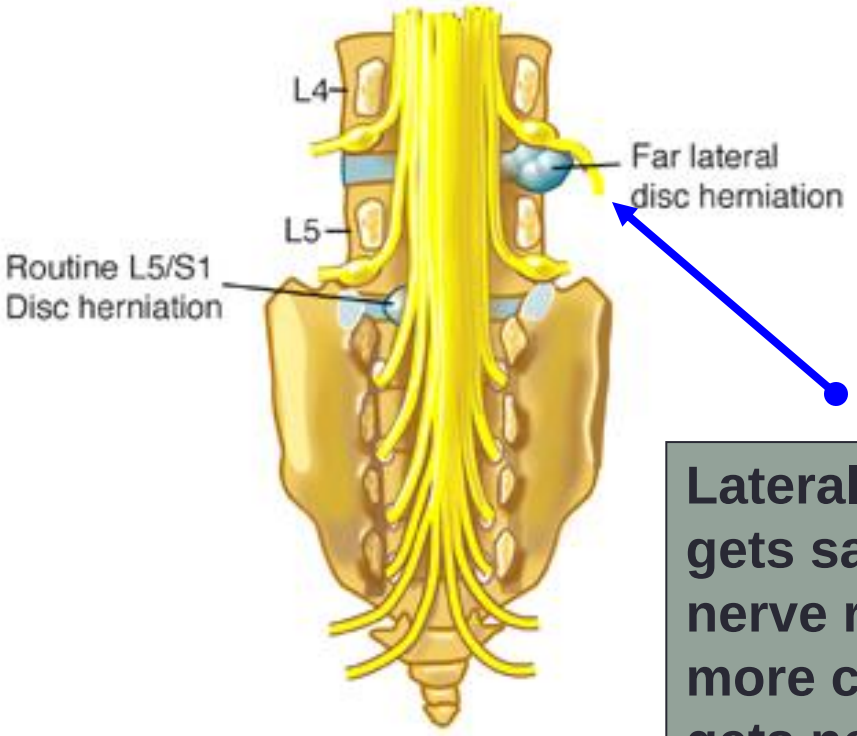
- **Slump Test**

  When negative - rules out disc herniation 95% of the time

  Pain below knee at less than 60 degrees of hip flexion (usually 30-60) with the knee straight, aggravated by ankle dorsiflexion & relieved by ankle plantar flexion or knee flexion

  SLR: 85% sensitive / 40% specific

Disc Herniation



Lateral disc bulge gets same level nerve root, while more central bulge gets next level down

Disk Herniation Treatment

- Conservative treatment is often most appropriate
  - Activity modifications
  - OMT
  - NSAID's (with precautions)
  - Short steroid treatment
  - McKenzie program
  - Squat program
  - Abdominal & spine strengthening
  - Epidural steroids
- Surgical Intervention
  - Refractory cases with progressive neurological deficit or persistent unrelieved pain

