

# **Pediatric Primary Care Sports Medicine Handbook**

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## 1. **MSK Physical Examination Review Resources**

- **American Medical Society for Sports Medicine Videos and Tutorials:** Repository of videos from various sources
  - <http://amssm.blogspot.com/p/videos.html>
- **American College of Emergency Physicians Musculoskeletal Videos:** Emergency Department-focused, high-yield videos, 3-8 minutes per joint
  - <https://www.acep.org/sportsmedicine/resources/>
- **UCSD Online Musculoskeletal Examination Tutorial:** Detailed tutorial for commonly affected joints that includes descriptions, annotated pictures, and videos
  - <http://meded.ucsd.edu/clinicalmed/joints.html>

## 2. Preparticipation Physical Evaluation

### Goals of the PPE

- Determine general **physical** and **psychological** health
- Evaluate for conditions that may be **life-threatening** or **disabling**
- Evaluate for conditions that may **predispose to injury** or **illness**
- Provide an opportunity for **discussion of health and lifestyle** issues
- Serve as an **entry point** into the health care system for adolescents without a medical home

### PPE Administration and Logistics

- **Timing:** At least **6 weeks before participation**, to allow further evaluation of any problems identified during the PPE.
- **Location:** Ideally in the **primary medical home**, by the child's PCP, with access to current and past medical records
- **Frequency:** A comprehensive PPE should be performed as part of the periodic health supervision examination **every 2 to 3 years**, with updated **interval histories and examinations** at intervening health supervision checks yearly.
  - Optimal frequency for the PPE has not been established
  - Reasonable to incorporate PPE into annual health supervision visit

### General Considerations: History

- Medical history alone detects **~90% of medical conditions** and **~70% of MSK conditions** identified on the PPE
- **Parents** should be **involved**, due to **poor correlation** between athlete and parental reports of medical history
- Incorporate **confidential history** with adolescent
- **Comprehensive review** of medical records
  - Medical and surgical history
  - Medications, supplements, and substance use
  - Allergies
  - Immunizations
- Incorporate **screening tools** routinely used at health supervision visits (PHQ, GAD-7, CRAFFT)

### General Considerations: Examination

- **Examination should include:**
  - Vital signs
  - Visual acuity
  - Growth curve measurements
  - Medical examination
  - MSK examination

EXAMINATION		
Height:	Weight:	
BP: / ( / )	Pulse:	Vision: R 20/ L 20/ Corrected: <input type="checkbox"/> Y <input type="checkbox"/> N
MEDICAL	NORMAL	ABNORMAL FINDINGS
Appearance • Marfan stigmata (kyphoscoliosis, high-arched palate, pectus excavatum, arachnodactyly, hyperlaxity, myopia, mitral valve prolapse [MVP], and aortic insufficiency)		
Eyes, ears, nose, and throat • Pupils equal • Hearing		
Lymph nodes		
Heart* • Murmurs (auscultation standing, auscultation supine, and ± Valsalva maneuver)		
Lungs		
Abdomen		
Skin • Herpes simplex virus (HSV), lesions suggestive of methicillin-resistant <i>Staphylococcus aureus</i> (MRSA), or tinea corporis		
Neurological		
MUSCULOSKELETAL	NORMAL	ABNORMAL FINDINGS
Neck		
Back		
Shoulder and arm		
Elbow and forearm		
Wrist, hand, and fingers		
Hip and thigh		
Knee		
Leg and ankle		
Foot and toes		
Functional • Double-leg squat test, single-leg squat test, and box drop or step drop test		

\* Consider electrocardiography (ECG), echocardiography, referral to a cardiologist for abnormal cardiac history or examination findings, or a combination of those.



### *General Considerations: Eligibility*

- Up to ~15% of athletes require further evaluation before eligibility status can be determined, and **> 98% qualify** to participate
- **5 eligibility categories:**
  - Medically eligible for all activities without restriction
  - Medically eligible for all activities with recommendations for further evaluation or treatment (e.g., "Check blood pressure in 1 month")
  - Not medically eligible for any activities until additional evaluation, treatment, or rehabilitation is completed
  - Not medically eligible to participate in specific activities
  - Not medically eligible to participate in any sports or physical activities
- Decisions should be based on **pertinent clinical guidelines:**
  - AAP Council on Sports Medicine and Fitness guidelines on medical conditions affecting sports participation
  - American Heart Association (AHA) and American College of Cardiology (ACC) guidelines on athletes with cardiovascular abnormalities

### *Cardiovascular System*

- In 2015, AHA and ACC updated consensus statement on preparticipation cardiovascular screening in athletes:
  - Specific recommendations for a detailed **personal** and **family history** and **physical examination**
- Warning symptoms that require further cardiac evaluation:
  - **Syncope, near-syncope**, and/or **chest pain or tightness** during exercise
  - **Palpitations** during exercise
  - Unexplained **breathlessness** during exercise
  - Unexplained **seizure**
- Personal history: elevated SBP, and previous recognition of murmur, restriction from participation, or CV testing
- Family history that may indicate **genetic cardiovascular disorder** placing athlete at increased risk of sudden cardiac death/arrest (SCD/SCA):
  - Sudden unexpected or unexplained death
  - Sudden death < 50 years (especially < 35 years) due to cardiac problems
  - Sudden infant death
  - Unexplained drowning or near drowning
  - Car crashes caused by unexplained driver LOC
  - Unexplained seizures
- Physical examination should include:
  - Auscultation for **heart murmurs**, performed in supine and standing positions (or with Valsalva maneuver), specifically to identify pathological murmurs
  - Simultaneous palpation of **radial and femoral artery pulses** to exclude coarctation of the aorta
  - Examination for the physical stigmata of **Marfan syndrome**
  - **Brachial artery BP** taken in the sitting position
- Further evaluation: athletes with suspected or identified risk for SCD/SCA should be evaluated by a cardiologist

- Limitations and controversies:
  - Limited ability of providers to **distinguish physiologic from pathologic** cardiac murmurs
  - **No outcomes-based studies** demonstrate effectiveness of PPE in preventing SCD, although many abnormalities identified during evaluations
  - Universal ECG screening remains controversial, **not currently recommended** by AHA/ACC for US athletes aged 12 to 24 years
  - Targeted ECG screening for **high-risk populations** is gaining acceptance
    - Use 2017 *International Criteria for ECG Interpretation in Athletes* by Drezner et. al.

Table 6A-5. Significance of Abnormal Heart Murmurs

Auscultatory Finding	Significance
<ul style="list-style-type: none"> <li>• Harsh, loud (usually <math>\geq</math> grade 3), systolic ejection murmur</li> <li>• Loudest right upper sternal border</li> <li>• Increases with maneuvers that decrease venous return (ie, Valsalva, or moving from squatting to standing)</li> </ul>	HCM-associated LV outflow tract obstruction
<ul style="list-style-type: none"> <li>• Systolic ejection murmur heard best at right upper sternal border</li> <li>• Radiation to neck</li> <li>• Diminishes with maneuvers that decrease venous return (ie, Valsalva) and increases with maneuvers that increase venous return (ie, squatting)</li> </ul>	Aortic stenosis
<ul style="list-style-type: none"> <li>• Holosystolic murmur heard best at the apex</li> <li>• Radiation to axilla</li> </ul>	Mitral valve regurgitation and possible dilated cardiomyopathy or HCM
<ul style="list-style-type: none"> <li>• Diastolic murmur heard at right upper sternal border</li> <li>• Murmur accentuated with hand grip (increased systemic vascular resistance)</li> </ul>	Aortic valve insufficiency and possible Marfan syndrome or bicuspid aortic valve
<ul style="list-style-type: none"> <li>• High-frequency diastolic murmur heard best at left upper sternal border</li> </ul>	Pulmonary valve insufficiency from primary pulmonary hypertension (Graham Steele murmur)
<ul style="list-style-type: none"> <li>• Soft early systolic murmur heard best at the upper sternal border while supine (increased venous return)</li> <li>• Murmur often absent or diminished when standing or sitting and with Valsalva maneuver</li> </ul>	Physiological (hyperdynamic) flow murmur in a well-trained athlete

Abbreviations: HCM, hypertrophic cardiomyopathy; LV, left ventricular.

### Nervous System

- Neurologic conditions that affect sports participation/activities:
  - **Concussion:** return to play (RTP) once athlete is completely asymptomatic and has successfully completed a graduated RTP program
  - **Cervical spine injuries/conditions:** evaluate for cervical spine stenosis, consider neurosurgical consultation, RTP varies based on condition
  - **Brachial plexus injuries** (stingers or burners): may RTP when asymptomatic
  - **Seizure disorders:** if well-controlled, does not preclude from physical activities or sports
  - **Headache disorders:** can be triggered or worsened by exercise, may prohibit physical activity

### General Medical Conditions

- **Diabetes:** documented action care plan for games and practices; always have medication/supplies readily available
- **Anaphylaxis:** immediate on-site access to injected epinephrine at all times; documented emergency action plan
- **Solitary organs or organ absence:** may not limit an athlete from contact activities; protective equipment may be advised
- **Infectious mononucleosis:** no return to sport for 3 to 4 weeks after symptom onset; return to contact/collision activity not advised for at least 4 weeks after symptom onset
- **Acute febrile illness:** limit participation until fever resolves
- **Hernia:** abdominal or groin hernia does not limit participation; symptomatic hernias should be repaired
- **Sickle cell trait:** at risk for sickling during high-intensity physical activity, especially in hot, humid environments; no clear evidence for limitations or modifications in exercise; universal screening not widely recommended (except NCAA)
- **Eye disorders and vision:** if corrected vision worse than 20/40 in one eye, then strongly consider eye protection of normal eye; eye protection is essential in certain high-risk sports
- **Skin conditions:** HSV, MSSA/MRSA, molluscum, and tinea require treatment before allowing participation
- If relevant, **medication/disease alert tag** should be worn

▪ **See AAP Council on Sports Medicine and Fitness guidelines on medical conditions affecting participation**

TABLE 2 Medical Conditions and Sports Participation	Condition	May Participate
	Atlantoaxial instability (instability of the joint between cervical vertebrae 1 and 2) Explanation: Athlete (particularly if he or she has Down syndrome or juvenile rheumatoid arthritis with cervical involvement) needs evaluation to assess the risk of spinal cord injury during sports participation, especially when using a trampoline. <sup>4-7</sup>	Qualified yes
	Bleeding disorder Explanation: Athlete needs evaluation. <sup>8,9</sup>	Qualified yes
	Cardiovascular disease Carditis (inflammation of the heart) Explanation: Carditis may result in sudden death with exertion.	No
	Hypertension (high blood pressure) Explanation: Those with hypertension >5 mm Hg above the 99th percentile for age, gender, and height should avoid heavy weightlifting and power lifting, bodybuilding, and high-static component sports (Fig 1). Those with sustained hypertension (>95th percentile for age, gender, and height) need evaluation. <sup>10-12</sup> The National High Blood Pressure Education Program Working Group report defined prehypertension and stage 1 and stage 2 hypertension in children and adolescents younger than 18 years of age. <sup>10</sup>	Qualified yes
	Congenital heart disease (structural heart defects present at birth) Explanation: Consultation with a cardiologist is recommended. Those who have mild forms may participate fully in most cases; those who have moderate or severe forms or who have undergone surgery need evaluation. The 36th Bethesda Conference <sup>12</sup> defined mild, moderate, and severe disease for common cardiac lesions.	Qualified yes
	Dysrhythmia (irregular heart rhythm) Long-QT syndrome Malignant ventricular arrhythmias Symptomatic Wolff-Parkinson-White syndrome Advanced heart block Family history of sudden death or previous sudden cardiac event Implantation of a cardioverter-defibrillator Explanation: Consultation with a cardiologist is advised. Those with symptoms (chest pain, syncope, near-syncope, dizziness, shortness of breath, or other symptoms of possible dysrhythmia) or evidence of mitral regurgitation on physical examination need evaluation. All others may participate fully. <sup>13-15</sup>	Qualified yes
	Heart murmur Explanation: If the murmur is innocent (does not indicate heart disease), full participation is permitted. Otherwise, athlete needs evaluation (see structural heart disease, especially hypertrophic cardiomyopathy and mitral valve prolapse).	Qualified yes
	Structural/acquired heart disease Hypertrophic cardiomyopathy Coronary artery anomalies Arrhythmogenic right ventricular cardiomyopathy Acute rheumatic fever with carditis Ehlers-Danlos syndrome, vascular form Marfan syndrome Mitral valve prolapse Anthracycline use Explanation: Consultation with a cardiologist is recommended. The 36th Bethesda Conference provided detailed recommendations. <sup>12,13,15-18</sup> Most of these conditions carry a significant risk of sudden cardiac death associated with intense physical exercise. Hypertrophic cardiomyopathy requires thorough and repeated evaluations, because disease may change manifestations during later adolescence. <sup>12,13,17</sup> Marfan syndrome with an aortic aneurysm also can cause sudden death during intense physical exercise. <sup>18</sup> Athlete who has ever received chemotherapy with anthracyclines may be at increased risk of cardiac problems because of the cardiotoxic effects of the medications, and resistance training in this population should be approached with caution; strength training that avoids isometric contractions may be permitted. <sup>19,20</sup> Athlete needs evaluation.	Qualified no Qualified no Qualified no Qualified no Qualified no Qualified yes Qualified yes Qualified yes
	Vasculitis/vascular disease Kawasaki disease (coronary artery vasculitis) Pulmonary hypertension Explanation: Consultation with a cardiologist is recommended. Athlete needs individual evaluation to assess risk on the basis of disease activity, pathologic changes, and medical regimen. <sup>21</sup>	Qualified yes
	Cerebral palsy Explanation: Athlete needs evaluation to assess functional capacity to perform sports-specific activity.	Qualified yes
	Diabetes mellitus Explanation: All sports can be played with proper attention and appropriate adjustments to diet (particularly carbohydrate intake), blood glucose concentrations, hydration, and insulin therapy. Blood glucose concentrations should be monitored before exercise, every 30 min during continuous exercise, 15 min after completion of exercise, and at bedtime.	Yes
	Diarrhea, infectious Explanation: Unless symptoms are mild and athlete is fully hydrated, no participation is permitted, because diarrhea may increase risk of dehydration and heat illness (see fever).	Qualified no
	Eating disorders Explanation: Athlete with an eating disorder needs medical and psychiatric assessment before participation.	Qualified yes
	Eyes Functionally 1-eyed athlete Loss of an eye Detached retina or family history of retinal detachment at young age High myopia Connective tissue disorder, such as Marfan or Stickler syndrome Previous intraocular eye surgery or serious eye injury	Qualified yes

