

# Overuse Injuries

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- How many are the parent or grandparent of a youth athlete?
- How many are the parent or grandparent of a youth performance artists?





# Overuse Injuries and Burnout in Youth Sports:

## A Position Statement from the American Medical Society for Sports Medicine

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# BACKGROUND

- Youth sport participation offers benefits:
  - development of self-esteem
  - peer socialization
  - general fitness
- Emphasis on competitive success becoming widespread
- Often driven by goals of
  - Travel team selection
  - Collegiate scholarships
  - Olympic and National team membership
  - Even professional contracts

# BACKGROUND

- Increased pressure to begin high intensity training at young ages
- Focus on early intensive training and competition at young ages can lead to overuse injury and burnout

# Statement Objectives

- Assist clinicians in recognizing young athletes at risk for overuse injuries and burnout.
- Delineate the risk factors and injuries that are unique to the skeletally immature young athlete.
- Describe specific high-risk overuse injuries that present management challenges and/or can lead to long-term health consequences.
- Summarize the risk factors and symptoms associated with burnout in young athletes.
- Provide recommendations on overuse injury prevention.



# Definition

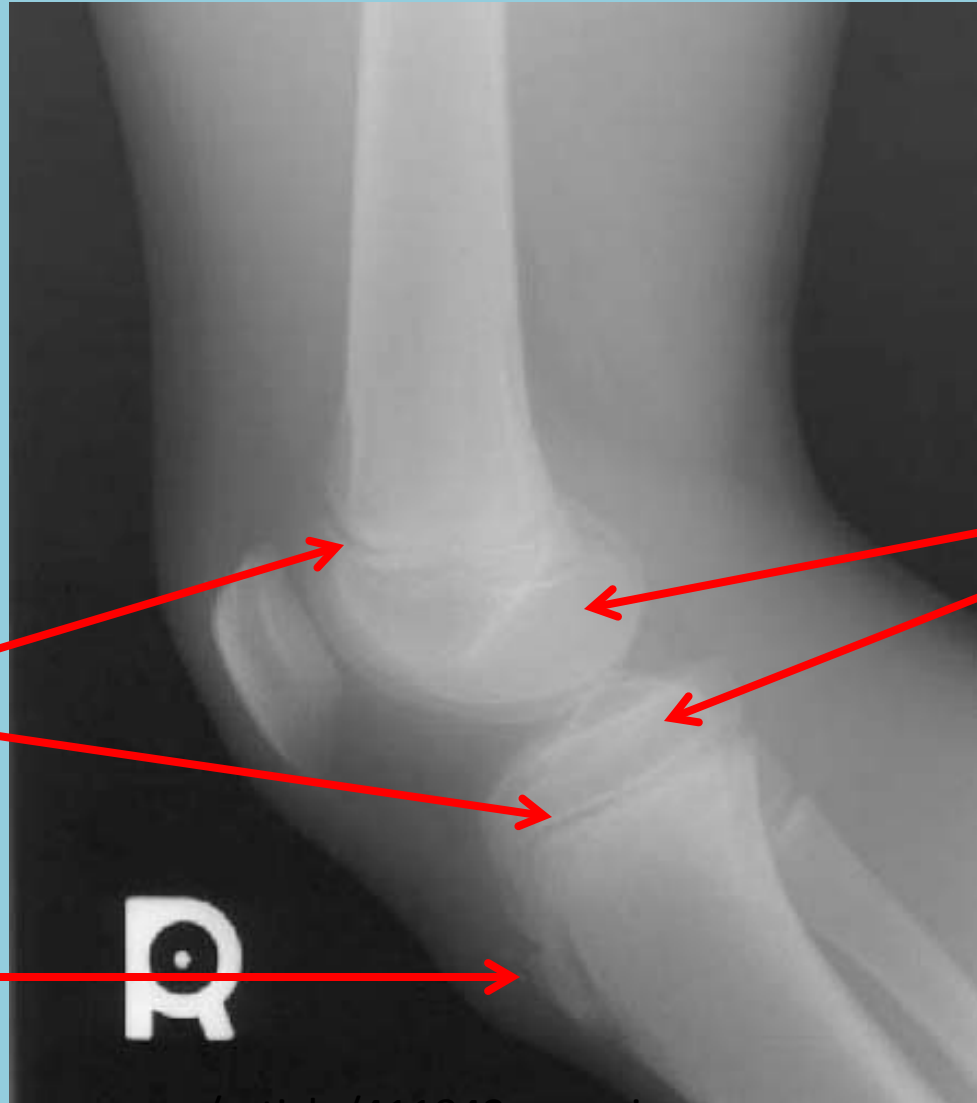
- Overuse injuries occur due to repetitive sub maximal loading of the musculoskeletal system when rest is not adequate to allow for structural adaptation to take place.
- Injury can involve the muscle-tendon unit, bone, bursa, neurovascular structures, and the physis.

# Pathophysiology

- During sport participation, repetitive loading results in microtrauma.
- When recovery between loading exposures is sufficient, tissue adaptation occurs to accommodate the imposed stress.
- However, excessive stress and/or an inadequate recovery period can overwhelm the ability of the tissue to remodel, resulting in a weakened, damaged structure.

- Because of ongoing growth and development, the types of overuse injuries that occur in young athletes differ compared to adults.
- Specifically, growth-related conditions such as apophysitis and physeal stress injury are unique to young athletes.

# Epiphysis vs Apophysis



Physis

Epiphysis

Apophysis

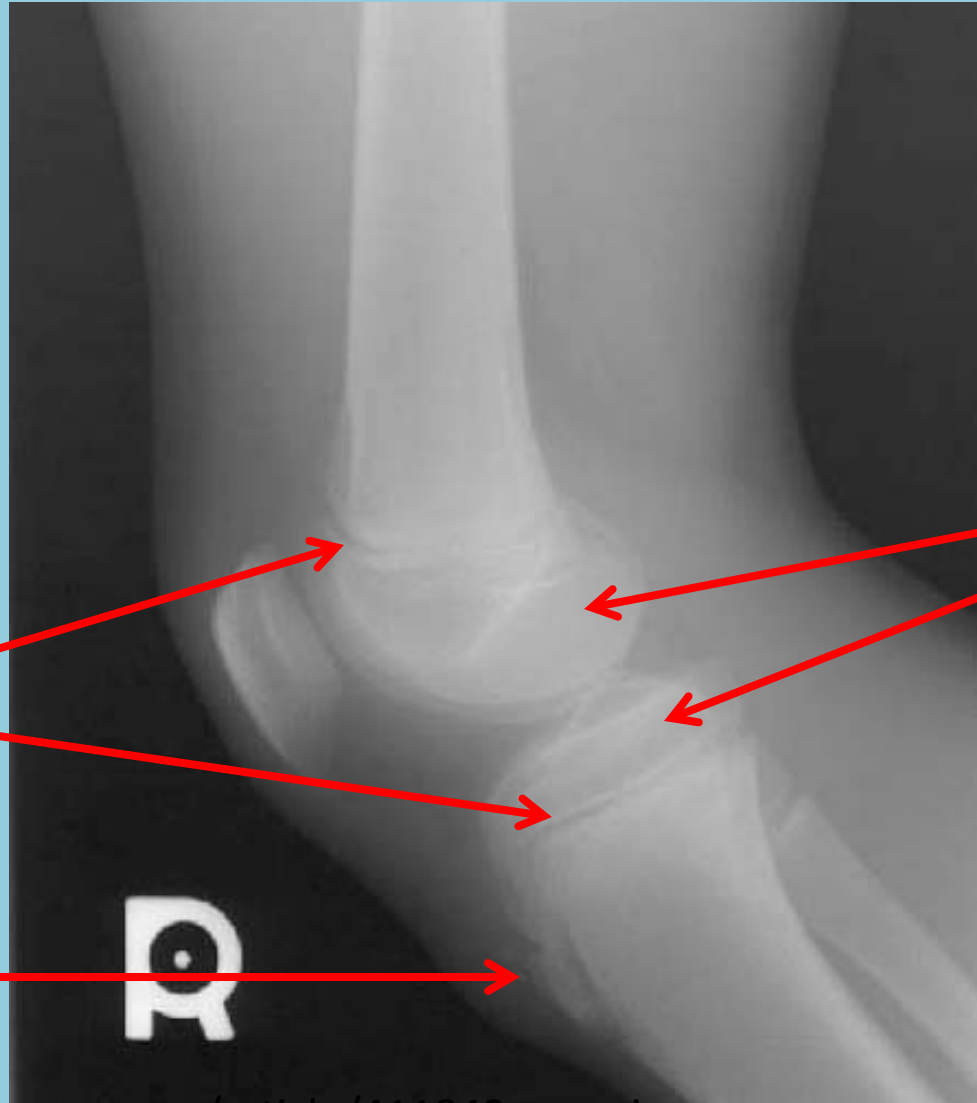
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# Epiphysis vs Apophysis

- Epiphysis
  - Perpendicular to longitudinal axis of a long bone
  - Main function longitudinal growth
  - Forms articular surface
  - Typically no musculo-tendinous attachment
- Apophysis
  - Parallel or oblique to long axis of a long bone
  - No participation in longitudinal growth or articular surface
  - Main purpose is musculo-tendinous attachment