Case #3

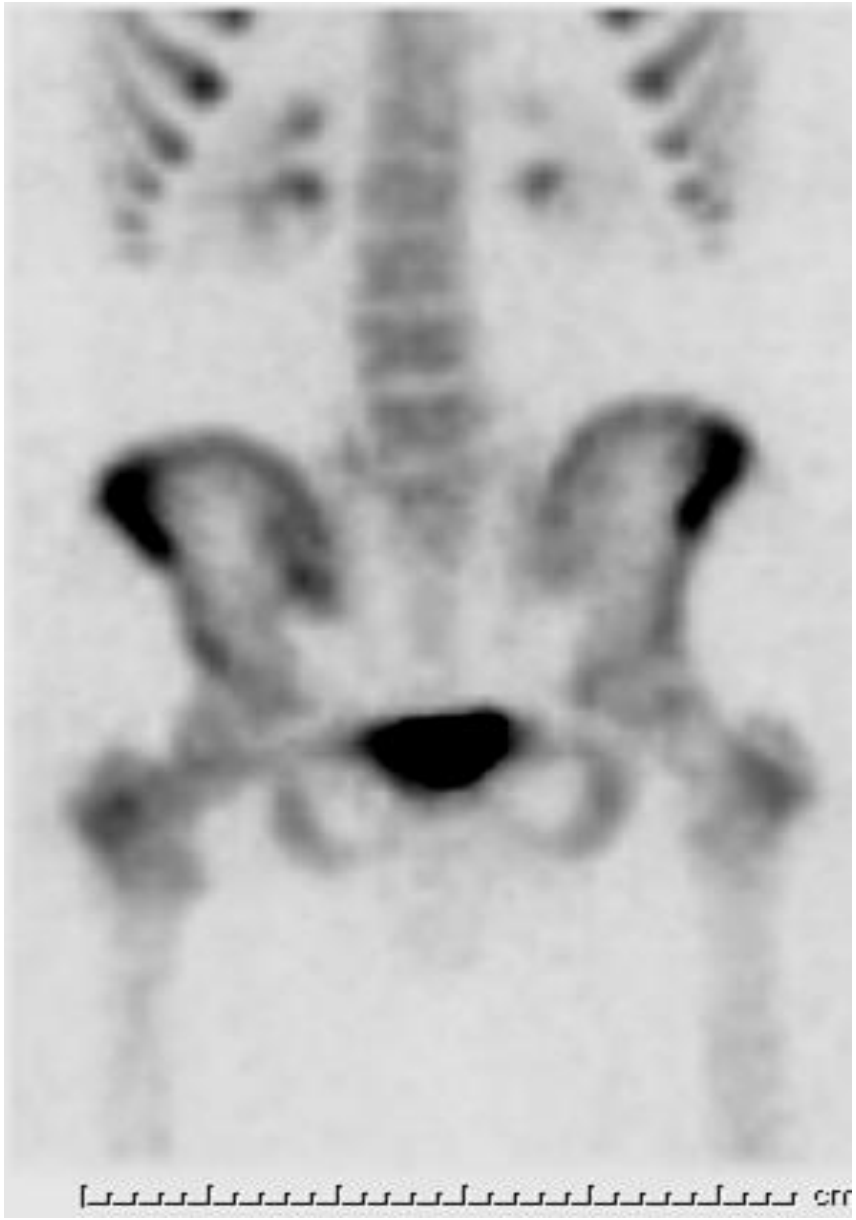
Subjective

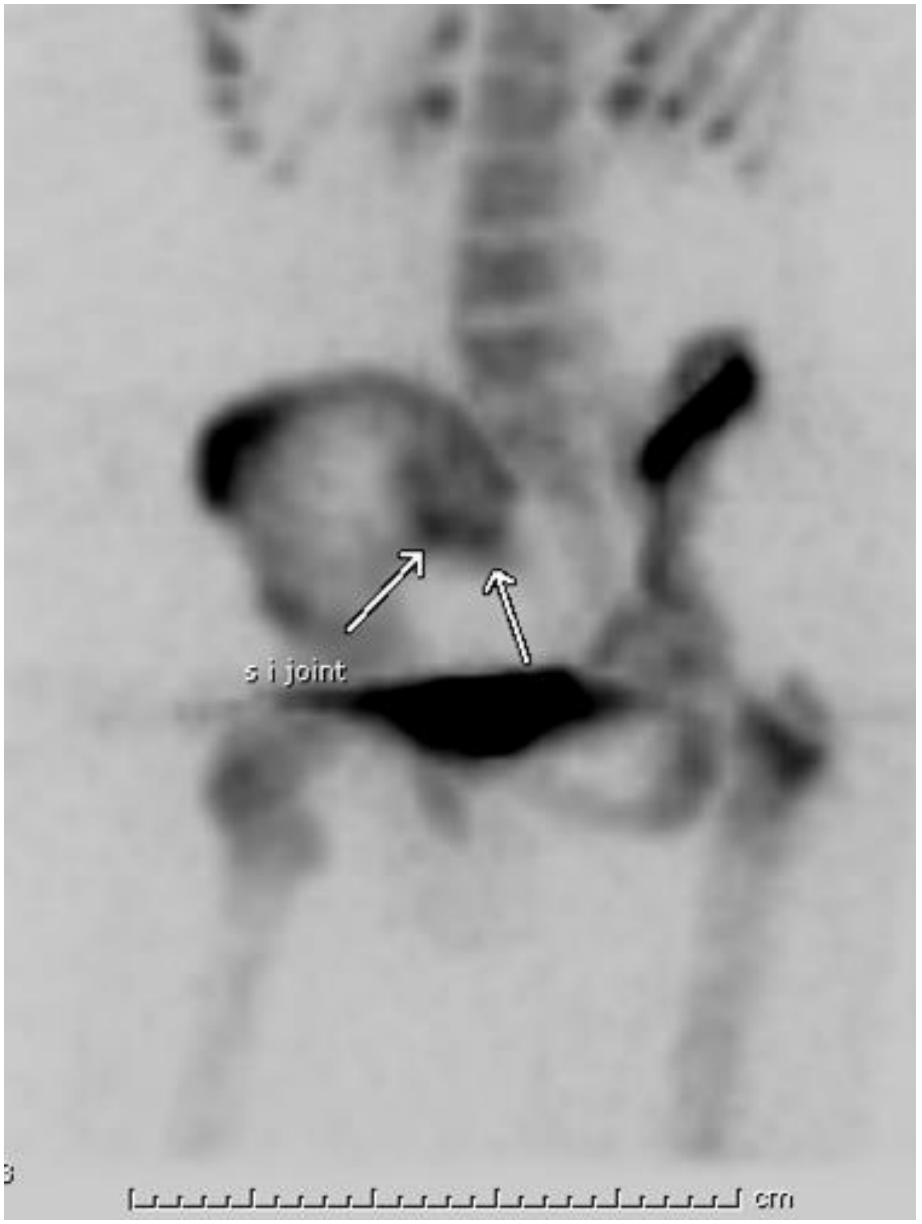
- 17yo male C/O of right-sided low back pain first noticed 1 year ago
- Pain has progressively worsened
- Bowls year round
- C/O right SI joint pain that radiates into right buttock & right hip, not into groin, & not into upper leg.
- Tried Ibuprofen & Prednisone - both helped a lot
- Has tried formal PT & that helped as well
- He now takes 600mg ibuprofen before bowling
- No other symptoms including no hematochezia, melena, no abdominal pain