TABLE 2 Continued

Condition	May Participate
Explanation: A functionally 1-eyed athlete is defined as having best-corrected visual acuity worse than 20/40 in the poorer-seeing eye. Such an athlete would suffer significant disability if the better eye were seriously injured, as would an athlete with loss of an eye. Specifically, boxing and full-contact martial arts are not recommended for functionally 1-eyed athletes, because eye protection is impractical and/or not permitted. Some athletes who previously underwent intraocular eye surgery or had a serious eye injury may have increased risk of injury because of weakened eye tissue. Availability of eye guards approved by the American Society for Testing and Materials and other protective equipment may allow participation in most sports, but this must be judged on an individual basis. <sup>22,23</sup>	
Conjunctivitis, infectious Explanation: Athlete with active infectious conjunctivitis should be excluded from swimming.	Qualified no
Fever Explanation: Elevated core temperature may be indicative of a pathologic medical condition (infection or disease) that is often manifest by increased resting metabolism and heart rate. Accordingly, during athlete's usual exercise regimen, the presence of fever can result in greater heat storage, decreased heat tolerance, increased risk of heat illness, increased cardiopulmonary effort, reduced maximal exercise capacity, and increased risk of hypotension because of altered vascular tone and dehydration. On rare occasions, fever may accompany myocarditis or other conditions that may make usual exercise dangerous.	No
Gastrointestinal Malabsorption syndromes (celiac disease or cystic fibrosis) Explanation: Athlete needs individual assessment for general malnutrition or specific deficits resulting in coagulation or other defects; with appropriate treatment, these deficits can be treated adequately to permit normal activities. Short-bowel syndrome or other disorders requiring specialized nutritional support, including parenteral or enteral nutrition Explanation: Athlete needs individual assessment for collision, contact, or limited-contact sports. Presence of central or peripheral, indwelling, venous catheter may require special considerations for activities and emergency preparedness for unexpected trauma to the device(s).	Qualified yes
Heat illness, history of Explanation: Because of the likelihood of recurrence, athlete needs individual assessment to determine the presence of predisposing conditions and behaviors and to develop a prevention strategy that includes sufficient acclimatization (to the environment and to exercise intensity and duration), conditioning, hydration, and salt intake, as well as other effective measures to improve heat tolerance and to reduce heat injury risk (such as protective equipment and uniform configurations). <sup>24,25</sup>	Qualified yes
Hepatitis, infectious (primarily hepatitis C) Explanation: All athletes should receive hepatitis B vaccination before participation. Because of the apparent minimal risk to others, all sports may be played as athlete's state of health allows. For all athletes, skin lesions should be covered properly, and athletic personnel should use universal precautions when handling blood or body fluids with visible blood. <sup>26</sup>	Yes
HIV infection Explanation: Because of the apparent minimal risk to others, all sports may be played as athlete's state of health allows (especially if viral load is undetectable or very low). For all athletes, skin lesions should be covered properly, and athletic personnel should use universal precautions when handling blood or body fluids with visible blood. <sup>26</sup> However, certain sports (such as wrestling and boxing) may create a situation that favors viral transmission (likely bleeding plus skin breaks). If viral load is detectable, then athletes should be advised to avoid such high-contact sports.	Yes
Kidney, absence of one Explanation: Athlete needs individual assessment for contact, collision, and limited-contact sports. Protective equipment may reduce risk of injury to the remaining kidney sufficiently to allow participation in most sports, providing such equipment remains in place during activity. <sup>22</sup>	Qualified yes
Liver, enlarged Explanation: If the liver is acutely enlarged, then participation should be avoided because of risk of rupture. If the liver is chronically enlarged, then individual assessment is needed before collision, contact, or limited-contact sports are played. Patients with chronic liver disease may have changes in liver function that affect stamina, mental status, coagulation, or nutritional status.	Qualified yes
Malignant neoplasm Explanation: Athlete needs individual assessment. <sup>27</sup>	Qualified yes
Musculoskeletal disorders Explanation: Athlete needs individual assessment.	Qualified yes
Neurologic disorders History of serious head or spine trauma or abnormality, including craniotomy, epidural bleeding, subdural hematoma, intracerebral hemorrhage, second-impact syndrome, vascular malformation, and neck fracture. <sup>4,5,28-30</sup> Explanation: Athlete needs individual assessment for collision, contact, or limited-contact sports.	Qualified yes
History of simple concussion (mild traumatic brain injury), multiple simple concussions, and/or complex concussion Explanation: Athlete needs individual assessment. Research supports a conservative approach to concussion management, including no athletic participation while symptomatic or when deficits in judgment or cognition are detected, followed by graduated return to full activity. <sup>28-32</sup>	Qualified yes
Myopathies Explanation: Athlete needs individual assessment.	Qualified yes
Recurrent headaches Explanation: Athlete needs individual assessment. <sup>33</sup>	Yes
Recurrent plexopathy (burner or stinger) and cervical cord neuropraxia with persistent defects Explanation: Athlete needs individual assessment for collision, contact, or limited-contact sports; regaining normal strength is important benchmark for return to play. <sup>34,35</sup>	Qualified yes
Seizure disorder, well controlled Explanation: Risk of seizure during participation is minimal. <sup>36</sup>	Yes
Seizure disorder, poorly controlled Explanation: Athlete needs individual assessment for collision, contact, or limited-contact sports. The following noncontact sports should be avoided: archery, riflery, swimming, weightlifting, power lifting, strength training, and sports involving heights. In these sports, occurrence of a seizure during activity may pose a risk to self or others. <sup>36</sup>	Qualified yes



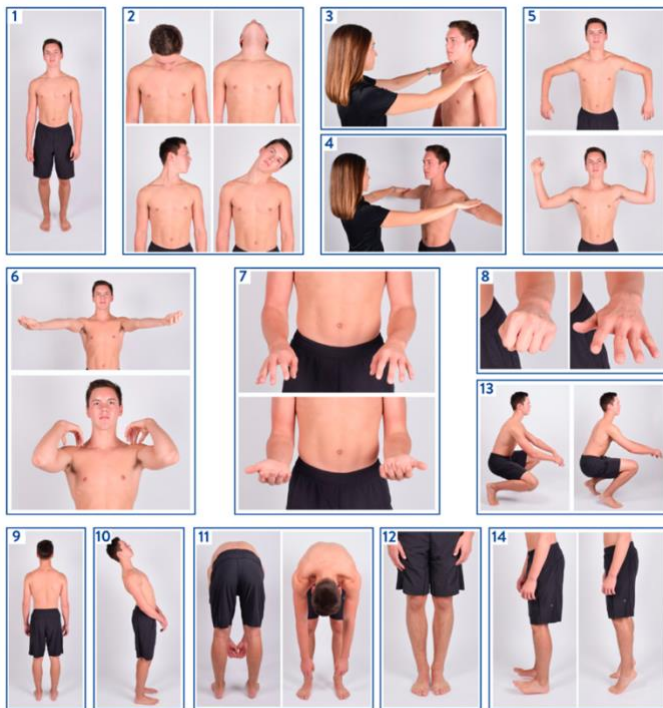
TABLE 2 Continued

Condition	May Participate
Obesity Explanation: Because of the increased risk of heat illness and cardiovascular strain, obese athlete particularly needs careful acclimatization (to the environment and to exercise intensity and duration), sufficient hydration, and potential activity and recovery modifications during competition and training. <sup>37</sup>	Yes
Organ transplant recipient (and those taking immunosuppressive medications) Explanation: Athlete needs individual assessment for contact, collision, and limited-contact sports. In addition to potential risk of infections, some medications (eg, prednisone) may increase tendency for bruising.	Qualified yes
Ovary, absence of one Explanation: Risk of severe injury to remaining ovary is minimal.	Yes
Pregnancy/postpartum Explanation: Athlete needs individual assessment. As pregnancy progresses, modifications to usual exercise routines will become necessary. Activities with high risk of falling or abdominal trauma should be avoided. Scuba diving and activities posing risk of altitude sickness should also be avoided during pregnancy. After the birth, physiological and morphologic changes of pregnancy take 4 to 6 weeks to return to baseline. <sup>38,39</sup>	Qualified yes
Respiratory conditions	
Pulmonary compromise, including cystic fibrosis Explanation: Athlete needs individual assessment but, generally, all sports may be played if oxygenation remains satisfactory during graded exercise test. Athletes with cystic fibrosis need acclimatization and good hydration to reduce risk of heat illness.	Qualified yes
Asthma Explanation: With proper medication and education, only athletes with severe asthma need to modify their participation. For those using inhalers, recommend having a written action plan and using a peak flowmeter daily. <sup>40-43</sup> Athletes with asthma may encounter risks when scuba diving.	Yes
Acute upper respiratory infection Explanation: Upper respiratory obstruction may affect pulmonary function. Athlete needs individual assessment for all except mild disease (see fever).	Qualified yes
Rheumatologic diseases	Qualified yes
Juvenile rheumatoid arthritis Explanation: Athletes with systemic or polyarticular juvenile rheumatoid arthritis and history of cervical spine involvement need radiographs of vertebrae C1 and C2 to assess risk of spinal cord injury. Athletes with systemic or HLA-B27-associated arthritis require cardiovascular assessment for possible cardiac complications during exercise. For those with micrognathia (open bite and exposed teeth), mouth guards are helpful. If uveitis is present, risk of eye damage from trauma is increased; ophthalmologic assessment is recommended. If visually impaired, guidelines for functionally 1-eyed athletes should be followed. <sup>44</sup>	
Juvenile dermatomyositis, idiopathic myositis	
Systemic lupus erythematosus	
Raynaud phenomenon Explanation: Athlete with juvenile dermatomyositis or systemic lupus erythematosus with cardiac involvement requires cardiology assessment before participation. Athletes receiving systemic corticosteroid therapy are at higher risk of osteoporotic fractures and avascular necrosis, which should be assessed before clearance; those receiving immunosuppressive medications are at higher risk of serious infection. Sports activities should be avoided when myositis is active. Rhabdomyolysis during intensive exercise may cause renal injury in athletes with idiopathic myositis and other myopathies. Because of photosensitivity with juvenile dermatomyositis and systemic lupus erythematosus, sun protection is necessary during outdoor activities. With Raynaud phenomenon, exposure to the cold presents risk to hands and feet. <sup>45-48</sup>	
Sickle cell disease Explanation: Athlete needs individual assessment. In general, if illness status permits, all sports may be played; however, any sport or activity that entails overexertion, overheating, dehydration, or chilling should be avoided. Participation at high altitude, especially when not acclimatized, also poses risk of sickle cell crisis.	Qualified yes
Sickle cell trait Explanation: Athletes with sickle cell trait generally do not have increased risk of sudden death or other medical problems during athletic participation under normal environmental conditions. However, when high exertional activity is performed under extreme conditions of heat and humidity or increased altitude, such catastrophic complications have occurred rarely. <sup>8,49-52</sup> Athletes with sickle cell trait, like all athletes, should be progressively acclimatized to the environment and to the intensity and duration of activities and should be sufficiently hydrated to reduce the risk of exertional heat illness and/or rhabdomyolysis. <sup>25</sup> According to National Institutes of Health management guidelines, sickle cell trait is not a contraindication to participation in competitive athletics, and there is no requirement for screening before participation. <sup>53</sup> More research is needed to assess fully potential risks and benefits of screening athletes for sickle cell trait.	Yes
Skin infections, including herpes simplex, molluscum contagiosum, verrucae (warts), staphylococcal and streptococcal infections (furuncles [boils], carbuncles, impetigo, methicillin-resistant <i>Staphylococcus aureus</i> [cellulitis and/or abscesses]), scabies, and tinea Explanation: During contagious periods, participation in gymnastics or cheerleading with mats, martial arts, wrestling, or other collision, contact, or limited-contact sports is not allowed. <sup>54-57</sup>	Qualified yes
Spleen, enlarged Explanation: If the spleen is acutely enlarged, then participation should be avoided because of risk of rupture. If the spleen is chronically enlarged, then individual assessment is needed before collision, contact, or limited-contact sports are played.	Qualified yes
Testicle, undescended or absence of one Explanation: Certain sports may require a protective cup. <sup>22</sup>	Yes