# Epiphysis vs Apophysis



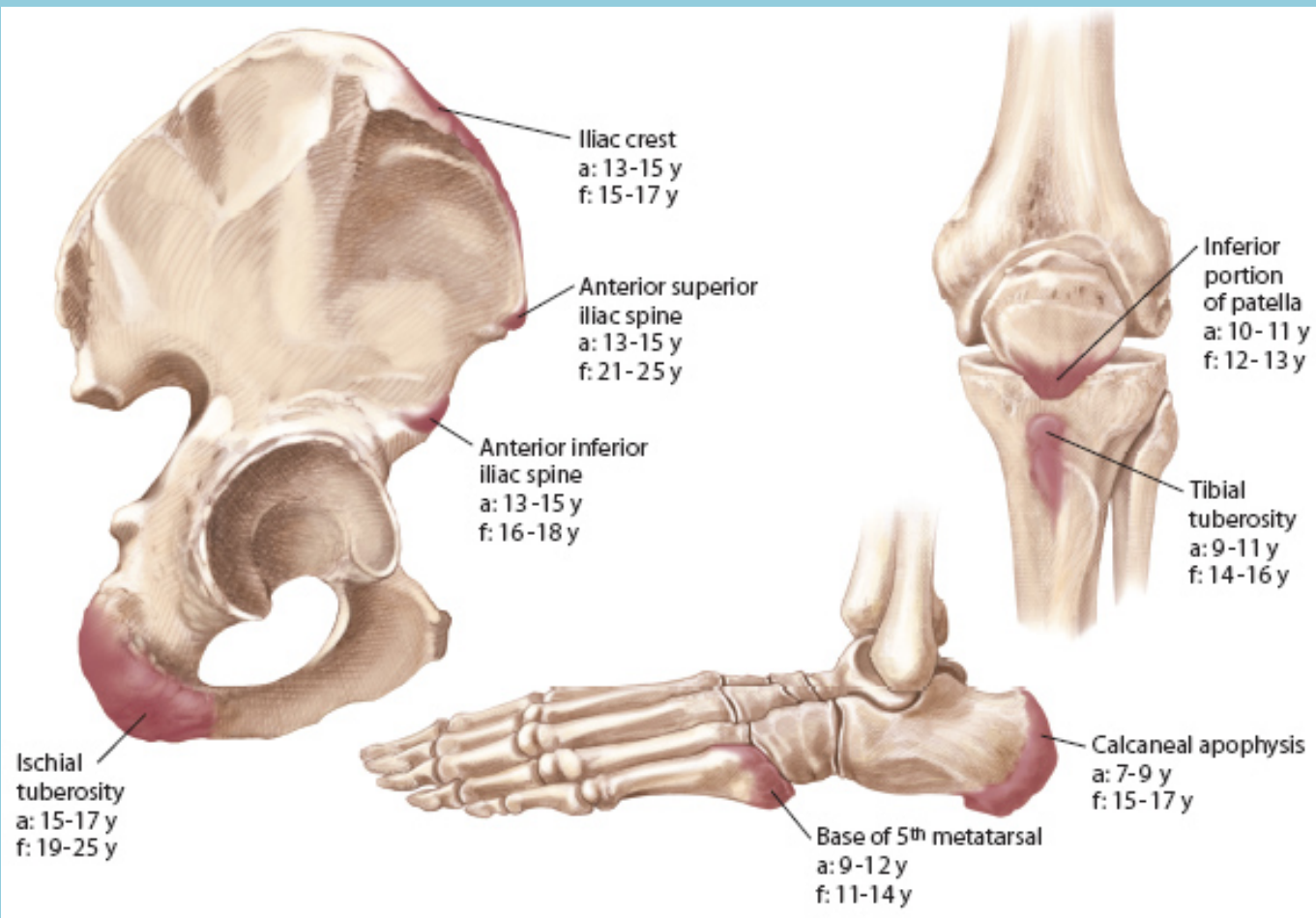
Physis

Epiphysis

Apophysis

R

# Common Sites of Apophysitis



Sinding Larsen Johansson  
Patellar Apophysitis

Osgood Schlatter  
Tibial Apophysitis

Iselin  
Base of the 5<sup>th</sup> metatarsal  
Apophysitis

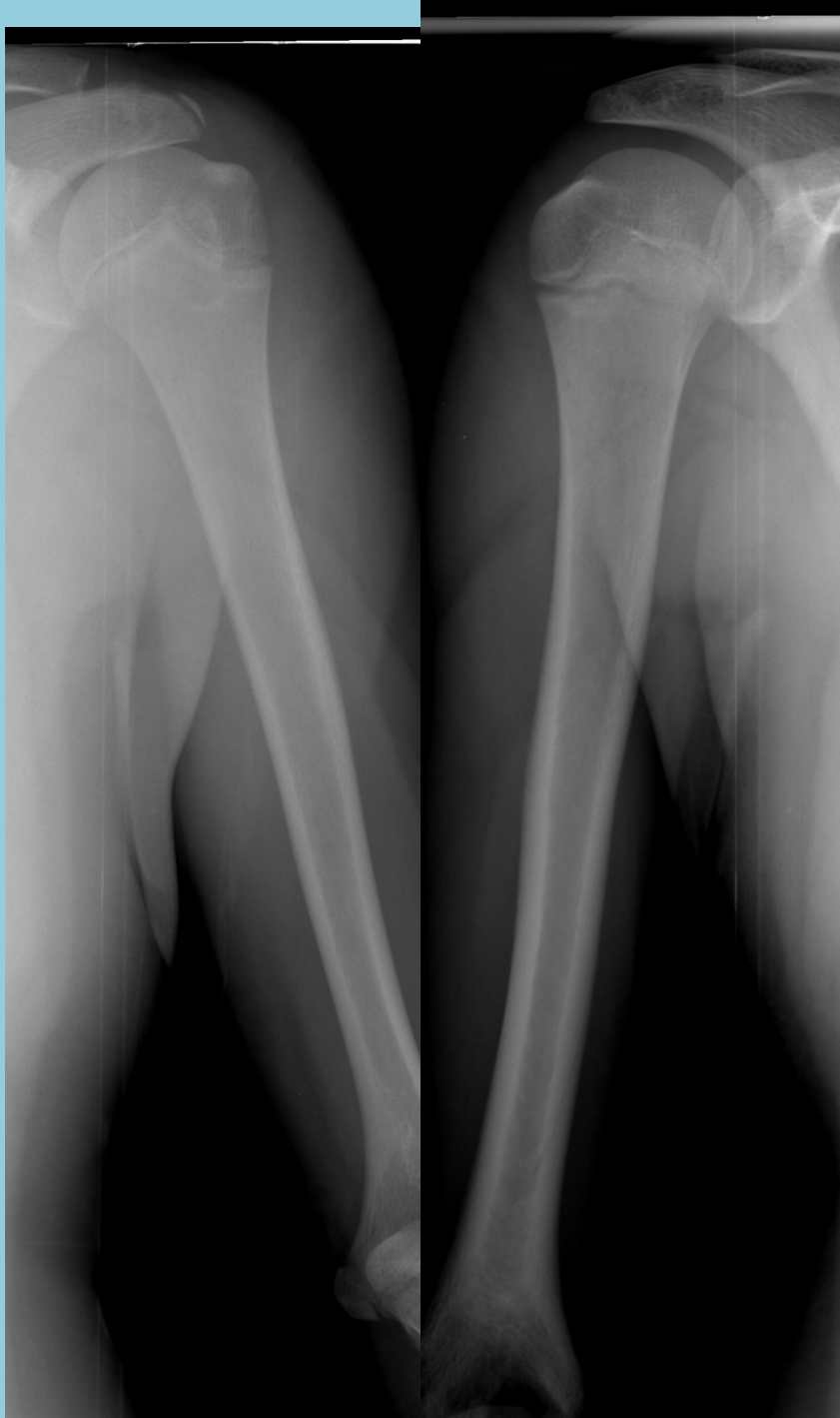
Sever  
Calcaneal Apophysitis

# Apophyseal Injuries

- Typically occur in early adolescence
- Most common sites involve the:
  - tibia tubercle of the knee (Osgood-Schlatter disease)
  - calcaneal apophysis of the heel (Sever's disease)
  - medial epicondylar apophysis of the elbow (often referred to as Little Leaguer's Elbow)
- Anterior knee pain is one of the most frequent complaints
  - usually due to Osgood-Schlatter disease,
  - later adolescence patellofemoral pain syndrome (PFPS) becomes the more common cause of knee pain

# Physeal Injuries

- Overuse injuries of the physis occur in early to midadolescence.
  - (eg, proximal humerus in throwers, distal radius in gymnasts)
- As skeletal maturity is achieved, overuse injuries to bone begin to follow adult injury patterns.
  - (eg, stress reactions and stress fractures)





# Risk Factors for Overuse Injuries

- Intrinsic factors are defined as individual biological characteristics and psychosocial traits.
- Extrinsic factors refer to external forces related to the sport type, the biomechanics of the activity, and the sporting environment.
- The contribution of an intrinsic or an extrinsic factor to injury risk is extremely variable depending on the individual athlete, the sport environment, and the interaction that occurs during participation.

# Categorization of Risk Factors

## Intrinsic Risk Factors

### Growth-Related Factors

- Susceptibility of growth cartilage to repetitive stress

- Adolescent growth spurt

- Previous injury

- Previous level of conditioning

- Anatomic factors

- Menstrual dysfunction

- Psychological and developmental factors—athlete specific

## Extrinsic Risk Factors

- Training workload (rate, intensity, and progression)

- Training and competition schedules

- Equipment/footwear

- Environment

- Sport technique

- Psychological factors—adult and peer influences

# Intrinsic Risk Factors: Prior Injury

- Previous injury is the strongest predictor of future injuries.
- Repeated overuse injury may occur due to:
  - inadequate rehabilitation of the index injury
  - failure to recognize and correct the factors that contributed to the original injury