Case #3 - Exam

- Straight leg raise negative
- Patrick Faber test positive on right
- Stork test negative
- Full and symmetric strength in lower extremities

What is this condition?




s i joint

What is this?

Ankylosing Spondylitis

- Inflammatory back pain
- Insidious onset
- Onset < 40yo
- Pain 3 months duration
- Morning stiffness (> 30 minutes)
- Pain relief with activity
- Pain forcing patient from bed
- H/o Reiter's Disease, Colitis

Ankylosing Spondylitis

- Exam
  - SI joint tenderness
  - Evidence of peripheral inflammatory joint disease

- XR
  - Overall bamboo appearance of spine
  - SI joint obliteration
  - Concentric narrowing of hip joints

Back Pain in Young Athletes

- Facet Syndrome
  - Repetitive hyperextension
  - Pain is localized to lateral structures
    - Worse with hyperextension and movement
    - Relieved by rest
  - Plain XR
    - Degenerative changes at facet joints

Back Pain in Young Athletes

- Facet Syndrome
  - Treatment
    - Therapeutic exercises to avoid hyperextension
    - PT
      - CORE strengthening
      - Flexibility (especially hamstrings)
  - Rule out spondylolysis

Back Pain in Young Athletes

- Sacroiliac Joint Dysfunction
  - Most common in rowing & cross-country skiing
  - Present with pain in SI Joint
    - Unilateral
    - Dull
    - Radiates to buttock, posterior thigh, or groin