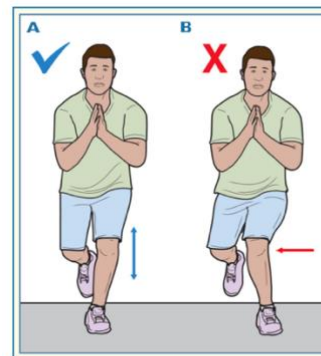
This table is designed for use by medical and nonmedical personnel. "Needs evaluation" means that a physician with appropriate knowledge and experience should assess the safety of a given sport for an athlete with the listed medical condition. Unless otherwise noted, this need for special consideration is because of variability in the severity of the disease, the risk of injury for the specific sports listed in Table 1, or both.

**MSK System**

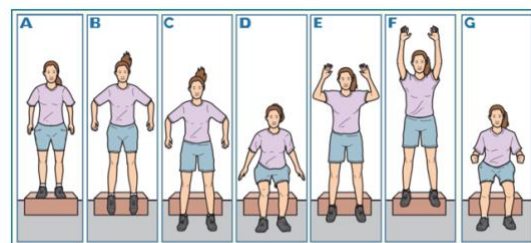
- **Asymptomatic athletes without a previous injury** should undergo a screening MSK examination
  - Limited sensitivity, but sufficient given high sensitivity of MSK history alone (> 90%)
  - Takes < 2 minutes to complete
- **Screen** for injury risk factors and **counsel** about injury prevention
- **Functional Movement Testing**
  - Consider in female athletes and players of pivoting / cutting sports
  - May identify **poor core strength** and **neuromuscular deficits** that increase risk of **lower extremity injuries** (ACL injury, patellofemoral pain syndrome)
  - Opportunity to **promote** cross-training, strength training, balance, agility, core strength for **injury prevention**
  - **Resources:**
    - FIFA 11+ / FIFA 11+ Kids
    - UCSF Sports Medicine Protocols & Videos: <https://sportsrehab.ucsf.edu/>
- **Any history of injury, symptoms, or findings on screening examination** warrants a more detailed, focused examination
  - Useful screening question: *Any previous injury that caused you to miss a game or practice?*
  - Injuries that have not been fully rehabilitated increase risk for subsequent injury
  - Athlete must demonstrate **pain-free full ROM, symmetric strength, and stability** before clearance to return to participation
  - Referral for further evaluation or treatment when necessary



**Figure.** Musculoskeletal screening examination. The general musculoskeletal screening examination consists of the following: 1) inspection, athlete standing, facing toward examiner (symmetry of trunk, upper extremities); 2) forward flexion, extension, rotation, lateral flexion of neck (range of motion, cervical spine); 3) resisted shoulder shrug (strength, trapezius); 4) resisted shoulder abduction (strength, deltoid); 5) internal and external rotation of shoulder (range of motion, glenohumeral joint); 6) extension and flexion of elbow (range of motion, elbow and wrist); 7) pronation and supination of the elbow (range of motion, elbow and wrist); 8) clench fist, then spread fingers (range of motion, hand and fingers); 9) inspection, athlete facing away from examiner (symmetry of trunk, upper extremities); 10) back extension, knees straight (spondylolysis/spondylolisthesis); 11) back flexion with knees straight, facing toward and away from the examiner (range of motion, thoracic, and lumbosacral spine; spine curvature; hamstring flexibility); 12) inspection of the lower extremities, contraction of quadriceps muscles (alignment, symmetry); 13) "tuck walk" 4 steps (motion of hip, knee, and ankle; strength; balance); 14) standing on toes, then on heels (symmetry, calf, strength; balance).



**Figure 6G-14. Single-Leg Squat Test**  
Patients should place their hands on their hips or in front, as pictured, and stand on one limb and flex the opposing limb to 90°. [A] They then should perform 3 single-leg squats to 30° of knee flexion and return to a fully extended knee position. [B] The examiner should note any abnormal responses, which consist of arms flailing, the Trendelenburg sign, or collapse of the supporting knee into valgus.<sup>21</sup>



**Figure 6G-15. Vertical Jump Maneuver**  
This series of figures illustrates a normal landing pattern. An abnormal test result would include "kissing knees," flailing arms, or loss of balance. [A] Starting position on a 31-cm box. [B] Mid-flight immediate after dropping off the box. [C] Initial contact. [D] Landing phase. [E] Toe off. [F] Maximum vertical jump height. [G] Second landing.<sup>21</sup>

### Mental Health

- **Underrecognized problem** for athletes (especially if injured or unable to participate)
- **PHQ-4** (combined depression and anxiety screening) **added to 5th Edition** PPE History Form (shown below)
- Use PPE History Form and/or **validated** screening and diagnostic tools and have **plan** for **referral** and **follow-up** if positive screen
- Develop a **multidisciplinary** treatment plan that includes local mental health providers to care for athletes who screen positive
- **Resources:** California Interscholastic Federation Mental Health Toolkit for Student-Athletes
  - [https://cifstate.org/sports-medicine/student\\_health\\_wellness/index](https://cifstate.org/sports-medicine/student_health_wellness/index)

Patient Health Questionnaire Version 4 (PHQ-4)				
Over the last 2 weeks, how often have you been bothered by any of the following problems? (Circle response.)				
	Not at all	Several days	Over half the days	Nearly every day
Feeling nervous, anxious, or on edge	0	1	2	3
Not being able to stop or control worrying	0	1	2	3
Little interest or pleasure in doing things	0	1	2	3
Feeling down, depressed, or hopeless	0	1	2	3

(A sum of  $\geq 3$  is considered positive on either subscale [questions 1 and 2, or questions 3 and 4] for screening purposes.)

### Female Athletes

- Greater emphasis on issues specific to **female athletes** in 5<sup>th</sup> Edition, including nutrition, bone health, and menstrual history
  - Both disordered eating and menstrual dysfunction **more prevalent** in athletes than non-athletes
- Questions included in PPE History Form (shown below)
  - **Menstrual history** (amenorrhea, oligomenorrhea)
  - **Disordered eating history** (nutrition, food habits, behaviors, beliefs)
  - **Bone health history** (bone stress injury, stress fracture)
- Opportunity for further **inquiry, early recognition, and intervention**
- **Resources:** RED-S Clinical Assessment Tool (BJSM) for guidance on return to play decisions

MEDICAL QUESTIONS (CONTINUED)	Yes	No
25. Do you worry about your weight?		
26. Are you trying to or has anyone recommended that you gain or lose weight?		
27. Are you on a special diet or do you avoid certain types of foods or food groups?		
28. Have you ever had an eating disorder?		

FEMALES ONLY	Yes	No
29. Have you ever had a menstrual period?		
30. How old were you when you had your first menstrual period?		
31. When was your most recent menstrual period?		
32. How many periods have you had in the past 12 months?		

### Transgender Athletes

- **Added to PPE 5<sup>th</sup> Edition:** begins to address care of transgender athletes, but literature on medical and MSK considerations specific to transgender athletes very limited
  - PPE History Form has been updated with separate entries for sex assigned at birth and gender identity
- As with all athletes, **address psychosocial challenges** associated with sport and life outside of sport
- Be familiar with local sport governing bodies' regulations to **help transgender athletes navigate sports participation**
  - Eligibility for high school transgender athletes is determined by the state high school athletic associations: <https://www.transathlete.com/k-12>



*Athletes With a Disability*

- PPE should be similar, and **address the unique needs** of the specific disability
- Identify and help manage conditions that may **compromise athlete safety**
- **Encourage physical activity** and provide support as needed
- Additional PPE History Form:
  - PPE Athletes with Disabilities Form: Supplement to the Athlete History

**Box 8-2. Findings to Screen for When Performing Physical Examinations on Athletes With Disabilities**

<b>Ocular Function</b>
<ul style="list-style-type: none"> <li>• Poor visual acuity</li> <li>• Refractive errors</li> <li>• Astigmatism</li> <li>• Strabismus</li> </ul>
<b>Cardiovascular System</b>
<ul style="list-style-type: none"> <li>• Congenital heart disease</li> </ul>
<b>Neurological Function</b>
<ul style="list-style-type: none"> <li>• Peripheral nerve entrapment</li> <li>• Carpal tunnel syndrome</li> <li>• Ulnar neuropathy (eg, cubital tunnel syndrome)</li> <li>• Inadequate motor control</li> <li>• Inadequate coordination and balance</li> <li>• Impaired hand-eye coordination</li> <li>• Ataxia</li> <li>• Muscle weakness</li> <li>• Spasticity</li> <li>• Sensory dysfunction</li> <li>• Atlantoaxial instability</li> <li>• Hyperreflexia</li> <li>• Clonus</li> <li>• Upper motor neuron and posterior column signs and symptoms</li> </ul>
<b>Dermatologic Function</b>
<ul style="list-style-type: none"> <li>• Abrasions</li> <li>• Lacerations</li> <li>• Blisters</li> <li>• Pressure ulcers</li> <li>• Rashes</li> </ul>
<b>Musculoskeletal System</b>
<ul style="list-style-type: none"> <li>• Limited neck range of motion</li> <li>• Torticollis</li> <li>• Atlantoaxial instability</li> <li>• Decreased flexibility, often with contractures, decreased strength, and muscle strength imbalance</li> <li>• Pelvic dysfunction caused by lower extremity prosthetic device that is creating unequal leg lengths</li> <li>• Rotator cuff tendinitis and impingement in athletes using wheelchairs</li> <li>• Wrist and elbow extensor tendinitis in athletes using wheelchairs</li> </ul>

*Conclusions*

- Controversies remain about PPE, but nevertheless offers an **entry point for healthy adolescents** into healthcare system
- PPE offers opportunities to: enhance **safe sports participation**, promote **healthy lifestyles**, encourage **physical activity**
- **All young patients** should routinely be asked if they participate or plan to participate in youth sports or any physical activity
- PPE should be an integral part of the health supervision visit for **any physically active patient**