# Intrinsic Risk Factors: Growth & Development

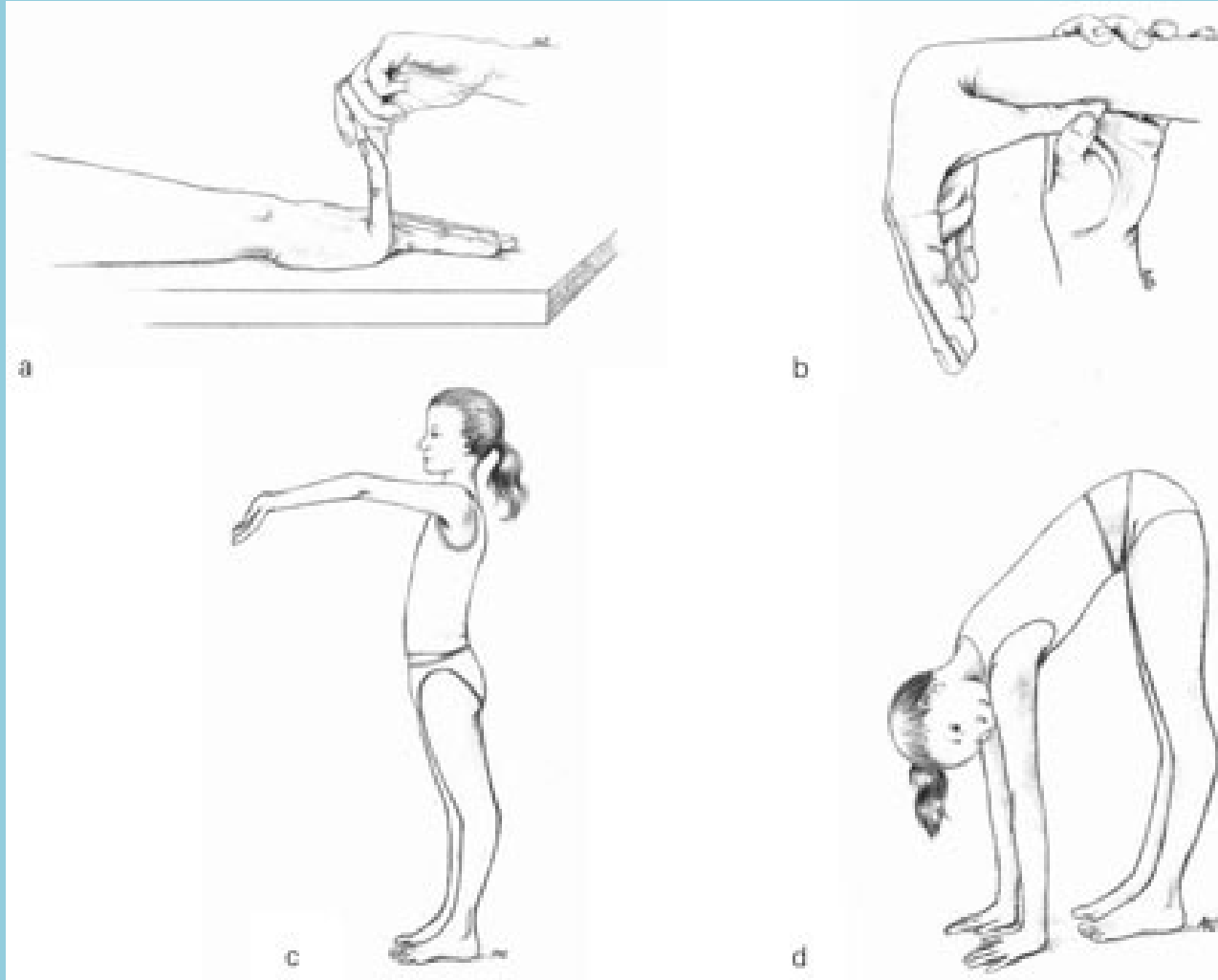
- Overuse injuries may be more common during the adolescent growth spurt.
- Growth cartilage present at the physes, apophyses, and articular surfaces in skeletally immature athletes in a rapid phase of growth are less resistant to tensile, shear, and compressive forces than bone.

# Intrinsic Risk Factors: Anatomic Alignment

- Alignment abnormalities
  - patellofemoral malalignment
  - pes planus
  - pes cavus
  - elbow hyperextension
  - excessive lumbar lordosis
- Some of the more commonly cited risk factors for overuse injuries



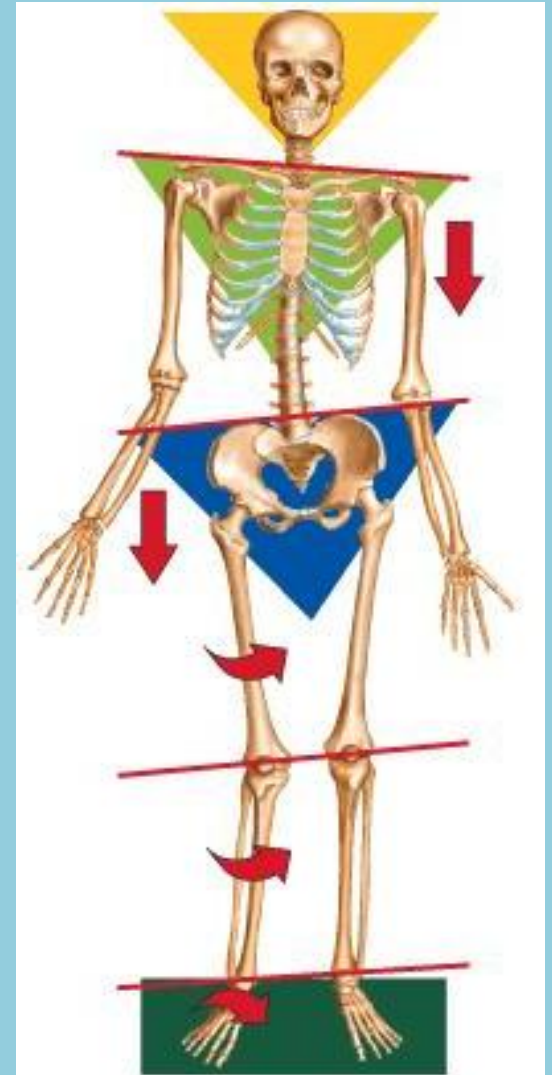




- Joint hypermobility has also been associated with injury in some studies.

# Risk Factors

- Miserable Malalignment Syndrome
- A combination of malalignments of the leg that include excess femoral anteversion with internal rotation of the hip, genu valgus, squinting patellae, external tibial torsion, and flat feet.



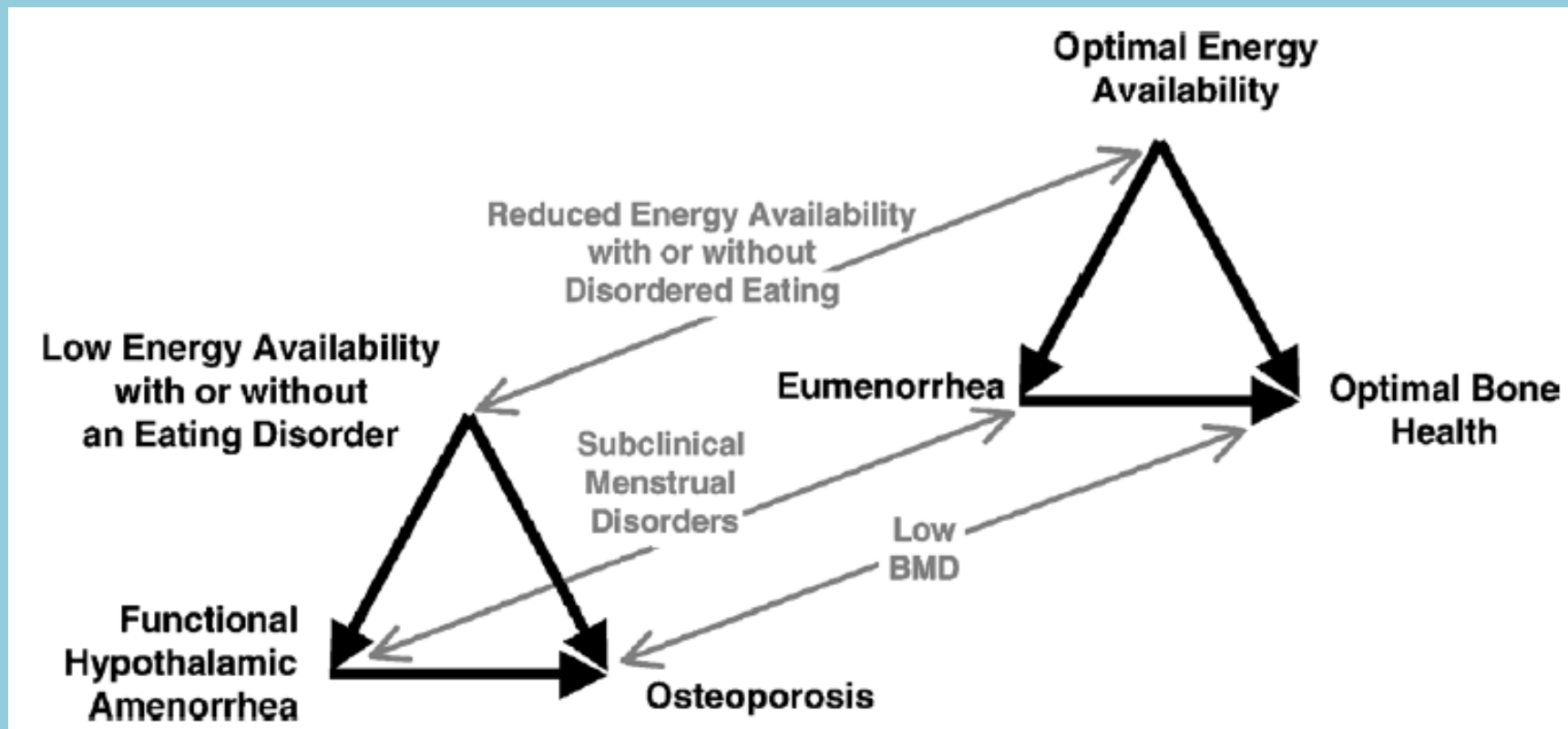
# Intrinsic Risk Factors: Strength & Conditioning

- Children who have not developed some foundation of general strength, endurance, and motor skills may be at increased risk for injury.



# Intrinsic Risk Factors: Menstrual Irregularity & Low Energy Availability

- A history of amenorrhea, especially in sports that emphasize leanness, is a risk factor for bone stress injury.
- Inadequate caloric intake with hypoestrogenemia, decreased bone density, leads to increased fracture risk.
- Female athletes with bone stress injuries who are found to have menstrual irregularity should be screened for disordered eating and low bone mineral density (ie, the female athlete triad).