Back Pain in Young Athletes

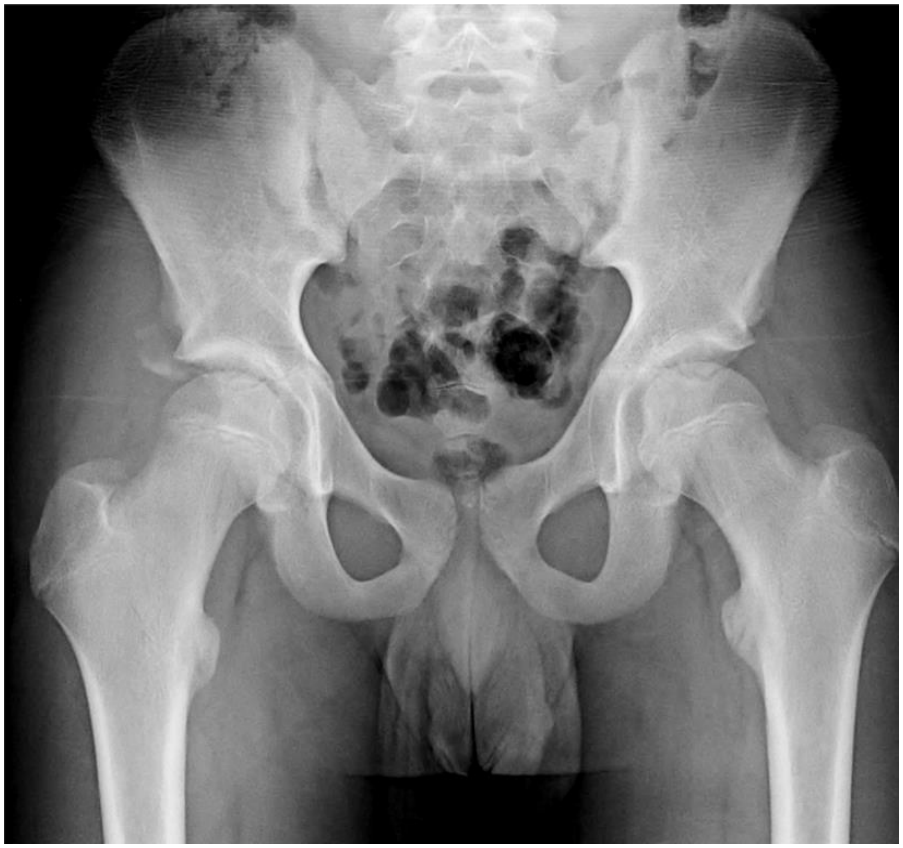
- Sacroiliac Joint Dysfunction
  - Examine statically and dynamically
    - Asymmetry or restricted motion segments
      - Restrictions in forward flexion of Lumbosacral Spine
      - Asymmetric tight hamstrings
      - Unilateral restriction of pelvic mobility
      - Functional leg length asymmetry

Back Pain in Young Athletes

- Sacroiliac Joint Dysfunction
  - Treatment
    - Ice
    - Heat
    - NSAID’s (with precautions)
    - PT for correcting biomechanical restrictions
    - OMT

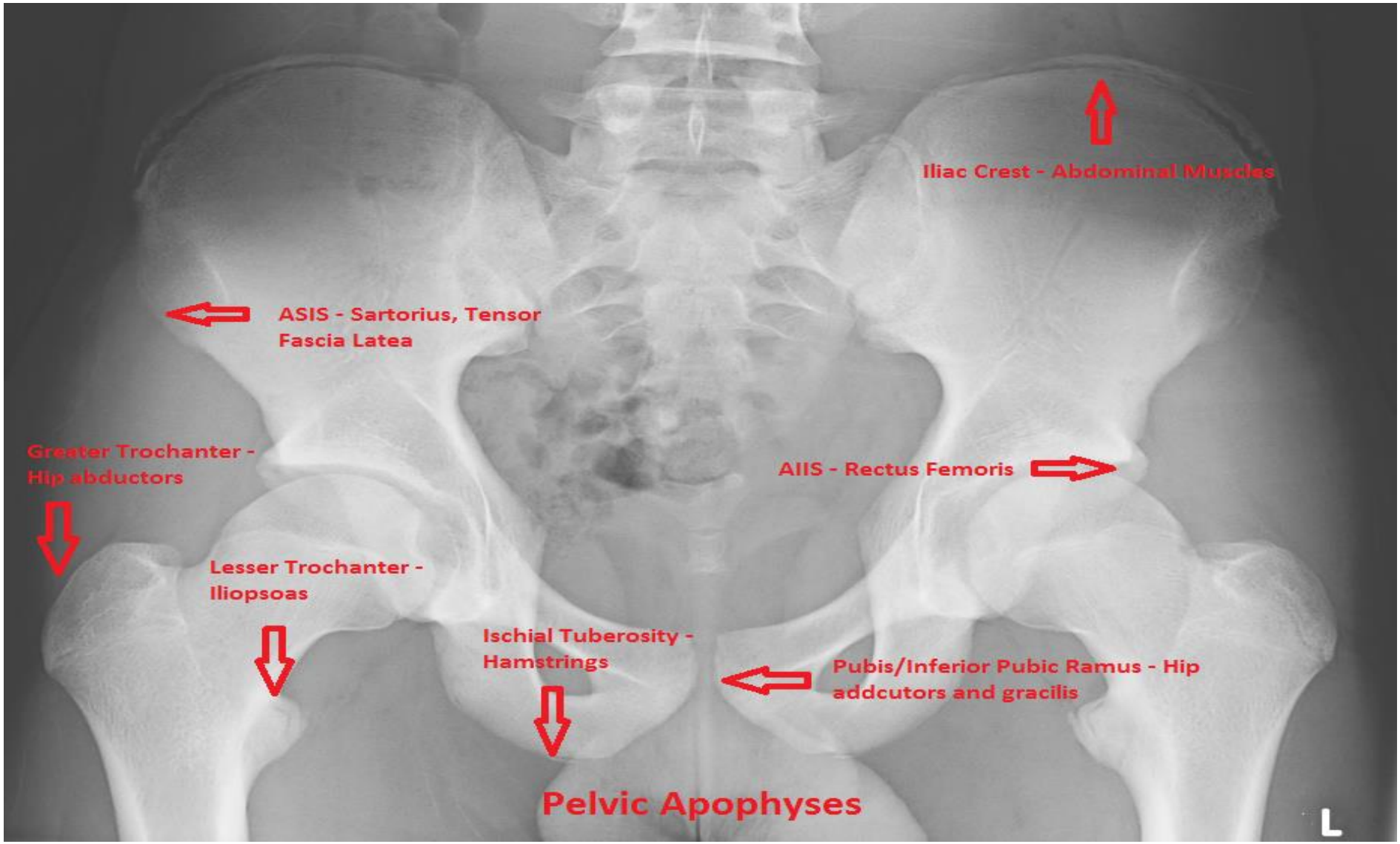
16yo M soccer player, felt pop in right hip when he kicked the ball at the same time as his opponent