*Resources for the PPE*

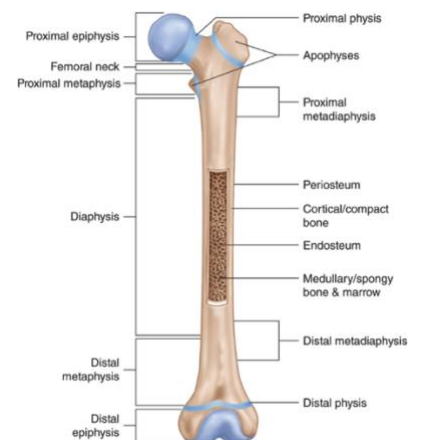
- **5<sup>th</sup> Edition PPE forms (History, Examination, Eligibility, also available in Spanish)**
  - <https://services.aap.org/en/patient-care/preparticipation-physical-evaluation/>
- **Beginner running programs:** Free Apps: “Couch to 5K” or “None To Run”
- **Injury prevention and strengthening/flexibility programs**
  - FIFA 11+ / FIFA 11+ Kids
  - UCSF Sports Medicine Protocols & Videos: <https://sportsrehab.ucsf.edu/>
- **California Interscholastic Federation Mental Health Toolkit for Student-Athletes**
  - [https://cifstate.org/sports-medicine/student\\_health\\_wellness/index](https://cifstate.org/sports-medicine/student_health_wellness/index)
- **Guidance on return to play decisions in Relative Energy Deficiency in Sport**
  - RED-S Clinical Assessment Tool. *Br J Sports Med.* 2015;49:421-23.
  - <https://bjsm.bmj.com/content/bjsports/49/7/421.full.pdf>
- **Guidance on medical eligibility decisions in various medical conditions**
  - Rice SG; AAP Council on Sports Medicine and Fitness. Medical Conditions Affecting Sports Participation. *Pediatrics.* 2008;121(4):841-8.  
<https://pediatrics.aappublications.org/content/pediatrics/121/4/841.full.pdf>

### 3. Overuse and Chronic Injuries

#### A. Apophysis and Epiphysis Injuries

##### General Principles

- Occur when anatomic structures are subjected to **repetitive stress**, resulting in **forces beyond what the structure can withstand**
- Affect bones, growth centers (physes, apophyses), tendons, fascia
- **Common features:**
  - Chronic
  - Insidious onset
  - Intermittent
  - Worse with activities
  - Improved with rest
- Intrinsic risk factors for overuse injuries
  - **Imbalances or deficits in strength and flexibility**
    - Related to growth/development
    - Increased bone plasticity
    - Open, weak physes
    - Ligamentous laxity
    - Underdeveloped muscles
  - **Poor technique or mechanics**
  - **Normal variants of anatomic alignment** (less common)
    - Femoral version or lower extremity valgus
    - Pes planus or pes cavus
- Extrinsic risk factors for overuse injuries
  - **Rapid increase in training (FIT, Frequency, Intensity, Time)**
  - **Long-term, high training volume**
    - Goal: hours/week < age in years
  - **Suboptimal equipment**
  - **Poor training surfaces** or sudden change in training surface
  - **Early sport specialization**
    - Long-term high-level training in a single sport
    - Year-round participation (> 8 months/year), multiple teams
    - No consensus about specific age for "early" sports specialization: <12 years (AOSSM) vs. before adolescence (AAP/AMSSM)
- Apophyseal injuries
  - **Bone and tendon:** composed of strong extracellular matrix designed to withstand compressive and tensile loads
  - **Growth plates:** composed mainly of cartilage cells, so they have little resistance to stress
  - **Apophyses:** areas of secondary ossification, where muscle-tendon units attach to bone
    - Weakest point in biomechanical chain
  - **Imbalance or deficits in strength and flexibility**
    - Bones grow faster than muscles
    - As bones get longer, muscles get tighter
  - Exacerbated by **increased physical demands**
  - **Once skeletally mature**, some injuries will transition from apophysitis to **tendonitis** if underlying imbalances/deficits are not corrected



### Medial Epicondyle Apophysitis (Little League Elbow)

- **Sports:** overhead athletes and throwers
- **Mechanism:** repetitive valgus force at elbow that occurs with pitching/throwing motion → traction stress at medial side of elbow
- **Presentation:** 9-12 years old, medial elbow pain during or after pitching, +/- stiffness or swelling, limited elbow extension, occasionally mechanical symptoms
- **Exam:** focal TTP over medial epicondyle, +/- swelling or effusion
- **Diagnosis:** clinical, XR often negative in early stages but may show physal widening, sclerosis, fragmentation
- **Plan:** rest until pain and tenderness resolve (usually 4-6 weeks), PT when pain-free, then RTP over 4-6 weeks gradually
- **Referral criteria:** no improvement after 6-8 weeks of rest, guidance for PT or clearance for return to throwing, widening or displacement of apophysis > 5 mm
- **Prognosis:** return to competitive sports 8-12 weeks, if untreated risk of avulsion fracture, growth disturbance, arthrosis
- **Prevention:** pitch count guidelines, education, biomechanics, core strength and cardiovascular fitness



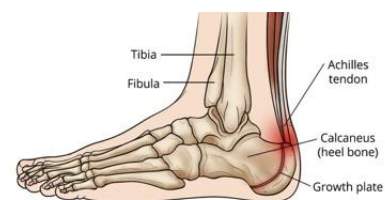
### Knee Extensor Mechanism Apophysitis (Osgood-Schlatter and Sinding-Larsen-Johansson)

- **Sports:** running or jumping sports (basketball, soccer, gymnastics)
- **Mechanism:** rapid growth, tight quadriceps, increased physical demands → traction stress along the knee extensor mechanism, leads to apophysitis of:
  - Tibial tuberosity: Osgood-Schlatter (OS)
  - Inferior pole of patella: SLJ
- **Presentation:** 9-15 years old, anterior knee pain during running/jumping activities, localized TTP (tibial tuberosity for OS vs. inferior pole of patella for SLJ), +/- painful resisted knee extension (OS), tight quadriceps and/or hamstrings
- **Diagnosis:** clinical, XR may help rule out other pathology if atypical presentation
  - Irregular or fragmented tibial tubercle can be normal variant and does not indicate OS (blue)
  - For SLJ may see irregular or fragmented inferior pole of patella (red)
- **Plan:** activity modifications, patellar strap, PT (quadriceps/hamstring stretching), ice/NSAIDs
- **Referral criteria:** no improvement after several weeks of rest, c/f tibial tubercle avulsion fracture (OS)
- **Prognosis:** waxes and wanes but will resolve over time, residual prominence of tubercle (OS), if untreated risk of avulsion fracture
- **Prevention:** maintain flexibility, especially during growth spurts

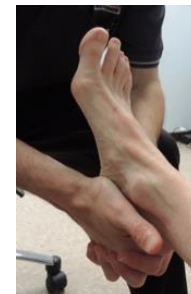


### Calcaneal Apophysitis (Sever Disease)

- **Sports:** running or jumping sports (basketball, soccer, gymnastics)
- **Mechanism:** repetitive traction stress from Achilles tendon or repetitive impact of heel
- **Presentation:** 8-14 years old, activity-related heel pain, worse on hard surfaces or wearing cleats, +/- limping

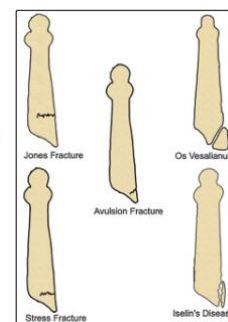
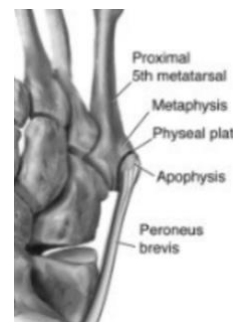


- **Exam:** tight calf muscles, TTP over Achilles tendon insertion, pain with calcaneal squeeze test (mediolateral compression of calcaneus, top right), +/- pes planus (flatfoot) or over-pronation
- **Diagnosis:** clinical, XR may help rule out other pathology if atypical presentation
- **Plan:** activity modifications, gel heel cups, PT (hamstring and calf stretching), ice/NSAIDs
  - Severe cases may need to be non-weight bearing with boot/cast
- **Referral criteria:** no improvement in 6-8 weeks
- **Prognosis:** waxes and wanes but will resolve over time, no long-term sequelae or complications
- **Prevention:** maintain calf flexibility and ankle dorsiflexion during periods of rapid growth, limit use of cleats or time on hard surfaces



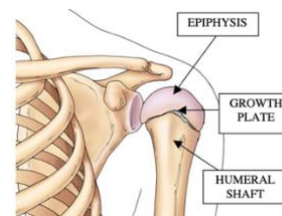
### 5<sup>th</sup> Metatarsal Apophysitis (Iselin Disease)

- **Sports:** sports that stress the forefoot (roller-skating, dance or ballet)
- **Mechanism:** repetitive traction stress from peroneus brevis tendon
- **Presentation:** 10-16 years old, lateral activity-related foot pain, may be exacerbated by shoe friction
- **Exam:** TTP over base of 5<sup>th</sup> metatarsal, mild swelling, may favor medial side of foot when weight bearing, pain with passive ankle inversion and resisted ankle eversion
- **Diagnosis:** clinical, XR may help rule out other pathology if uncertain or rule out fracture in acute injury
  - Normal apophysis: fleck of bone parallel to long axis of 5<sup>th</sup> metatarsal ( $\neq$  avulsion fracture), visible in girls 9-11 and boys 11-14 years of age
- **Plan:** activity modifications, PT (peroneal and calf stretching), ice/NSAIDs
- **Referral criteria:** persistent pain or inability to return to activities despite treatment
- **Prognosis:** waxes and wanes but will resolve over time, ossicles or bony prominence may persist but do not cause problems
- **Prevention:** maintain calf, peroneal, and ankle flexibility and strength, check shoe size during rapid periods of growth



### Proximal Humeral Epiphysitis / Epiphysiolysis (Little League Shoulder)

- **Sports:** throwing and overhead sports (swimming, tennis, volleyball)
- **Mechanism:** repetitive micro-traumatic traction or torque stress to proximal humeral physis
- **Presentation:** 10-16 years old, progressive non-focal shoulder pain, worse with throwing/overhead activity, loss of throwing velocity or accuracy
- **Exam:** TTP over proximal lateral humerus, +/- painful or decreased shoulder ROM, pain with resisted ROM
- **Diagnosis:** clinical, XR may show physeal widening (compare to unaffected side), +/- sclerosis, fragmentation
- **Plan:** rest from overhead activities for  $\geq$  6 weeks, followed by gradual return to throwing over the next 6 weeks through PT guidance, full RTP usually in 3 months

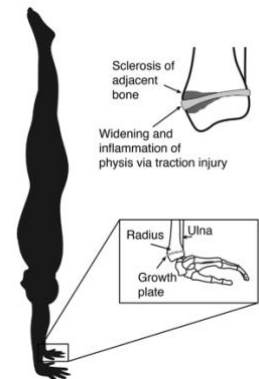




- **Referral criteria:** persistent pain despite 4-6 weeks of rest, pain at rest, instability, significant weakness
- **Prognosis:** resolves with skeletal maturity, RTP usually within 3 months
- **Prevention:** pitch count guidelines, education, biomechanics, core strength and cardiovascular fitness

### Distal Radial Epiphysitis (Gymnast Wrist)

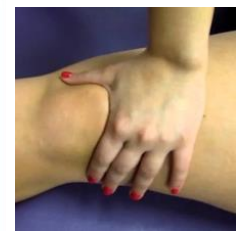
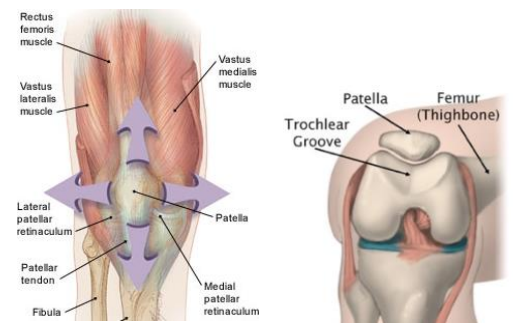
- **Sports:** gymnastics most often, less commonly rock climbing, weight lifting
- **Mechanism:** repetitive loading of extended wrist leading to compressive vs. traction stress injury of distal radial physis
- **Presentation:** 10-14 years old, dorsal, radial wrist pain, worse with axial stress loading (vaulting, hand-walking)
- **Exam:** mild distal forearm swelling, TTP over distal radius, pain with hyperextension and axial loading
- **Diagnosis:** clinical, XR shows widening and irregular borders of distal radius physis (compare to unaffected side)
- **Plan:** non-weight bearing and cast (> splint) immobilization for 6-8 weeks, gradual RTP
- **Referral criteria:** no improvement after 6-8 weeks
- **Prognosis:** successful RTP if early intervention, can take up to 4-5 months if late to care, risk of recurrence and growth disturbance (radial shortening, ulnar overgrowth) which may require corrective surgery
- **Prevention:** load management, strength and flexibility exercises, proper technique