# Extrinsic Risk Factors: Workload

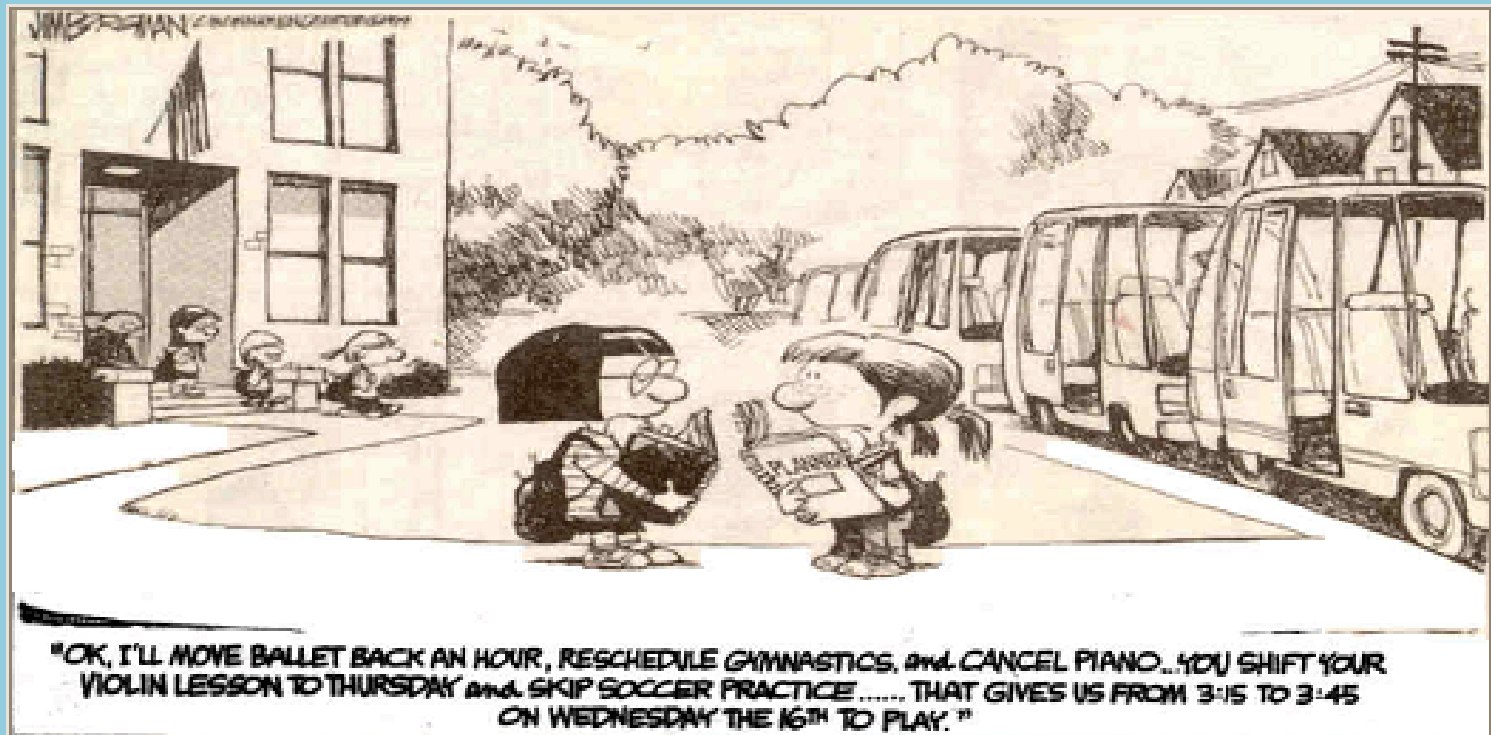
- Training more than 16 hours per week was associated with a significantly increased risk.
- In youth baseball among pitchers, pitch volume has the greatest association with injury rate.
- Among young gymnasts, wrist pain was significantly related to training intensity, as measured by skill level and number of hours training per week.

# Extrinsic Risk Factors: Scheduling

- Concern has been raised for year-round training in a single sport and simultaneous involvement in multiple teams in the same sport.
- It is not uncommon for a young athlete to compete on a community-based team and a club team during the same season.

# Extrinsic Risk Factors: Scheduling

- Tournament scheduling, where several games are often played in a single day, extending over consecutive days



# 10,000 Hour Rule

- Dan McLaughlin and the 10,000 hour rule



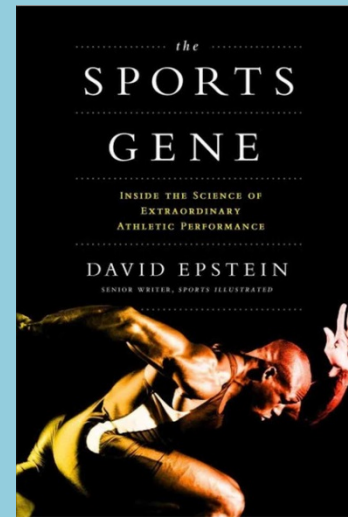
# Practice vs Genetics



- Stefan Holm
  - 5ft. 11in.
  - 28 in. standing vertical jumpThickened Achilles

vs

Donald Thomas  
6ft. 2in.  
?  
Long Achilles



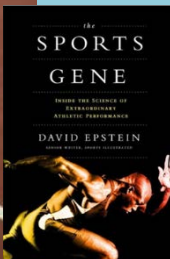


# Genetics and Practice?



# Genetics

- Michael Phelps
  - 22 medals, 18 gold
  - 6ft. 4in.
  - 32in. Inseam
- Hicham El Guerrouj
  - World record in mile
  - 5ft. 9in.
  - $\geq 32$ in. inseam





# READINESS FOR SPORTS

- Related to the match between a child's level of growth and development and the tasks/demands of the competitive sport.
  - (motor, sensory, cognitive, social/emotional)
- Chronological age is not a good indicator on which to base sport developmental models
  - motor, cognitive, and social skills progress at different rates, independent of age

# READINESS FOR SPORTS

- Coaches and parents may lack knowledge about normal development and signs of readiness for certain tasks, both physically and psychosocially.
- Unrealistic expectations may cause children and adolescents to feel as if they are not making progress in their sport.
- Children may lose self-esteem and withdraw from the sport.

# SPORT SPECIALIZATION

- Intensive, year-round training in a single sport at the exclusion of other sports.
- There is debate about whether early specialized training and intensive training volumes are necessary to achieve high skill levels in sports or if beginning more specialized and intensive training during late adolescence is more advantageous.
  - Gymnastics, Diving may be exceptions
- Growing concern regarding the potential negative effects of early sports specialization, including injury and sport burnout.

# SPORT SPECIALIZATION

- Diversified sports training during early and middle adolescence may be a more effective strategy in ultimately developing elite-level skills in the primary sport due to a positive transfer of skills.
- Consideration should be given to delaying intensive, specialized training until late adolescence, rather than a specific age, to optimize skill development in most sports.

# SPORT SPECIALIZATION

- Youth baseball pitchers who pitch >8 mo/y who are more likely to have shoulder or elbow surgery.
- Youth pitchers who pitched more than 100 innings/year were 3.5 times more likely to be injured.
- Study evaluating junior competitive tennis players, those players who reported competing only in tennis were 1.5 times more likely to have reported an injury.
- Comparing athletes with sports-related injuries to uninjured athletes presenting for sports physicals suggests that more specialized athletes were more likely to be injured.

# THE PITCH COUNT

*Figure 1*

MAXIMUM PITCH COUNTS	
AGE	PITCHES PER DAY
7-8	50
9-10	75
11-12	85
13-16	95

*Figure 2*

REST PERIOD AGES 7-16	
PITCHES THROWN	REST DAYS
61+	3
41-60	2
21-40	1
1-20	0

*Adopted from Little League Rule Book 2009*

# HIGH-RISK OVERUSE INJURIES

- High risk:
  - unrecognized or inappropriately treated
  - can result in significant loss of time from sport
  - and/or threaten future sport participation
- Include:
  - certain stress fractures, physeal stress injuries, osteochondritis dissecans, some apophyseal injuries, and effort thrombosis



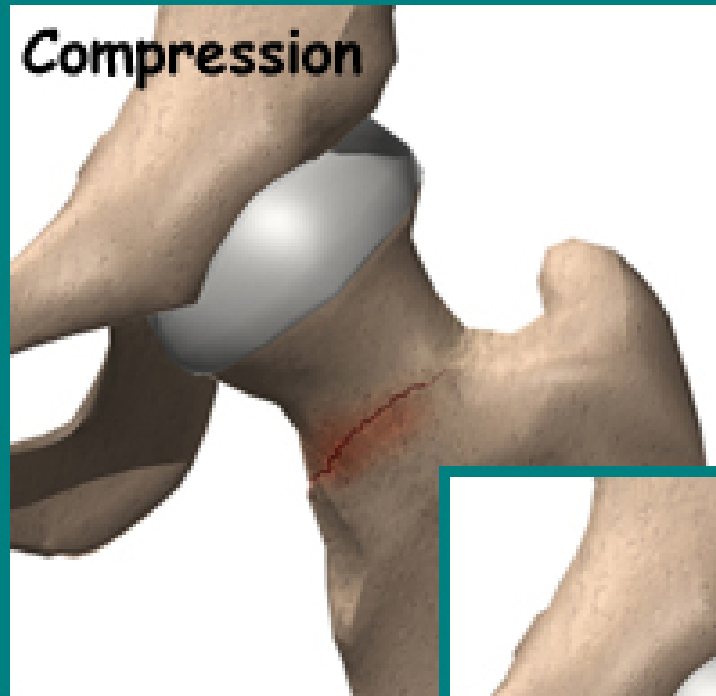
# High-Risk vs Low-Risk Overuse Injuries