- Pain medication not helpful
- Hip flexed on exam table
- ROM/Strength limited by pain



AIIS Avulsion Fracture

Hip Apophyses




1
2
3
4
Risser Score, skeletal maturity = 5

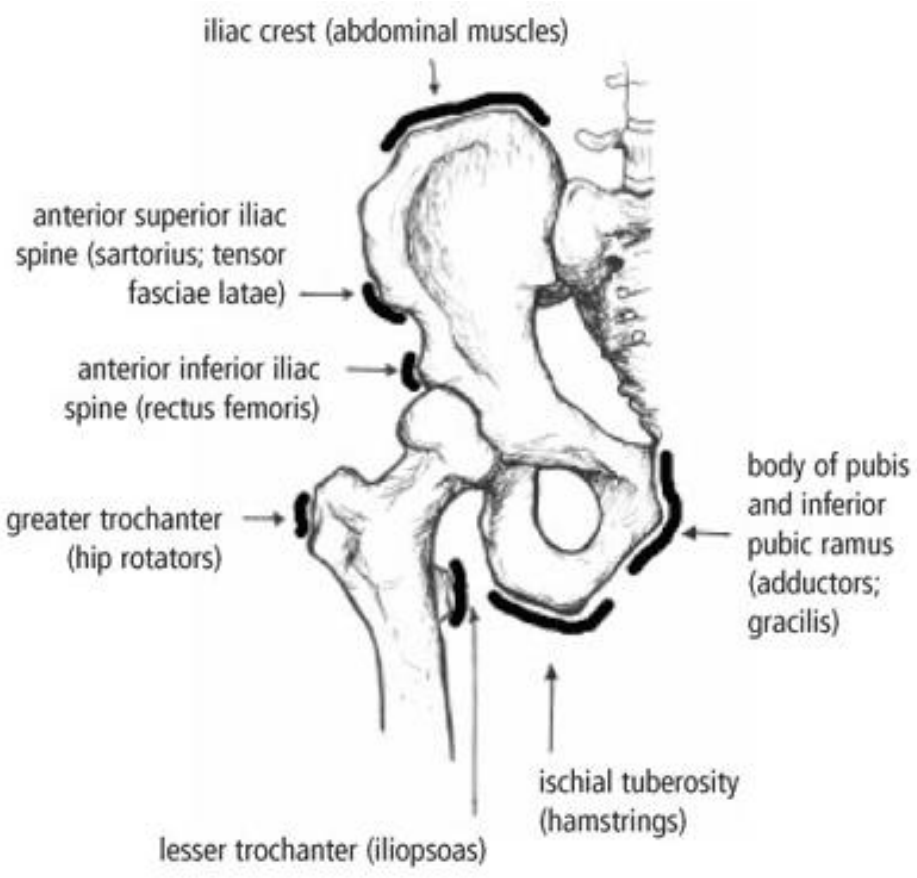
Apophysitis

- Apophysis – site of tendon attachment prior to skeletal maturity
- Apophysitis – inflammation from repetitive microtrauma from traction by tendon
- Avulsion – traumatic contraction of tendon on apophysis