## B. Muscle and Tendon Injuries

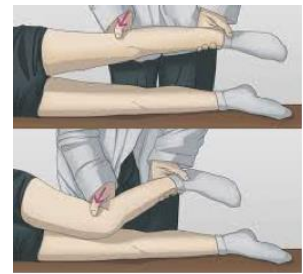
### Patellofemoral Pain Syndrome

- **Sports:** running or jumping sports (soccer, lacrosse, basketball), can also be seen in less active children
- **Mechanism:** combination of overuse and abnormal patellar tracking → mechanical strain on retinaculum or subchondral bone
  - Quadriceps weakness and tightness, relative imbalance in strength and flexibility during periods of growth
- **Presentation:** any age, non-specific anterior knee pain, usually bilateral, worse with activity (running, jumping, stairs) or after prolonged sitting, “giving way” sensation (caused by pain inhibiting quadriceps, resulting in knee collapse), +/- mild swelling or grinding, popping, cracking
- **Exam:** normal, may have infrapatellar swelling, TTP along patellar facets, positive patellar grind, weak hip abductors/external rotators (unstable single-leg squat with valgus collapse), tight quadriceps
- **Diagnosis:** clinical, XR may help rule out other pathology if atypical presentation
- **Plan:** activity modifications, PT (quadriceps, hamstrings, IT band, core and hip stabilizers), ice/NSAIDs, stabilizing brace or taping
- **Referral criteria:** no improvement despite comprehensive rehabilitation program
- **Prognosis:** spontaneous resolution over time
- **Prevention:** avoid rapid increases in activities, maintain core and LE strength and flexibility (hip abductors/external rotators, quadriceps, hamstrings, IT band)



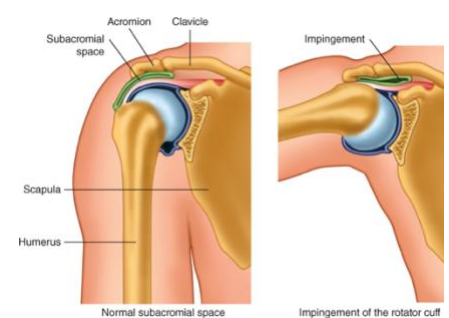
### Iliotibial Band Syndrome

- **Sports:** running and cycling most common, also soccer and other running sports
- **Mechanism:** combination of overuse, malalignment (weak hip abductors), and muscle tightness (IT band, hip flexors, calf muscles)
- **Presentation:** usually adolescence, lateral knee pain, worse with activity (running, cycling), improved with rest, sharp or burning
- **Exam:** focal TTP at distal IT band as it courses over lateral knee, positive Noble compression test (top), tight IT band +/- hip flexors (Ober test (middle) or Thomas test (bottom))
- **Diagnosis:** clinical
- **Plan:** activity modifications, PT (address hip abductor weakness and IT band flexibility, core/hip stabilizers), ice/NSAIDs
- **Referral criteria:** no improvement despite comprehensive rehabilitation program
- **Prognosis:** spontaneous resolution over time
- **Prevention:** avoid rapid increases in activities, maintain core and LE strength and flexibility (hip abductors/external rotators, IT band, hamstrings, calf muscles)



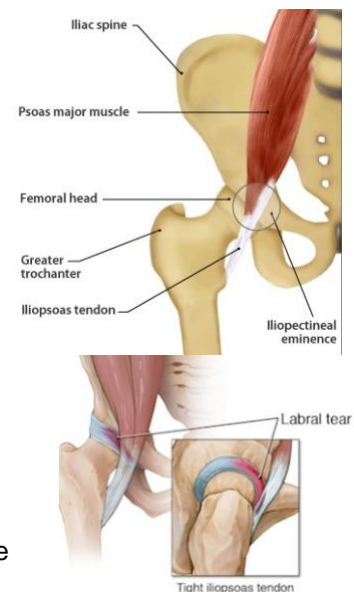
### Rotator Cuff Impingement

- **Sports:** overhead sports (tennis, baseball, softball, volleyball, swimming)
- **Mechanism:** inflammation and thickening of rotator cuff (RTC) tendons or subacromial bursa, leads to impingement under coracoacromial arch with arm elevation (in pediatrics, due to muscle imbalances)
- **Presentation:** adolescence, pain with overhead activity, may progress to pain with ADLs or at rest and night, +/- reduced strength with overhead activities
- **Exam:** TTP in subacromial space (left, #5), ROM +/- strength limited by pain, pain with resisted RTC testing, positive Neer (middle) and Hawkins (right) impingement tests
- **Diagnosis:** clinical, XR if c/f Little League shoulder, MRI if there is concern for labral injury
- **Plan:** rest from overhead activities, NSAIDs, PT (ROM, RTC strengthening, periscapular stabilization)
- **Referral criteria:** no improvement with rest and PT
- **Prognosis:** full RTP expected with PT (ranges from 2-4 weeks to 4-6 months), may progress/recur if muscle imbalances, joint stability, and/or biomechanics not addressed
- **Prevention:** pitch count guidelines, education, biomechanics, core strength and cardiovascular fitness, RTC strengthening program



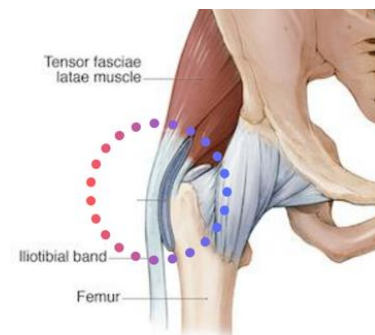
### Internal Snapping Hip (Dancer's Hip)

- **Sports:** sports with repetitive hip flexion (gymnastics, dancing)
- **Mechanism:** tight or inflamed iliopsoas tendon subluxes over iliopectineal eminence or femoral head
- **Presentation:** adolescence, anterior hip pain, snapping sensation with hip flexion or external rotation, sometimes audible, unilateral or bilateral
- **Exam:** ROM often normal, flexion and external rotation may be limited by pain, +/- TTP over iliopsoas tendon, snapping reproducible with active hip flexion
- **Diagnosis:** clinical, obtain XR to rule out other causes of anterior hip pain (should be normal), M RI arthrogram can distinguish from labral tear
- **Plan:** PT (hip muscle strengthening and flexibility)
- **Referral criteria:** persistent symptoms despite several months of PT
- **Prognosis:** pain usually resolves with PT (may take 6+ months), snapping often persists, full RTP expected
  - May lead to labral tear
- **Prevention:** maintain hip muscle strength and flexibility, avoid repetitive hip flexion activities



### External Snapping Hip

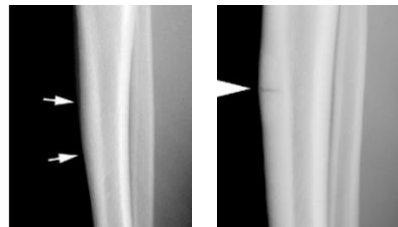
- **Sports:** sports with repetitive hip flexion (gymnastics, dancing)
- **Mechanism:** tight or inflamed IT band snaps across greater trochanter
- **Presentation:** adolescence, pain or audible snapping on lateral aspect of hip with flexion and external rotation, unilateral or bilateral
- **Exam:** pain and snapping reproducible with active flexion and external rotation (but not passive), TTP over greater trochanter and proximal IT band
- **Diagnosis:** clinical, XR may help rule out other pathology if atypical presentation
- **Plan:** activity modifications, NSAIDs, PT (hip muscle strengthening and flexibility, soft tissue massage to tight IT band)
- **Referral criteria:** persistent symptoms despite several months of PT
- **Prognosis:** pain usually resolves with PT (may take 6+ months), snapping often persists, full RTP expected, often resolves with skeletal maturity
- **Prevention:** maintain hip muscle strength and flexibility, avoid repetitive hip flexion activities



### C. Bone Stress Injuries

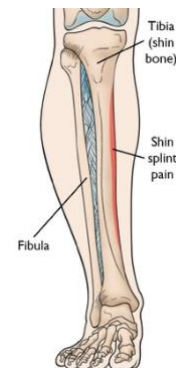
#### *Tibial Stress Fracture*

- **Sports:** endurance and high-impact sports (long-distance running, dancing, soccer, track/field)
- **Mechanism:** repetitive load/stress of bone that exceeds ability to form new bone relative to bone resorption → weaker microtrabecular network → fails under persistent load
- **Presentation:** usually adolescence, very focal, localized, progressive shin pain, worse with activity, relieved with rest
- **Exam:** localized TTP, positive single leg hop
- **Diagnosis:** XR may be positive (sclerosis, cortical thickening, periosteal reaction) if present for 4-6 weeks, MRI recommended when XR negative and there is high suspicion
- **Plan:** pain-free weight bearing (boot +/- crutches), activity restrictions, gradual return to activities (after 6-8 weeks), PT (address strength and flexibility imbalances)
- **Referral criteria:** involvement of anterior tibial cortex (high risk of progression to acute transverse fracture)
- **Prognosis:** if treated complete recovery, if untreated progressive pain (eventually at rest)
- **Prevention:** avoid rapid increases in training (FIT), use proper running shoes and replace when needed, avoid hard or irregular terrain if possible, do not run through persistent pain, evaluate promptly, address risk factors (relative energy deficiency in sport)



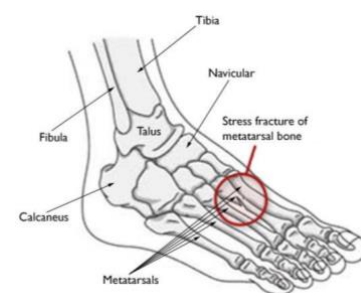
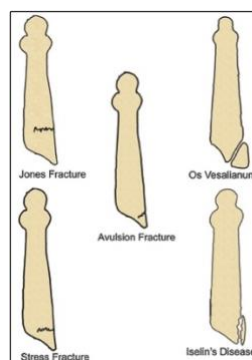
#### *Medial Tibial Stress Syndrome (Shin Splints)*

- Stress fracture must be differentiated from MTSS
- **Presentation:** diffuse medial shin pain in runners, worse with activity, relieved with rest
- **Exam:** diffuse TTP over medial tibia (≠ very focal in tibial stress fracture), no discrete localized lesion
- **Diagnosis:** clinical, may need XR/MRI to rule out stress fracture
- **Plan:** can continue running but reduce total mileage, ice/NSAIDs
- **Prognosis:** spontaneous resolution over time
- **Prevention:** flexibility (hip flexor, calf muscles, quadriceps, hamstring) and strengthening (core, hip external rotators/abductors, calf muscles), cross-training

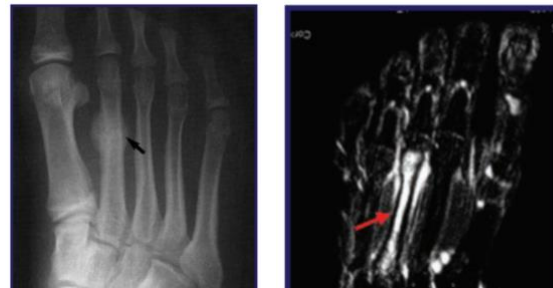


#### *Metatarsal Stress Fracture*

- **Sports:** endurance and high-impact sports (running, dancing)
- **Mechanism:** same as tibial stress fractures
- **Presentation:** usually adolescence, very focal, localized, progressive dorsal foot pain, worse with activity, relieved with rest
  - 2<sup>nd</sup> and 3<sup>rd</sup> metatarsals most common
  - 5<sup>th</sup> metatarsal rare but risk of nonunion
- **Exam:** localized TTP, +/- mild soft tissue swelling, positive single leg hop, +/- pain with mediolateral compression of metatarsals or axial loading



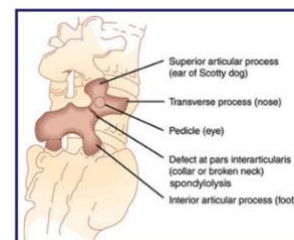
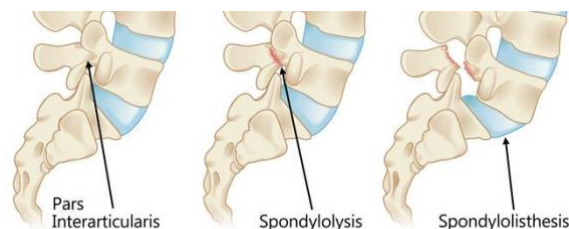
- **Diagnosis:** XR (left) may be positive (sclerosis, cortical thickening, periosteal reaction) if present for 4-6 weeks, MRI (right) recommended when XR negative and there is high suspicion
- **Plan:** pain-free weight bearing (boot +/- crutches), activity restrictions, gradual return to activities (after 4-6 weeks)
- **Referral criteria:** fracture of proximal 5<sup>th</sup> meta tarsal at diaphyseal-metaphyseal junction (Jones fracture): risk of nonunion, may need surgical fixation
- **Prognosis:** if treated complete recovery, if untreated progressive pain (eventually at rest)
- **Prevention:** same as tibial stress fractures