Location	High Risk	Low Risk
Hip/Pelvis	Femoral neck (tension-sided)	Femoral shaft stress fracture
Back (lumbar spine)	Pars interarticularis stress fracture	Congenital spondylolysis, pedicle stress fracture
Leg	Anterior cortical tibial stress fracture	Medial tibial stress fracture, fibular shaft stress fracture
Ankle	Medial malleolar stress fracture, talar dome osteochondral defect, talar neck stress fracture	Distal fibular stress fracture
Foot	Tarsal navicular stress fracture, fifth metatarsal proximal diaphyseal stress fracture, sesamoid stress fracture	Second, third, fourth metatarsal stress fractures, cuboid
Knee	Patellar stress fracture, osteochondritis dissecans of femoral condyle or patella	Tibial tubercle and inferior patellar pole apophysitis
Shoulder/arm	Effort thrombosis	Proximal humeral physeal stress fracture
Elbow	Osteochondral dissecans capitellum, apophyseal non-union of medial epicondyle	Medial epicondyle apophysitis
Wrist	Distal radial physeal stress injury	

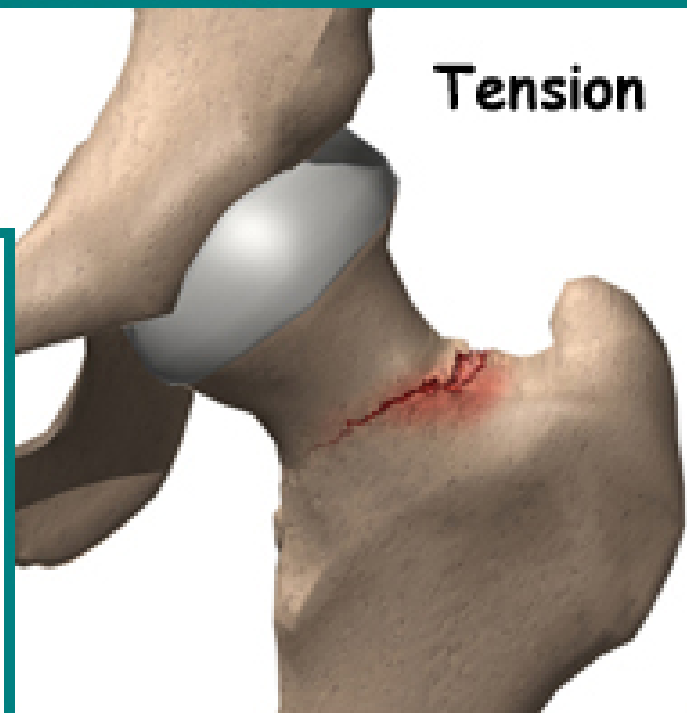
# Femoral Neck Stress fractures

- If not recognized early complete fracture may occur, with significant long-term implications.
- A high index of suspicion should be maintained with any young athlete who presents with anterior hip or groin pain.
- If x-rays are negative, an MRI should be obtained for diagnosis.

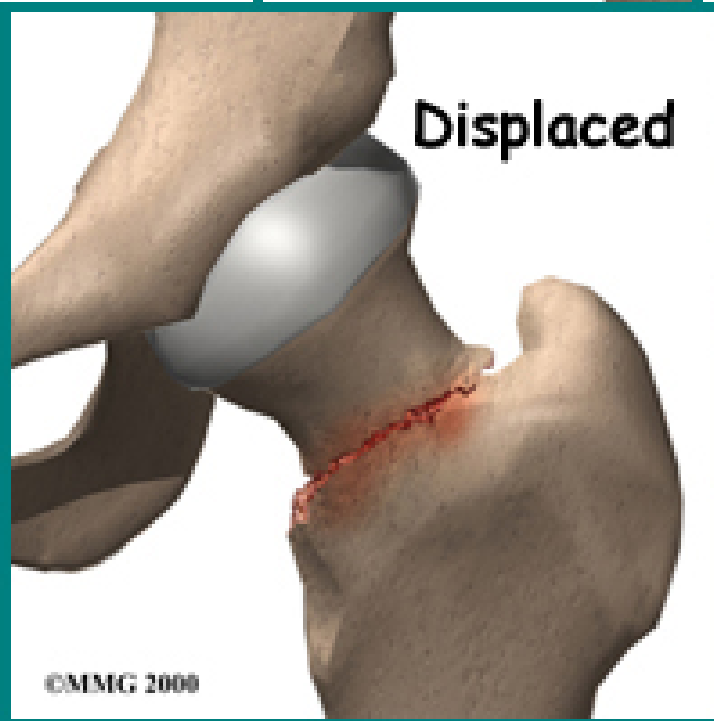
**Compression**



**Tension**



**Displaced**



**Types of  
stress fracture**

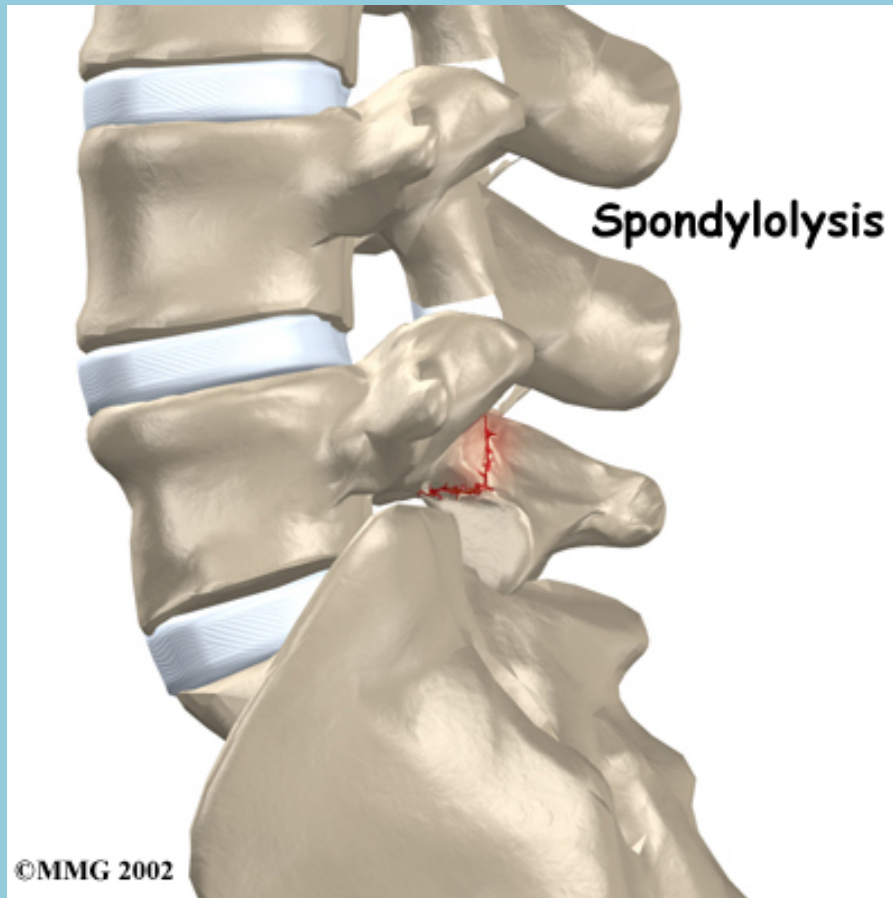
# Spine (Pars Interarticularis)

- Spondylolysis
- Relatively common cause of back pain in active children
- Progress to nonunion 14% to 70%
- Retrospective analysis of 57 youth soccer players
  - those who took at least 3 months off from the sport with or without bracing had the most optimal results

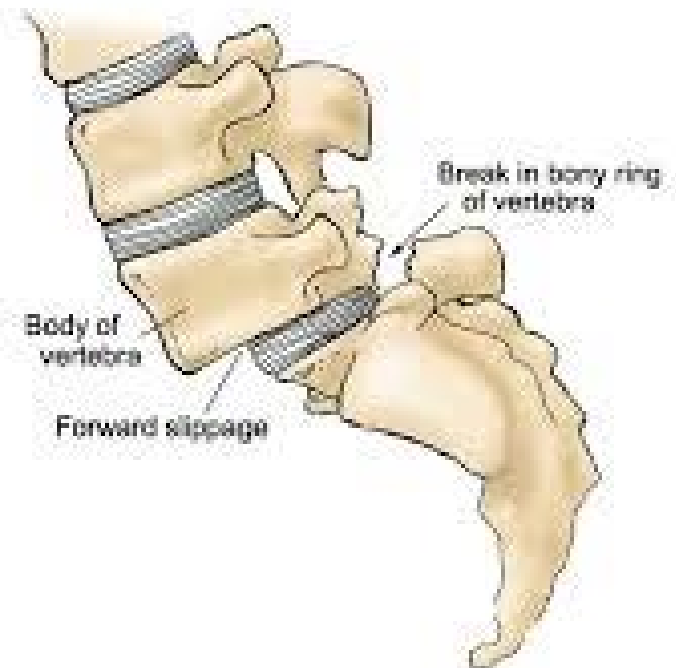
# Spine (Pars Interarticularis)

- Surgical pars repair
  - for painful spondylolysis with nonunion
  - after 6 months of nonoperative treatment and at least 9 to 12 months of symptoms
- May progress to spondylolisthesis if bilateral
- Surgery for spondylolisthesis
  - >50% slip
  - persistent radicular or neurologic symptoms