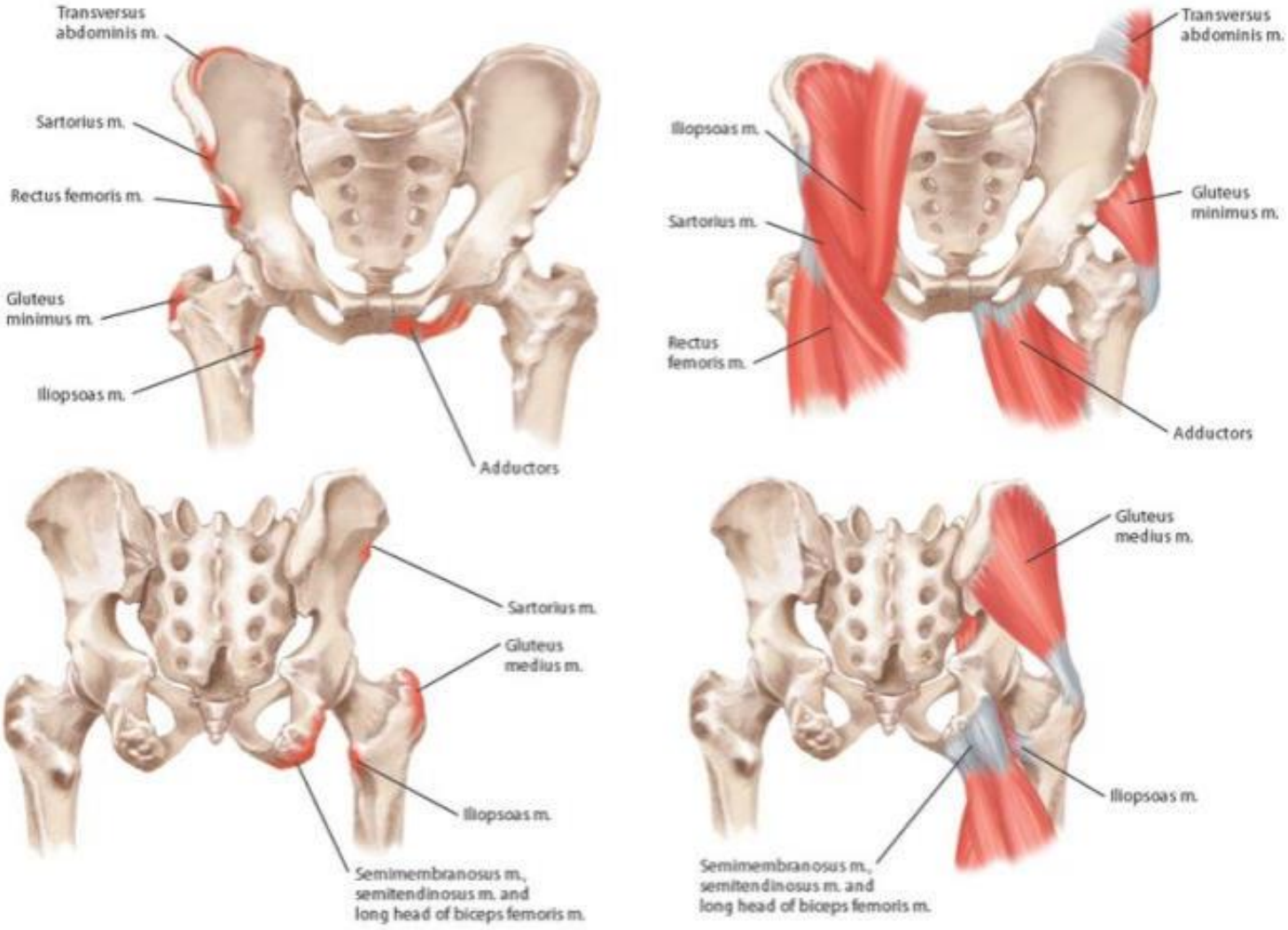
- Clinical diagnosis based on location of pain in an adolescent
- Hurts to stretch or contract
- XRs used to confirm widening to help with prognosis & RTP more than diagnosis