#### D. Back Pain

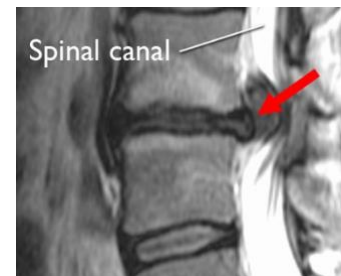
##### *Spondylolysis*

- **Sports:** sports that require hyperextension and rotational loading of spine (gymnastics, diving, linemen, pitching, volleyball)
- **Mechanism:** repetitive hyperextension of lumbar spine results in stress reaction or fracture of pars interarticularis (**spondylolysis**) → may lead to forward translation (slip) of one vertebra over the one beneath it (**spondylolisthesis**)
- **Presentation:** < 16 years old, activity-related lumbar pain, worse with extension, improved with flexion, +/- radiation to buttock or posterior thigh, most commonly L5
- **Exam:** paraspinal tenderness, limited lumbar mobility, pain with extension leading to lumbar lordosis, tight hamstrings, positive Stork test (single-leg lumbar hyperextension)
- **Diagnosis:** requires imaging, AP and lateral XR sufficient (“Scotty dog sign”), SPECT bone scan if XR negative to detect stress reaction
- **Plan:** avoid impact and hyperextension activities (rest), bracing (controversial, may allow earlier RTP), PT (hamstring flexibility, core and back strengthening, postural techniques)
- **Referral criteria:** persistent low back pain, pain with hyperextension on physical exertion, sports-related back pain, all spondylolysis/listhesis should be referred, high-grade slips (> 50%) often need surgical treatment
- **Prognosis:** full RTP expected with proper treatment, risk of spondylolisthesis if untreated
- **Prevention:** core strength, hamstring flexibility



### *Herniated Intervertebral Disc*

- **Sports:** weightlifting, rugby, football, any collision sports
- **Mechanism:** increased axial forces exerted on the spine during extreme flexion and extension
  - Portion of disc extrudes posteriorly and compresses adjacent spinal cord or exiting spinal nerves
- **Presentation:** usually adolescence, sudden onset “burning” or “shooting” lower back pain, +/- radicular leg pain, pain worse with flexion, most common in L4-L5 and L5-S1
- **Exam:** pain with forward flexion, positive straight leg raise
- **Diagnosis:** MRI can confirm diagnosis (bottom), wait until 4-6 weeks of conservative treatment before imaging (many asymptomatic individuals have disc bulge or protrusion)
- **Plan:** activity modification (avoid prolonged inactivity), NSAIDs PRN, PT once pain has improved, epidural corticosteroid injection for persistent symptoms
- **Referral criteria:** persistent symptoms despite 4-6 weeks of conservative treatment
- **Prognosis:** high rate of resolution with conservative care
- **Prevention:** proper lifting technique, regular activity



### *Mechanical Low Back Pain*

- Most common cause of back pain in children is actually mechanical LBP!
- Also called Hyperlordotic, Muscular, or Idiopathic Low Back Pain
- **Mechanism:** related to poor mechanics (weak core and hips, lumbar lordosis), rapid growth and inflexibility
- **Presentation:** any age, chronic and intermittent low back pain, no identifiable pain generator
- **Exam:** increased lumbar lordosis, normal exam, +/- tight hamstrings and hip flexors, weak core and hips
- **Diagnosis:** clinical, no imaging, diagnosis of exclusion
- **Plan:** activity modification, PT (core and hip strengthening, stretching), NSAIDs PRN
- **Prevention:** encourage physical activity, core and hip strength, hamstring and hip flexor flexibility



### *Back Pain Red Flag Symptoms*

- Fever, chills, malaise
- Anorexia, weight loss, decreased appetite
- Unrelenting pain
- Night pain
- Associated radicular signs or symptoms
- Bowel or bladder dysfunction, saddle paresthesia
- Focal neurologic deficits
- **Indications for imaging:**  $\leq 4$  years, ‘Red Flag’ symptoms, duration of symptoms  $> 6$  weeks
  - If obtaining XR, remember to order lumbar XR in standing position

## E. Early Sport Specialization

### Definitions

- Long-term high-level training in a single sport
- Year-round participation (> 8 months/year), multiple teams
- No consensus about specific age for "early" sports specialization: <12 years (AOSSM) vs. before adolescence (AAP/AMSSM)

### Outcomes

- Increased risk of overuse injuries
- Increased risk of physical, emotional, and social problems
- Increased risk of anxiety, depression, and attrition / early retirement from sports

### Guidance for the Pediatrician – Adapted from the AAP Clinical Report on Sports Specialization (2016)

- The primary focus of sports for young athletes should be to **have fun** and **learn lifelong physical activity skills**. Encourage **free, unstructured** play.
- No clear evidence yet, but some have proposed: participation in hours of organized sports per week **< age in years**.
- Participating in **multiple sports**, at least until puberty, **decreases the chances** of injuries, stress, and burnout in young athletes.
- For most sports, specializing in a sport **later** (i.e., **late adolescence, ~15-16 years**) may lead to a higher chance of the young athlete accomplishing his or her athletic goals.
- **Early diversification** and **later specialization** provides for a greater chance of lifetime sports involvement, lifetime physical fitness, and possibly elite participation.
- Having **at least a total of 3 months off throughout the year**, in increments of 1 month, from their particular sport of interest will allow for athletes' physical and psychological recovery. They can still **remain active in other activities** to meet physical activity guidelines during the time off.
- Young athletes having **at least 1 to 2 days off per week** from their particular sport of interest can **decrease** the chance for injuries.
- **Closely monitoring** young athletes who pursue intensive training for physical and psychological growth and maturation as well as nutritional status is an important parameter for health and well-being.
- **Address misconceptions:** No evidence that early specialization increases athletic success.

## F. Relative Energy Deficiency in Sport

- RED-S describes impact of energy deficiency on **various physiologic functions** and **performance** in athletes
- Underlying etiology is **low energy availability (LEA)**
  - **Mismatch** between **energy intake** (nutrition) and **energy expended** (training, recovery)
  - Leaves **inadequate energy** to support optimal health and physiologic functions as well as optimal performance
- **Classic triad:** disordered eating, osteopenia, amenorrhea
  - Expanded RED-S concept incorporates application to **male athletes** and wider range of **health consequences** beyond triad
- Disordered eating in athletes includes **spectrum** of unhealthy nutritional behaviors
- Pediatricians must **recognize** and **intervene early** to **prevent escalation** to more serious eating disorders

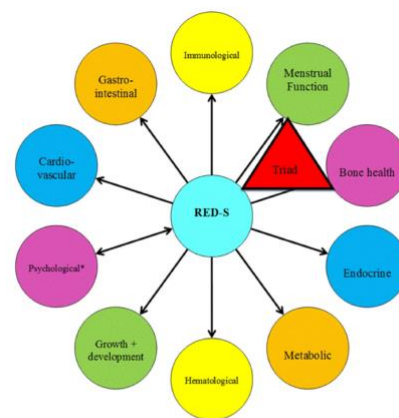


Figure 1 Health consequences of Relative Energy Deficiency in Sport (RED-S) showing an expanded concept of the Female Athlete Triad to acknowledge a wider range of outcomes and the application to male athletes (\*Psychological consequences can either precede RED-S or be the result of RED-S).<sup>4</sup>

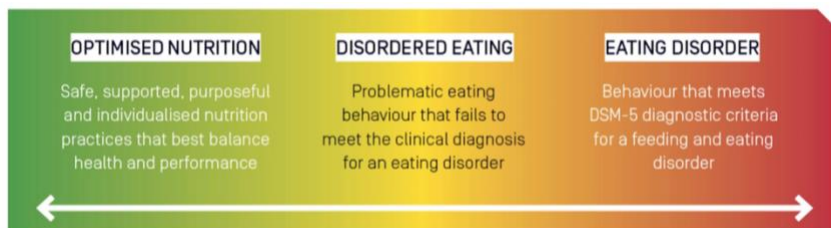


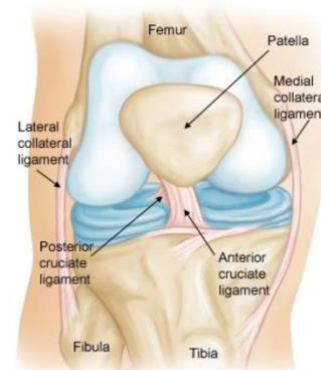
Figure 1 The spectrum of eating behaviour in the high performance athlete from optimised nutrition to disordered eating to eating disorders. DSM-5, Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition.

#### 4. Acute and Traumatic Injuries

##### A. Acute Knee Injuries

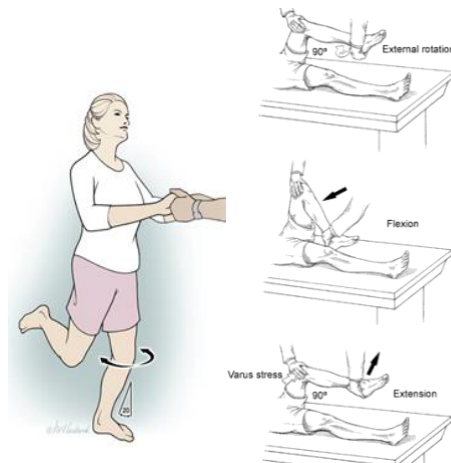
###### ACL Tear

- **Sports:** soccer, basketball, football, skiing
- **Mechanism:** hyperextension or valgus / rotational force to the knee with the foot planted, contact or non-contact (landing, rapid deceleration, sudden change of direction)
- **Presentation:** ≥ 11 years old, painful “pop” felt or heard, followed by immediate swelling, feeling of instability, difficulty bearing weight
- **Exam:** large effusion, limited ROM, exam may be limited by effusion, positive Lachman (bottom left) and/or anterior drawer test
- **Diagnosis:** clinical, rule out other ligament/meniscus injuries with exam and XR, MRI to confirm (bottom right)
- **Plan:** immediate immobilization and RICE, early PT (within 5-7 days), referral to ortho for operative treatment, transition to hinged knee brace and weight bearing as tolerated, PT for rehabilitation
- **Referral criteria:** immediately after acute injury
- **Prognosis:** many return to previous level of competition, usually 9+ months after operative treatment, ~10% risk of graft rupture
- **Prevention:** neuromuscular training programs (strengthening, balance, agility, safe landing mechanics), cross-training



###### Meniscus Injury

- **Sports:** any involving twisting or pivoting
- **Mechanism:** twisting or pivoting while running or jumping
- **Presentation:** ≥ 14 years old, painful “pop” during twisting injury, delayed swelling and may be minimal, mechanical symptoms (snapping, catching, locking sensation, limited ROM)
- **Exam:** small effusion, joint line tenderness, limited ROM, positive Thessaly (left), positive McMurray (right), pain with deep squat or duck-walk (walking in deep squat position)



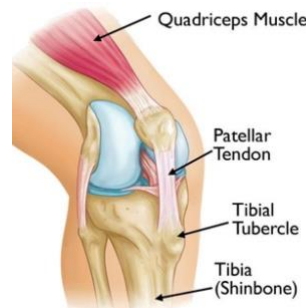


- **Diagnosis:** MRI (right), rule out other injuries with exam and XR
- **Plan:** depends on location and size/type of tear, PT, many will require operative treatment
- **Referral criteria:** all meniscus tears, urgently if inability to extend knee (suggests displaced tear locked between tibia / femur)
- **Prognosis:** many return to previous level of competition, long-term may develop early osteoarthritis



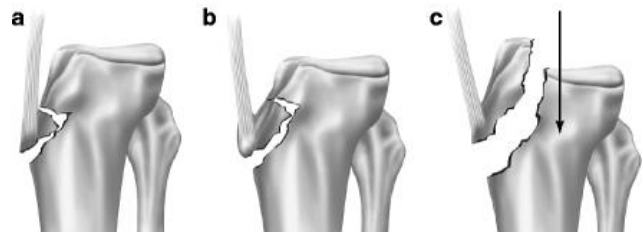
### Tibial Avulsion Fracture

- **Sports:** jumping or kicking sports (soccer, basketball, volleyball)
- **Mechanism:** sudden forceful contraction of quadriceps, often during repetitive, forceful jumping or kicking
- **Presentation:** adolescence, painful “pop” during jumping, kicking, or landing, immediate swelling, difficulty bearing weight
- **Exam:** inability to extend knee or perform straight leg raise, swelling and TTP over tibial tubercle