## Spondylolysis



## Spondylolisthesis

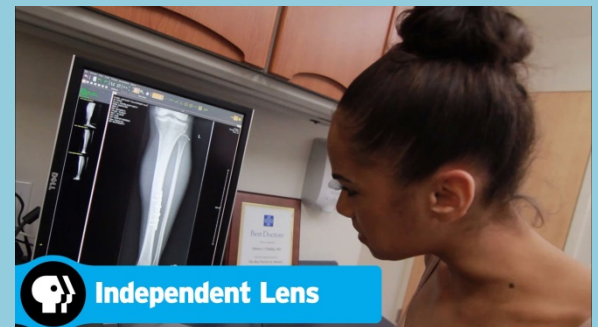


Side View of Low Backbone

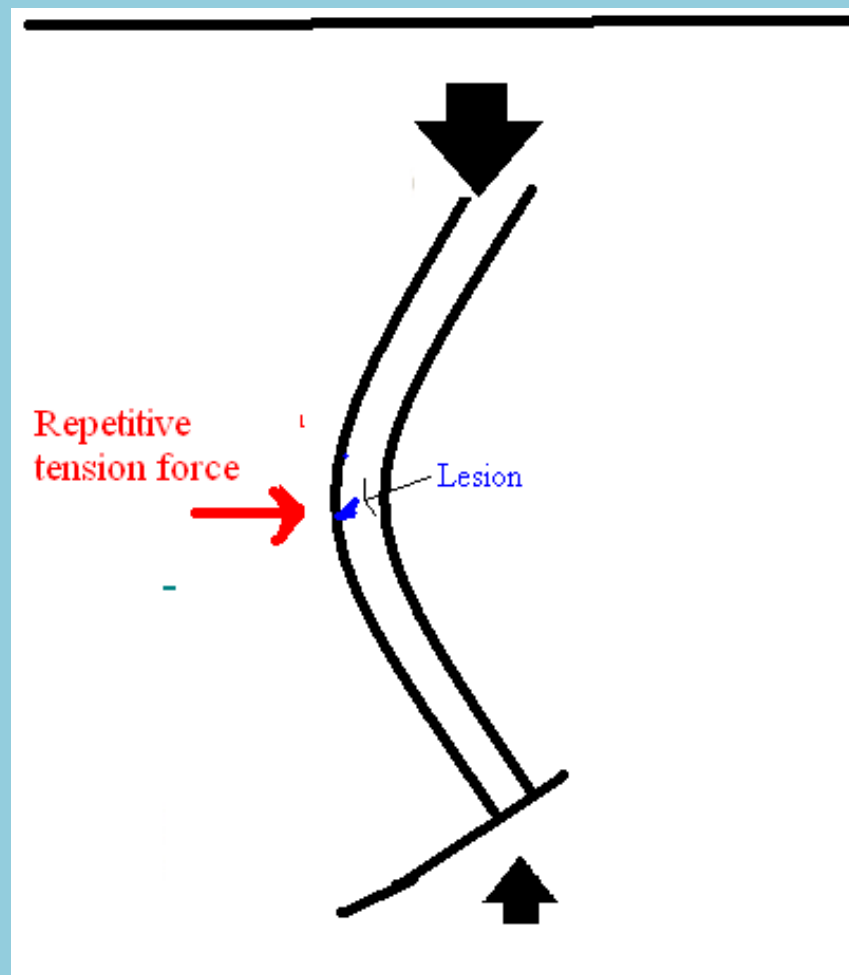
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# Anterior Tibia

- Anterior tibial stress fractures are tension-sided injuries that have a high risk of nonunion.
- Radiographs may display the “dreaded black line.”
- MRI or CT may be helpful in making the diagnosis







# Stress Fractures in the Foot

- In a retrospective review of 3 decades of x-rays from a single pediatric orthopedic clinic, 507 children with tarsal stress fractures were identified.
- Of the tarsal stress fractures identified, the following specific bones were involved:
  - calcaneus (244), cuboid (188), talus (121), navicular (24), and cuneiforms (23).
- Many occurred during resumption of weight bearing after cast immobilization for another injury.
  - Immobilization is an Osteopenia risk



# Imaging:

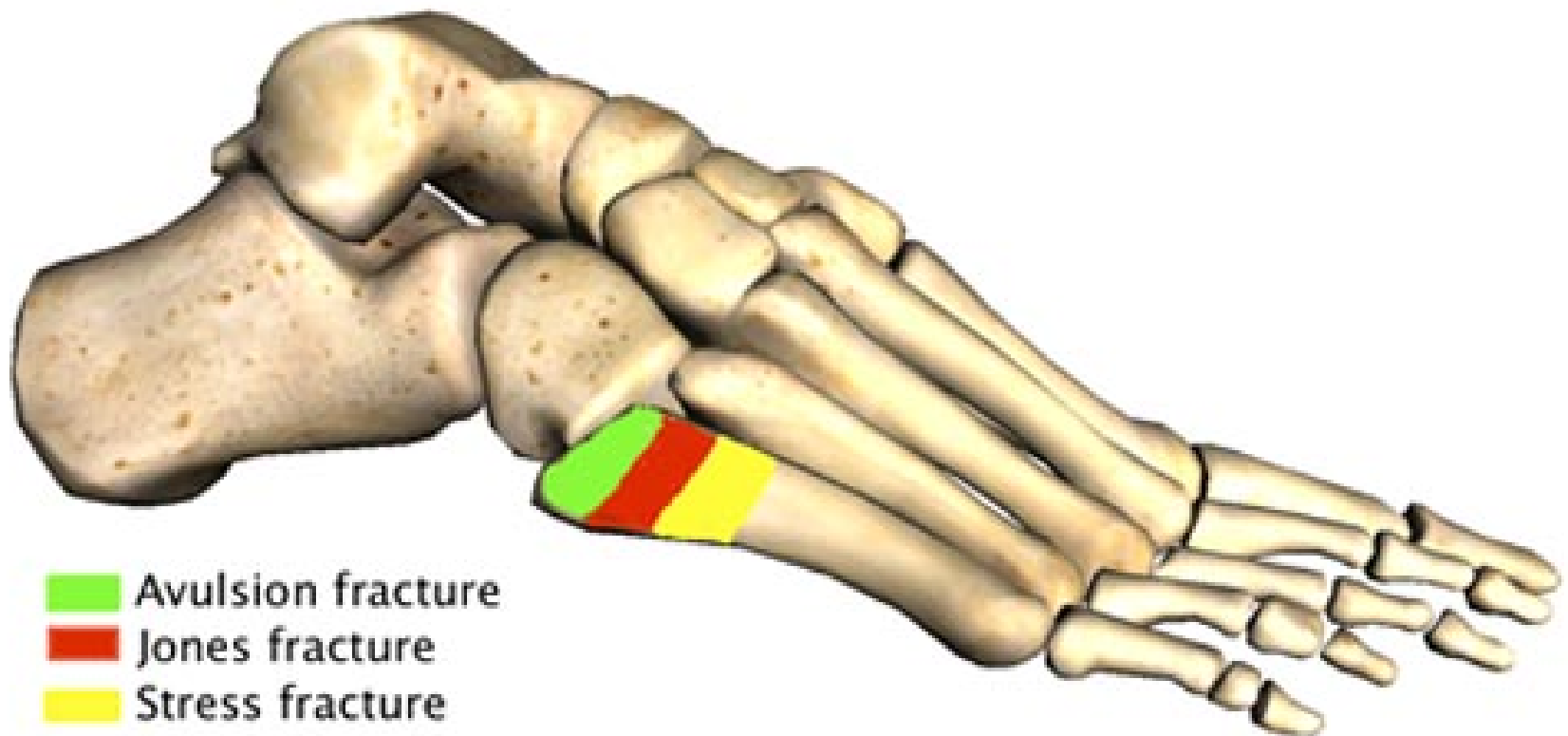
## Stress Reactions & Stress Fractures

- Imaging for stress reactions/fractures should begin with x-rays.
- Bone stress injuries may not be visible on plain radiographs for several weeks following the onset of pain.
  - some may never become apparent on radiographs
- MRI is the study of choice for early stress fracture diagnosis in most situations.

# Treatment of Stress Fractures

- Treatment of high-risk stress reactions and stress fractures depends on the specific site of the injury.
- For fractures that fail to heal and cause persistent symptoms, open reduction with internal fixation may be required.
- Surgical treatment may also be considered as initial treatment for stress fractures of
  - the tension side of the femoral neck, anterior tibia, tarsal navicular, and at the diaphyseal/metaphyseal junction of the fifth metatarsal.

## Characterization of Proximal 5th Metatarsal Fractures by Location



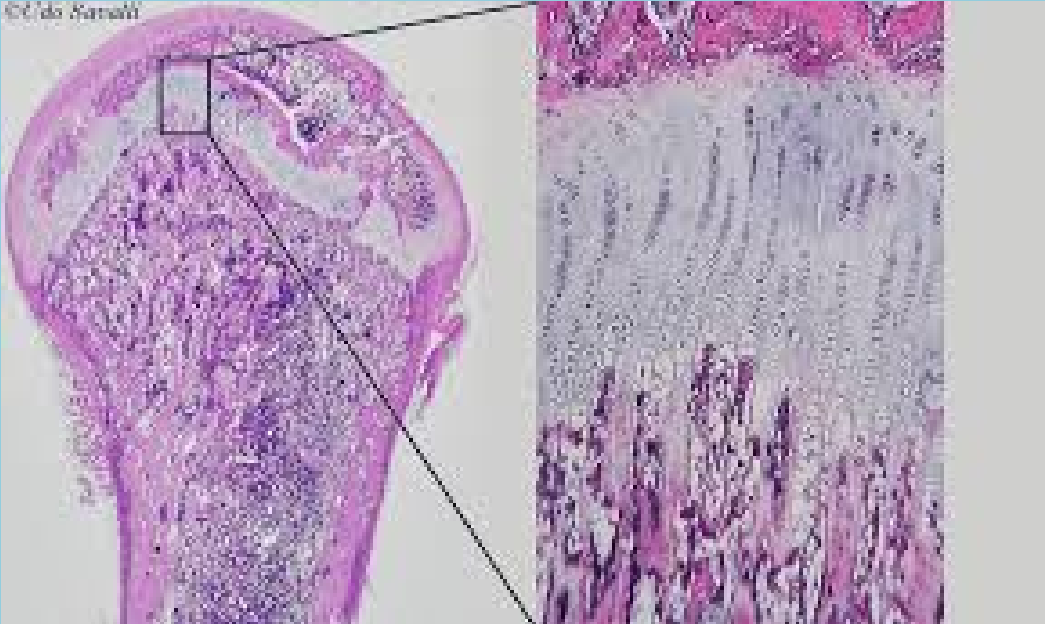
# Prevention of Stress Fractures

- Setting limits on impact activities
  - Optimizing Vitamin D and calcium intake
  - Screening for the female athlete triad
  - Considering the use of shoe orthotics
- 
- Early recognition is the key to optimal treatment.