Apophyses

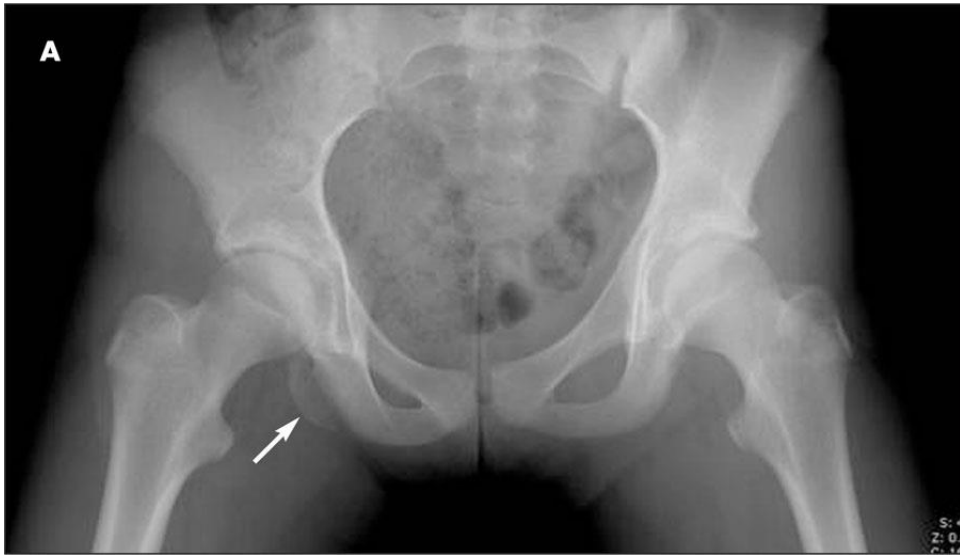
- Iliac Crest: abdominal (internal/external oblique and transversus abdominus)
- ASIS: sartorius
- AIIS: rectus femoris
- Greater Trochanter: glut med/min
- Lesser Trochanter: iliopsoas
- Ischial Tuberosity: hamstring
- Inferior pubic ramus: adductors