- **Diagnosis:** XR (AP and lateral), distinguish from Osgood-Schlatter (which has mild fragmentation of apophysis but no fracture)

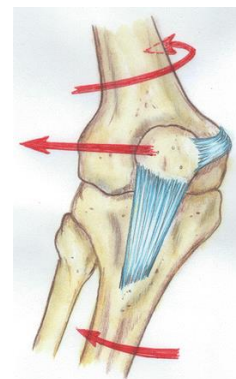
- Watson-Jones classification (right): type III (c in figure) passes across the epiphyseal plate and proximal articular surface of tibia (Salter-Harris Type III)



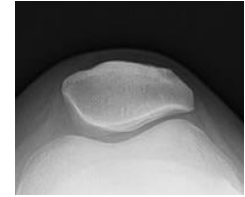
- **Plan:** types I/II (a/b in figure) long-leg cast immobilization with knee in extension for 4-6 weeks followed by PT
- **Referral criteria:** urgently, for surgical fixation, if significant displacement or type III (c in figure)
- **Prognosis:** complete healing and return to previous level of activity with proper treatment, no growth disturbance
- **Prevention:** maintain flexibility, especially during growth spurts

### Patellar Dislocation

- **Sports:** any involving sudden twisting or lateral changes of direction
- **Mechanism:** sudden internal twisting force applied to semi-flexed knee on planted foot (e.g. spinning or twirling maneuver in dance or gymnastics, swinging baseball bat, quick lateral change of direction while running or ice skating), less commonly direct trauma to medial knee
- **Presentation:** 10-17 years old, painful “pop” or tearing sensation, feeling patella shift out of place, majority dislocate laterally, most reduce spontaneously with knee extension, immediate swelling, limited ROM, difficulty bearing weight



- **Exam:** patellar TTP especially along medial edge, effusion in acute dislocation, positive patellar apprehension test (left)
- **Diagnosis:** clinical, pre/post reduction XR to rule out osteochondral fracture, sunrise vs. merchant view may show lateral patellar tilt after reduction (right)
- **Plan:** prompt reduction if not spontaneous, immobilization in extension & non-weight bearing for 7-10 days, transition to patellar stabilizing brace and weight bearing as tolerated, PT for rehabilitation, RTP in 8-12 weeks
- **Referral criteria:** recurrent dislocations despite PT, osteochondral fracture or loose body
- **Prognosis:** risk of recurrence, 30-50% with chronic patellofemoral pain
- **Prevention:** patellar stabilizing brace during activity to prevent recurrent instability, lower extremity strengthening (quadriceps, hips)



### Knee Red Flag Symptoms

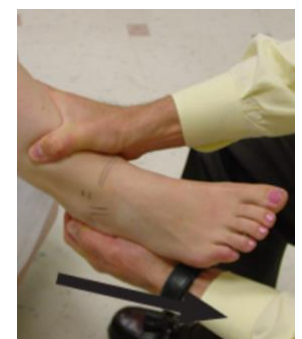
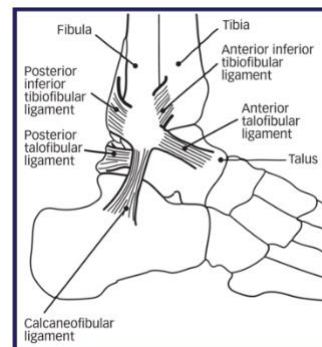
- Painful “pop” at injury
- Effusion
- Dislocation or shifting of patella
- Instability
- Mechanical symptoms:
  - Catching, locking, or inability to extend knee



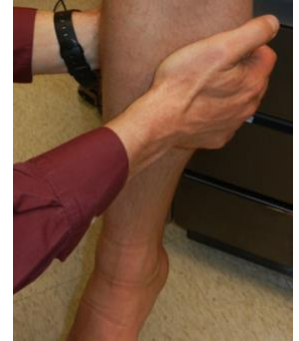
### B. Inversion Ankle Injuries

#### Lateral Ankle Sprain

- **Sports:** basketball, soccer, football, volleyball
- **Mechanism:** excessive inversion of plantarflexed ankle, twisting injury
  - Most common ligaments: anterior talofibular ligament (ATFL), then calcaneofibular (CFL)
- **Presentation:** adolescence, acute lateral ankle pain, +/- “pop” at time of injury, pain with weight bearing, +/- swelling and/or bruising
- **Exam:** ROM limited by pain, TTP over injured ligament, +/- positive anterior drawer (ATFL, right) and talar tilt (CFL, left) tests – may have false negative in acute phase due to guarding
- **Must rule out syndesmosis sprain (high ankle sprain):** mechanism is excessive external rotation on dorsiflexed ankle, exam with positive squeeze test (bottom right) and pain with forced external rotation (bottom left)
- **Diagnosis:** clinical, XR to rule out fracture if meets Ottawa ankle rules criteria (see below)
  - XR required if medial or syndesmosis sprain

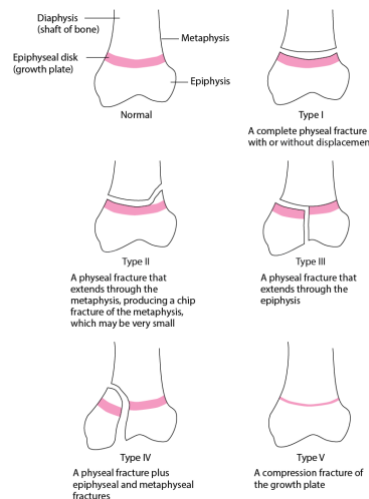


- **Plan:** RICE, NSAIDs for 7-10 days after injury, weight bearing as tolerated, may need crutches/boot, early PT for rehabilitation (ROM, flexibility, strength, proprioception)
- **Referral criteria:** persistent symptoms despite comprehensive rehabilitation, syndesmosis sprain
- **Prognosis:** RTP in 1-4 weeks depending on grade, re-injury risk 5x higher after initial injury, risk of chronic instability or pain with improper rehabilitation
- **Prevention:** rehabilitation that includes proprioception training, ankle brace or taping



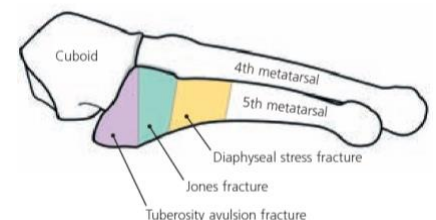
### Salter-Harris I Distal Fibula Fracture

- **Sports:** basketball, soccer, football, volleyball
- **Mechanism:** acute inversion injury
  - In a child, physis is weaker than ligaments, so skeletally immature children are more likely to have physeal fracture than ligament sprain
  - SH 1: traverses across physis without entering epiphysis or metaphysis
- **Presentation:** skeletally immature (<12-15 years old), acute lateral ankle pain, pain with weight bearing, +/- mild swelling
- **Exam:** TTP over distal fibular physis (~1 cm above tip of fibula), +/- soft tissue swelling over distal fibula
- **Diagnosis:** clinical, XR (AP, lateral, mortise) frequently normal, may show soft tissue swelling or subtle physeal widening
  - *Regardless of XR*, any skeletally immature child with TTP over distal fibula after inversion injury is treated for SH I fracture of distal fibula
- **Plan:** pain-free weight bearing with immobilization in walker boot (+/- crutches) for 3-4 weeks, re-evaluate in 2-3 weeks, RTP when no TTP and pain-free weight bearing
- **Referral criteria:** displaced fractures, may need reduction +/- surgical fixation
- **Prognosis:** complete healing and full RTP expected, growth disturbance <1%

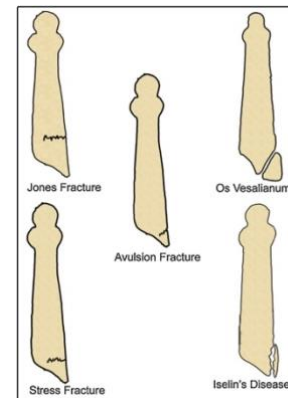


### 5<sup>th</sup> Metatarsal Tuberosity Avulsion Fracture

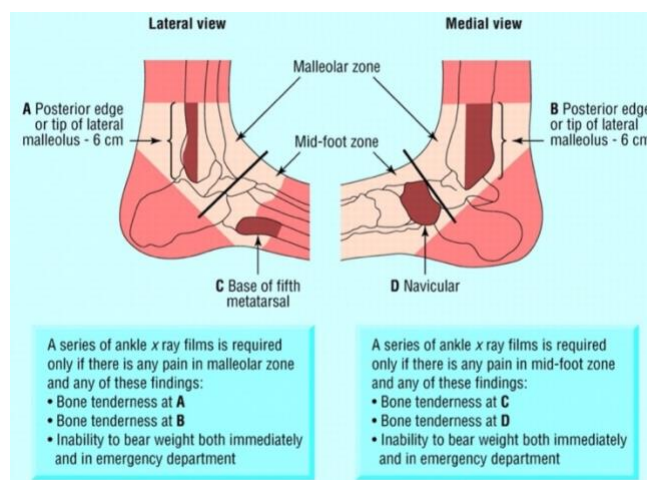
- **Sports:** basketball, soccer, football, volleyball
- **Mechanism:** excessive inversion of plantarflexed ankle, twisting injury
- **Presentation:** sudden, painful “pop” or snap at the lateral foot at time of injury, pain with weight bearing, +/- swelling and/or bruising
- **Exam:** TTP, swelling, and bruising along lateral aspect of foot at base of 5<sup>th</sup> metatarsal over tuberosity (styloid)
- **Diagnosis:** XR required (AP, lateral, oblique): transverse fracture line through tuberosity perpendicular to long axis of the metatarsal



- **Differentiate from normal apophysis:** fleck of bone parallel to long axis of 5<sup>th</sup> metatarsal, seen in girls 9-11 and boys 11-14 years old
- **Differentiate from Jones fracture:** stress fracture of proximal 5<sup>th</sup> metatarsal at diaphyseal-metaphyseal junction, risk of nonunion, may need surgical fixation
- **Plan:** weight bearing as tolerated in cast or walking boot, RTP when no TTP and pain-free weight bearing, usually at 3-4 weeks
- **Referral criteria:** displaced fractures, may need surgical fixation
- **Prognosis:** complete healing, full RTP expected



*Ankle Injury: Indications for Imaging – Ottawa Ankle Rules*



**C. Sports-Related Concussion**

*Concussion*

- **Sports:**
  - Males: football (#1), lacrosse, ice hockey, wrestling
  - Females: soccer (#1), lacrosse, field hockey, basketball
- **Mechanism:** usually a direct blow to the head, may also be a blow elsewhere on the body with secondary force transmitted to the head
- **Presentation:** symptoms in 5 categories: somatic, vestibular, oculomotor, cognitive, emotional and sleep (Table); LOC rare
  - Headache most frequently reported, followed by dizziness, difficulty concentrating, and confusion
- **Exam:** often normal, may have impaired balance (Romberg and/or tandem gait), impaired memory and/or concentration on cognitive testing (can use SCAT5 for 13+ years, Child SCAT5 for ≤ 12 years), and/or vestibular-ocular symptoms
  - Exam must also include full neurologic, head, neck/c-spine evaluation (see NEXUS criteria below)
- **Diagnosis:** clinical, neuroimaging typically normal, follow evidence-based guidelines for head imaging (see 'Red Flags' below)

**TABLE 2** Signs and Symptoms of a Concussion

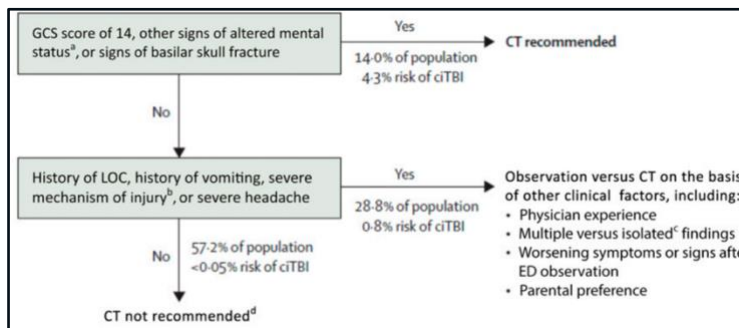
Category	Symptoms
Somatic	Headache
	Nausea and/or vomiting
	Neck pain
	Light sensitivity
Vestibular and/or oculomotor	Noise sensitivity
	Vision problems
	Hearing problems and/or tinnitus
Cognitive	Balance problems
	Dizziness
	Confusion
	Feeling mentally "foggy"
Emotional	Difficulty concentrating
	Difficulty remembering
	Answers questions slowly
	Repeats questions
	Loss of consciousness
Sleep	Irritable
	More emotional than usual
	Sadness
	Nervous and/or anxious
Sleep	Drowsiness and/or fatigue
	Feeling slowed down
	Trouble falling asleep
	Sleeping too much
	Sleeping too little