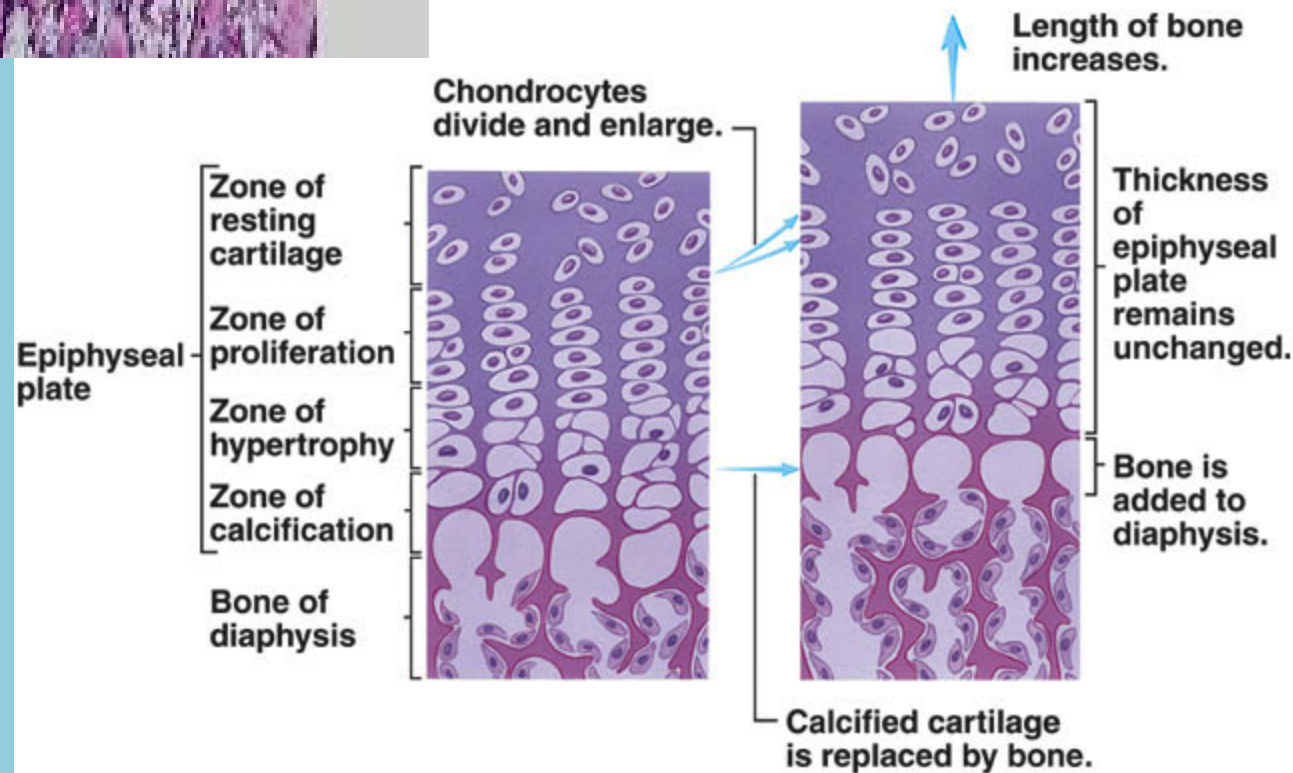
# Physeal Stress Injuries

- Most resolve with rest
- Some may cause growth disturbance and joint deformity
- Occur at the proximal humerus, distal radius, distal femur, and the proximal tibia



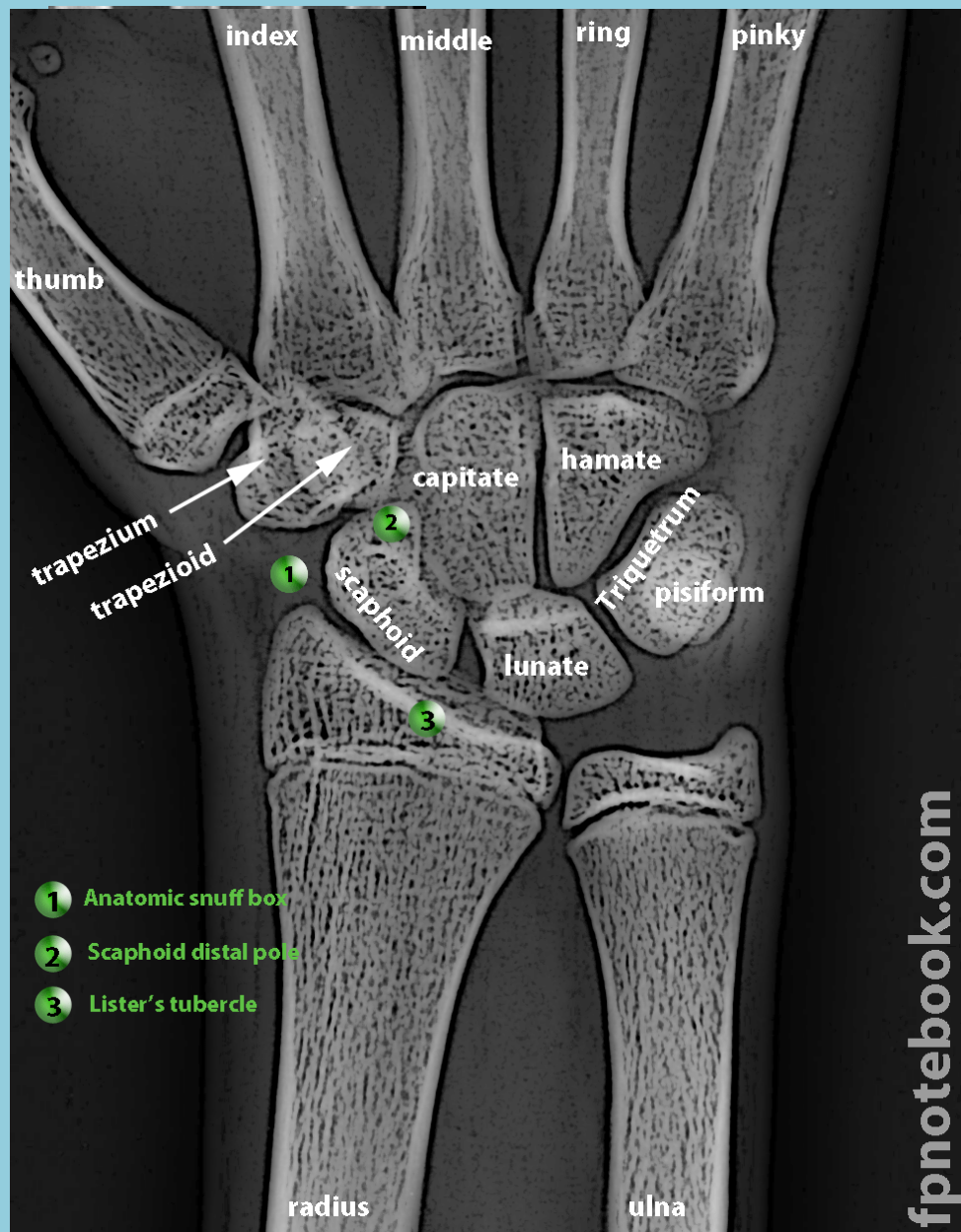


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# Distal Radius Stress Injury

- Perhaps the most studied physeal stress injury involves the distal radius in young gymnasts.
- Potential premature physeal closure
- If this occurs prior to closure of the distal ulnar physis, positive ulnar variance may ensue.
- Can lead to impingement of the triangular fibrocartilage complex, degenerative joint disease, and chronic ulnar-sided wrist pain.



# Osteochondritis Dissecans

- Injury to the subchondral bone and articular cartilage of joints
- Most common OCD sites
  - femoral condyles, capitellum, and the talar dome
- Joint pain, swelling, limited motion, and mechanical symptoms (locking, catching)
- X-ray to diagnose, MRI to stage

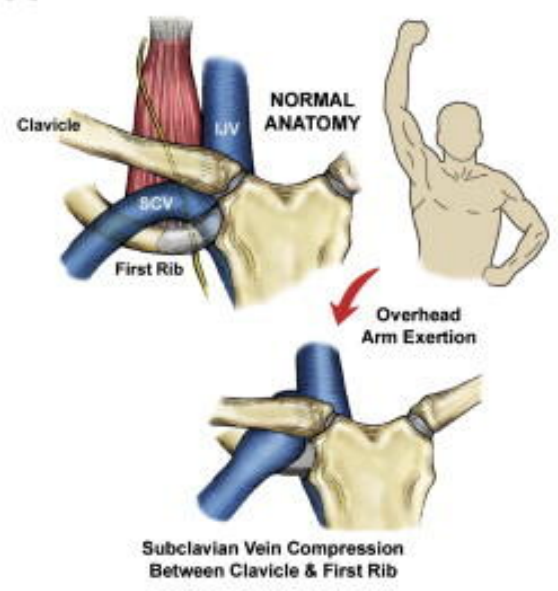


# Effort Thrombosis

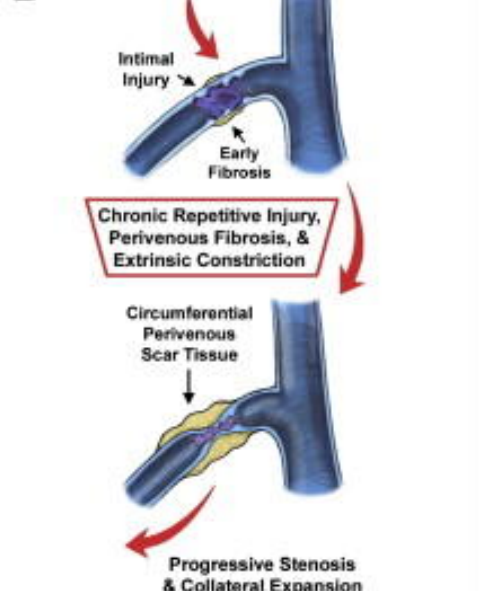
- Effort thrombosis of the upper extremity typically occurs in athletes as a consequence of thoracic outlet syndrome.
- Sometimes referred to as Paget-Schroetter syndrome.
  - Subclavian vein compression
- Common presenting symptoms are unilateral arm swelling and discoloration.