Hip Apophyses



Pelvic Avulsions

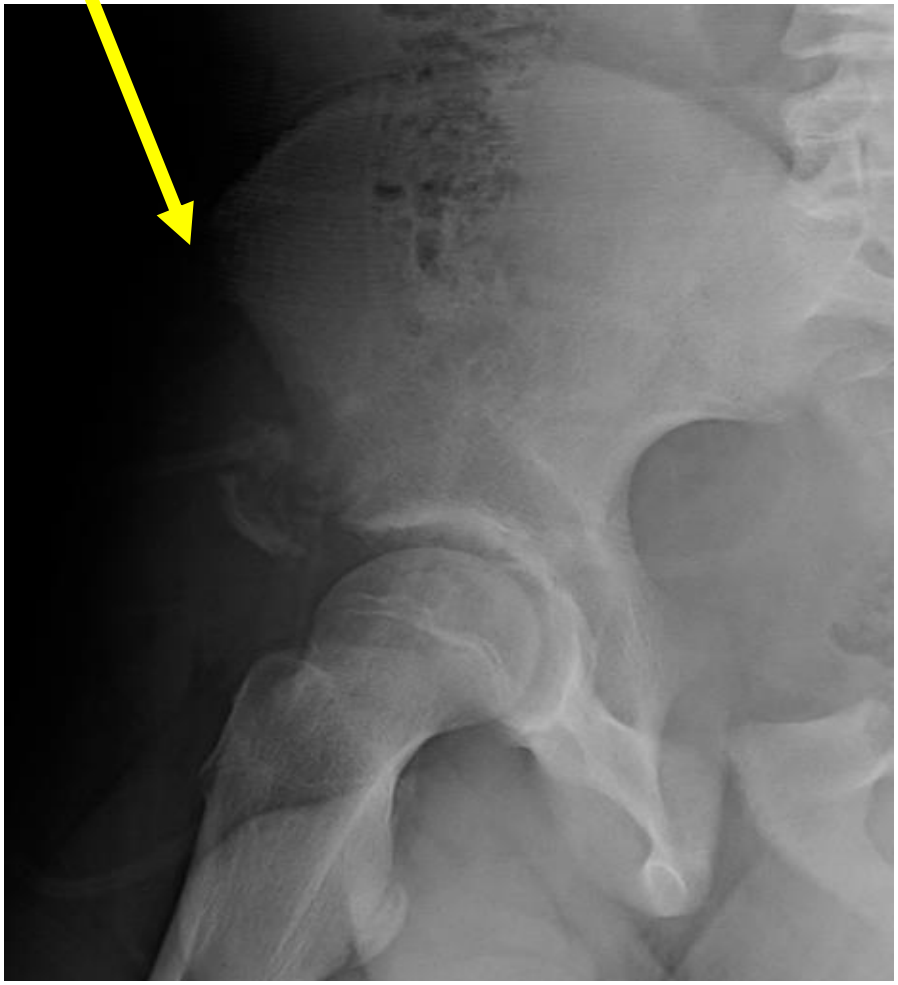


Treatment

- Avoid vigorous stretching
- **Relative** rest
- Crutches if needed
- NSAIDS/Prednisone?
- RTP as long as no pain to stretch, good strength, and pass a functional progression without limping
- Risk is avulsion
- Most are treated conservatively
- Surgery if pain does not resolve, cosmetic reason, or >2 cm (in general)
- Manual Therapy, Tenotomy, Autologous Blood Injection (ABI) or Platelet Rich Plasma (PRP) prior to surgery

AIIS Avulsion Fx s/p treatment

AIIS Avulsion Fx s/p treatment



QUESTIONS

THANK YOU

References

- Bracker, Archer, Pana, Taylor. The 5-Minutes Sports Medicine Consult. Lippincott Williams and Wilkins, 2011.
- Corrado D. Screening for hypertrophic cardiomyopathy in young athletes. N Engl J Med 1998;339:364.
- Dean, Peter et al. Return to Play After Coronavirus Infection: Pediatric Cardiologists' Perspective. American College of Cardiology July 14, 2020. Dores H, Cardim N. Return to play after COVID-19: a sport cardiologist's view British Journal of Sports Medicine Published Online First: 07 May 2020. doi: 10.1136/bjsports-2020-102482.
- Di Biase L. Epidemiology, clinical manifestations, and diagnosis of the Wolff-Parkinson-White syndrome. In: Levy S (Ed). UpToDate. https://www.uptodate.com/contents/epidemiology-clinical-manifestations-and-diagnosis-of-the-wolff-parkinson-white-syndrome
- Dural Ectasia Case courtesy of Dr Franco Ruales, Radiopaedia.org, rID: 16114.
- Eiff M, Hatch R. Fracture Management for Primary Care. Elsevier, 2020
- Eckert RE. Sudden Death in Young Adults: A 25-year Review of Autopsies in Military Recruits. Ann Intern Med 2004; 141:829
- Finocchiaro G. Etiology of sudden death in sports: Insights from a United Kingdom Registry Regional Registry. J Am Coll Cardiol 2016; 67;2108
- Harmon KG. Incidence of sudden cardiac death in National Collegiate Athletic Association Athletes. Circulation. 2011;123(15):1594.

References

- Harmon KG. Cardiac Disease in Athletes. In: Madden CC, eds. Netter's Sports Medicine. 2nd Ed. Philadelphia: Elsevier; 2018:243-250.
- Hong E. Lacrosse. In: Madden CC, eds. Netter's Sports Medicine. 2nd Ed. Philadelphia: Elsevier; 2018:561-563.
- Maron BJ. Sudden death in young athletes. N Engl J Med 2003;349:1064-1075.
- Maron, BJ. Comparison of the frequency of sudden cardiovascular deaths in young competitive athletes versus nonathletes: should we really screen only athletes? AM J Cardiol. 2016;117(8):1339-1341.
- Maron BJ. Recommendations and Considerations Related to Preparticipation Screening for Cardiovascular Abnormalities in Competitive Athletes. Circulation 2007; 115:1643.
- Maron BJ, Zipes DP. 36th Bethesda Conference: Eligibility Recommendations for Competitive Athletes With Cardiovascular Abnormalities. J Am Coll Cardio 2005; Vol 45, No 8.
- McKenna WJ. Arrhythmogenic right ventricular cardiomyopathy: Diagnostic evaluation and diagnosis. In: Calkins H (Ed). UpToDate. https://www.uptodate.com/contents/arrhythmogenic-right-ventricular-cardiomyopathy-diagnostic-evaluation