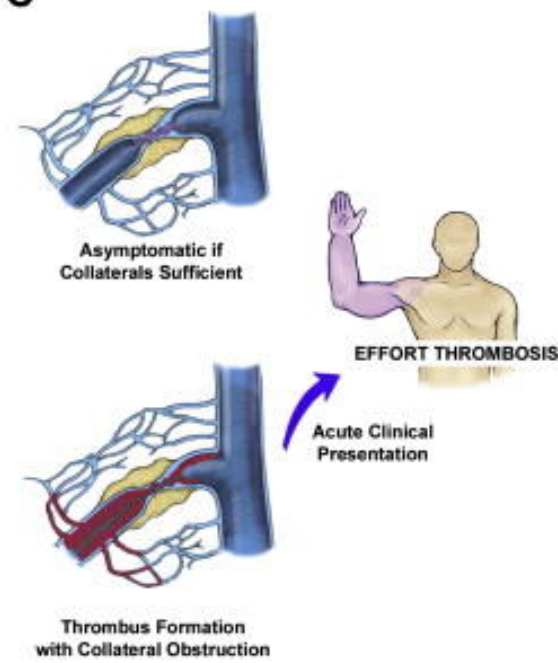
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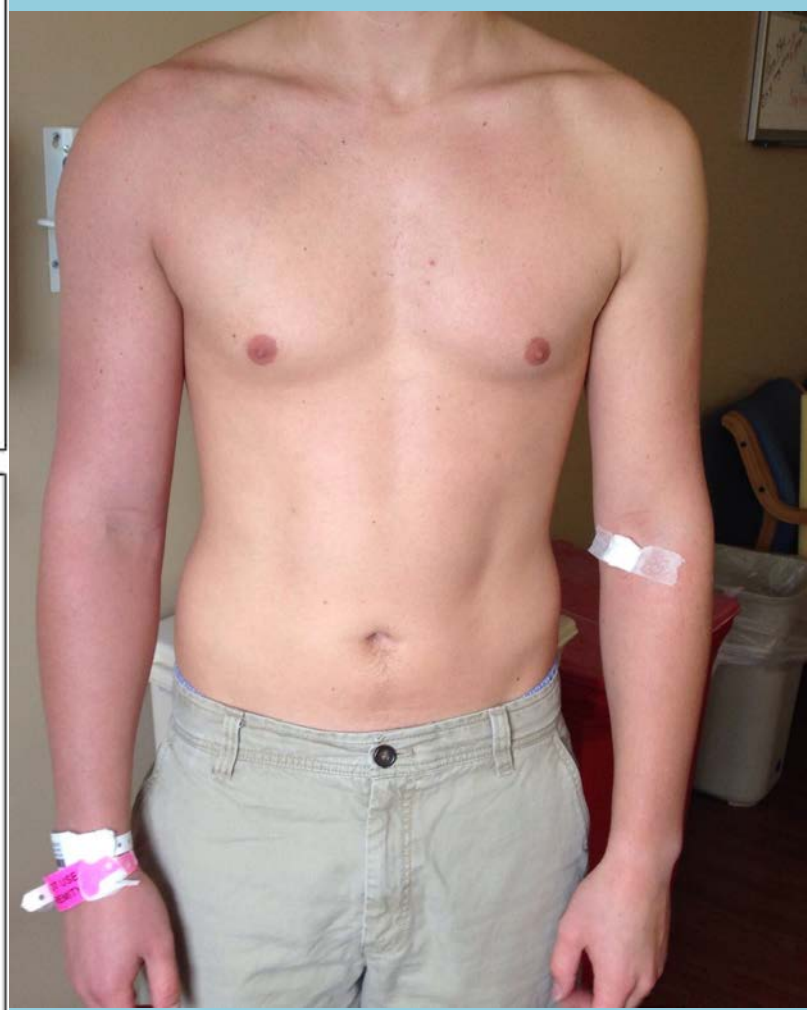
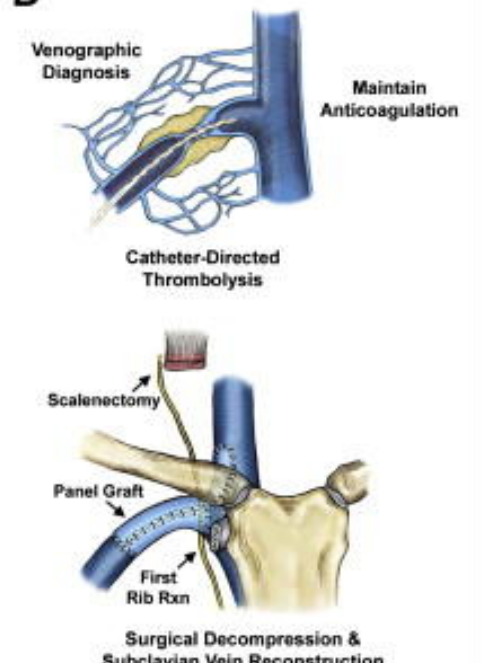
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# Summary

- Overuse injuries are underreported in the current literature because most injury definitions have focused on time loss from sport.
- Preparticipation exams may identify prior injury patterns and provide an opportunity to assess sport readiness.



# Summary

- A history of prior injury is an established risk factor for overuse injuries and should be noted as part of each injury assessment.
- Adolescent female athletes should be assessed for menstrual dysfunction as a potential predisposing factor to overuse injury.

# Summary

- Parents and coaches should be educated regarding the concept of sport readiness.
- Variations in cognitive development, as well as motor skills, should be considered when setting goals and expectations.

# Summary

- Early sport specialization may not lead to long-term success in sports and may increase risk for overuse injury and burnout.
- With the exception of early entry sports such as gymnastics, figure skating, and swimming/diving, sport diversification should be encouraged at younger ages.

# Summary

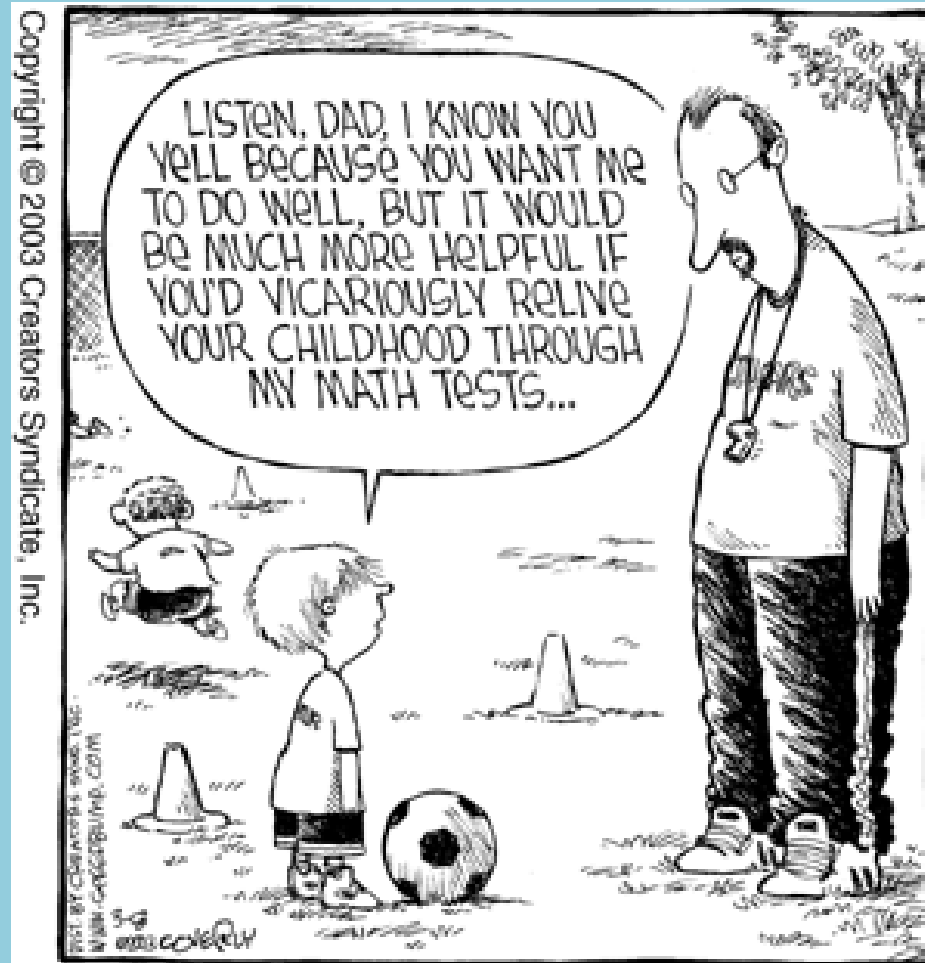
- When an overuse injury is diagnosed, it is essential to address the underlying cause.
- The athlete, parents, and coaches should be involved in reviewing all risk factors and developing a strategy to attempt to avoid recurrent injury.

# Summary

- All overuse injuries are not inherently benign.
- Clinicians should be familiar with specific high-risk injuries, including stress fractures of the femoral neck, tarsal navicular, anterior tibial cortex and physis, and effort thrombosis.

# Questions

- Thank You



# References

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