- **Plan:** immediate removal from play, graduated stepwise return to learn and return to play protocols, avoid complete physical and cognitive rest, early low-moderate intensity sub-symptom aerobic exercise, need written medical clearance from healthcare provider for full RTP
- **Referral criteria:** h/o multiple concussions, prolonged recovery (> 4 weeks)
- **Prognosis:** majority recover within 4 weeks (adolescents take longer than adults)
  - Females: prolonged recovery and worse outcomes
  - Prolonged inactivity: higher symptom level, prolonged recovery
  - Factors associated with prolonged recovery: h/o previous concussion, neurologic or psychiatric condition (migraines, ADHD, depression, anxiety), learning difficulties, family and social stressors
- **Prevention:** legislation, education, +/- equipment design and cervical strengthening programs may be of benefit

*Head Injury Red Flag Symptoms – Indications for Urgent Head Imaging*

- **Red Flags:** weakness or tingling in arms or legs, focal neurologic deficits, severe or progressively increasing headache, loss of consciousness > 30 seconds, deteriorating level of consciousness, repeated emesis, combative state or significant irritability, seizures or convulsions
- **PECARN head rules** (2-18 years of age):



ciTBI, clinically important TBI

Signs of AMS: agitation, somnolence, repetitive questioning, or slow response to verbal communication

*NEXUS Low-Risk Criteria – Decision Rule for Cervical Spine Radiography*

Table 1. The NEXUS Low-Risk Criteria.*
Cervical-spine radiography is indicated for patients with trauma unless they meet all of the following criteria: No posterior midline cervical-spine tenderness,† No evidence of intoxication,‡ A normal level of alertness,§ No focal neurologic deficit,¶ and No painful distracting injuries.‖

\* Criteria are from Hoffman and colleagues.<sup>26</sup>  
 † Midline posterior bony cervical-spine tenderness is present if the patient reports pain on palpation of the posterior midline neck from the nuchal ridge to the prominence of the first thoracic vertebra, or if the patient evinces pain with direct palpation of any cervical spinous process.  
 ‡ Patients should be considered intoxicated if they have either of the following: a recent history provided by the patient or an observer of intoxication or intoxicating ingestion, or evidence of intoxication on physical examination such as an odor of alcohol, slurred speech, ataxia, dysmetria, or other cerebellar findings, or any behavior consistent with intoxication. Patients may also be considered to be intoxicated if tests of bodily secretions are positive for alcohol or drugs that affect the level of alertness.  
 § An altered level of alertness can include any of the following: a Glasgow Coma Scale score of 14 or less; disorientation to person, place, time, or events; an inability to remember three objects at five minutes; a delayed or inappropriate response to external stimuli; or other findings.  
 ¶ A focal neurologic deficit is any focal neurologic finding on motor or sensory examination.  
 ‖ No precise definition of a painful distracting injury is possible. This category includes any condition thought by the clinician to be producing pain sufficient to distract the patient from a second (neck) injury. Such injuries may include, but are not limited to, any long-bone fracture; a visceral injury requiring surgical consultation; a large laceration, degloving injury, or crush injury; large burns; or any other injury causing acute functional impairment. Physicians may also classify any injury as distracting if it is thought to have the potential to impair the patient's ability to appreciate other injuries.



*Resources for Sport-Related Concussion*

- **SCAT5:** Sport concussion assessment tool - 5th edition. *British Journal of Sports Medicine*. 2017;51:851-8.  
 - <https://bjsm.bmj.com/content/bjsports/51/11/851.full.pdf>
- **Child SCAT5:** Sport concussion assessment tool for childrens ages 5 to 12 years, *British Journal of Sports Medicine*. 2017;51:862-9.  
 - <https://bjsm.bmj.com/content/bjsports/51/11/862.full.pdf>
- **California Interscholastic Federation protocols**
  - Return to Learn: [https://cifstate.org/sports-medicine/concussions/CIF\\_Concussion\\_RTL\\_Protocol.pdf](https://cifstate.org/sports-medicine/concussions/CIF_Concussion_RTL_Protocol.pdf)
  - Return to Play: [https://cifstate.org/sports-medicine/concussions/CIF\\_Concussion\\_Return\\_to\\_Play\\_Protocol.pdf](https://cifstate.org/sports-medicine/concussions/CIF_Concussion_Return_to_Play_Protocol.pdf)

D. Fractures

1) **General Principles**

*Imaging Fractures*

- **For long bone injuries:** obtain typically 3 views taken at 90 degrees to each other and include the joint above and below the site of pain to evaluate for any associated fractures or dislocations
- **Imaging the opposite extremity:** helpful in comparing physeal appearance or differentiating an accessory ossification center from a fracture or an avulsion
- **Some fractures are not visible on XR:** if a fracture is suspected and XR is normal, the patient can be treated as if there is a fracture and XR repeated in 1 to 2 weeks when a fracture line or periosteal reaction may become visible

**Table 37-1. Common Radiographic Series to Evaluate Fractures**

Area	Series
Cervical spine	AP/lateral/oblique/flexion and extension lateral
Thoracic spine	AP/lateral
Lumbar spine	AP/lateral/spot L5-S1/oblique
Sacrum	AP/lateral
Pelvis	AP/oblique
Shoulder	AP with internal and external rotation/axillary/Y view
Elbow	AP/lateral/oblique
Wrist	PA/lateral/scaphoid/carpal tunnel view
Hand	AP/lateral/oblique
Finger	AP/lateral/oblique
Hip	AP/frog-leg lateral
Femur	AP/lateral
Knee	AP/lateral/sunrise/tunnel
Tibia/Fibula	AP/lateral
Ankle	AP/lateral/mortise
Foot	AP/lateral/oblique
Toes	AP/lateral/oblique



### Fracture Types and Classification

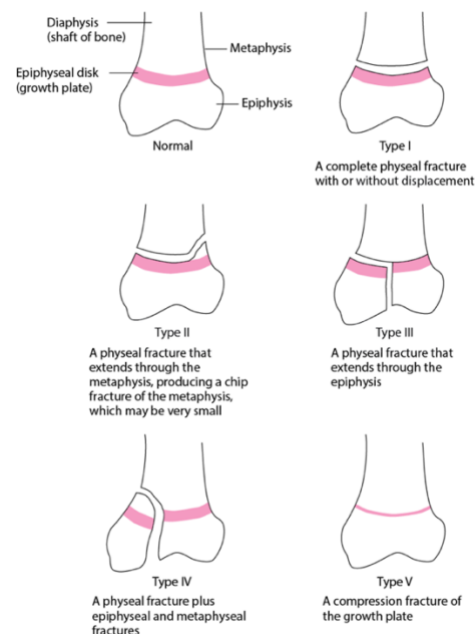
- **Plastic deformation:** instead of breaking, an immature bone can bend or bow
- **Buckle or torus fracture:** impaction injury of a single cortex, occurs at the diaphyseal-metaphyseal junction, most common fracture type in children, often with no bruising or deformity and little or no swelling
- **Greenstick fracture:** occurs in the diaphysis when the cortex on the tension side fails and breaks but the fracture does not propagate through to the opposite cortex, has varying degrees of angulation
- **Spiral fracture:** spiral appearance of a fracture in the diaphysis, not indicative of abuse unless the child is pre-ambulatory
- **Oblique fracture:** occurs diagonally at the diaphysis
- **Transverse fracture:** occurs at a right angle to the cortex usually near the bone mid-shaft
- **Physeal fracture:** occurs at the growth plate, use Salter-Harris classification (see below)

Fracture type	Characteristics
Transverse	Fracture line perpendicular to the shaft of the bone
Oblique	Angulated fracture line
Spiral	A multiplanar and complex fracture line
Torus	An incomplete buckle fracture
Greenstick	An incomplete fracture with angular deformity

Figure 38-4. Fracture types of long bones in children. From Johnson TR, Steinbach LS, eds. *Essentials of Musculoskeletal Imaging*. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2004. Reproduced with permission.

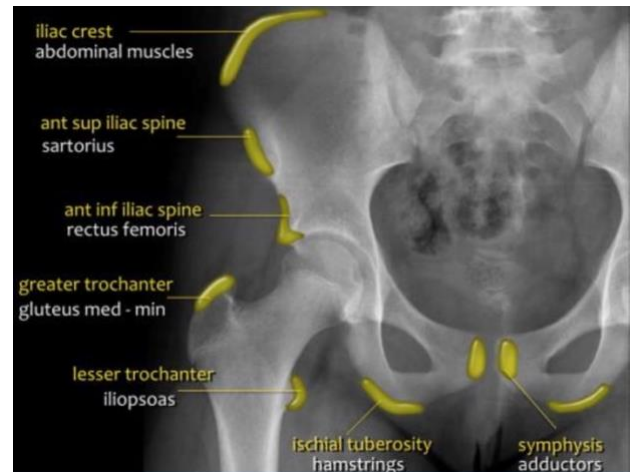
### Physeal Fractures

- **Pathology:** with open physes, more common for a child to sustain a fracture or injury through the relatively weaker physis than to sustain a ligamentous or tendinous injury
- **Typical age:** more likely to occur around the most rapidly growing physes and during times of rapid growth
- **Presentation:** most commonly involves distal radius, followed by distal tibia, distal fibula, distal humerus, distal ulna, proximal humerus, and distal femur
- **Exam:** point tenderness at physis +/- swelling, ecchymosis, and deformity
- **Diagnosis:** XR but physeal fractures may not be apparent on initial radiographs, may show adjacent soft-tissue swelling or a fat pad sign
- **Treatment:**
  - If symptoms and clinical findings suggest a fracture but XR is normal → treat as a fracture and re-evaluate in 10-14 days
  - Non-displaced fractures → splint, make non-weight bearing, and refer to orthopedics/sports medicine within 10 to 14 days
  - Displaced fracture → refer urgently
- **Referral criteria:** any growth plate fracture, refer urgently for displaced fractures
- **Potential for physeal arrest:** higher risk with higher Salter-Harris grade, most common with fractures of the distal femur, distal tibia, and proximal tibia
  - All physeal fractures require continued monitoring over 12 to 24 months



### Apophyseal Avulsion Fractures

- **Pathology:** occur at apophyses (areas of secondary ossification, where muscle-tendon units attach to bone, weakest point in biomechanical chain) rather than physes
- **Presentation:** acute-onset pain at proximal or distal muscle insertion/origin, frequently mistaken for muscle strain in skeletally immature athlete, common locations include pelvis (AIIS, ASIS, ischial tuberosity, iliac crest), tibial tubercle, 5<sup>th</sup> metatarsal tuberosity
- **Exam:** point tenderness at muscle insertion/origin at location of apophysis
- **Diagnosis:** XR will show widening or separation of apophysis
- **Management:**
  - See [Tibial Tubercle Avulsion Fracture](#)
  - See [5<sup>th</sup> Metatarsal Tuberosity Avulsion Fracture](#)
- **Referral criteria:** any apophyseal avulsion fracture



## 2) Upper Extremity Fractures

### Scaphoid

- **Typical age:** less common in young children, incidence rises with age, peaks in adolescence
- **Mechanism:** fall on outstretched hand
- **Presentation:** pain with minimal swelling
- **Exam:** tenderness in the anatomical snuff-box (dorsal space between the extensor pollicis longus and brevis), +/- tenderness and swelling on palmar surface of the scaphoid, no deformity or bruising, wrist motion and grip strength limited by pain
- **Diagnosis:** XR wrist 3 views (AP, lateral, and oblique), consider additional scaphoid view (AP view with wrist in ulnar deviation), XR may be negative initially
- **Treatment:**
  - If clinical suspicion but XR negative → thumb spica cast, repeat XR in 2-3 weeks out of cast
  - Non-displaced fractures → immobilization for 6 weeks in thumb spica cast
  - Displaced fractures → surgical ORIF because of risk of nonunion and AVN
- **Referral criteria:** any scaphoid fracture

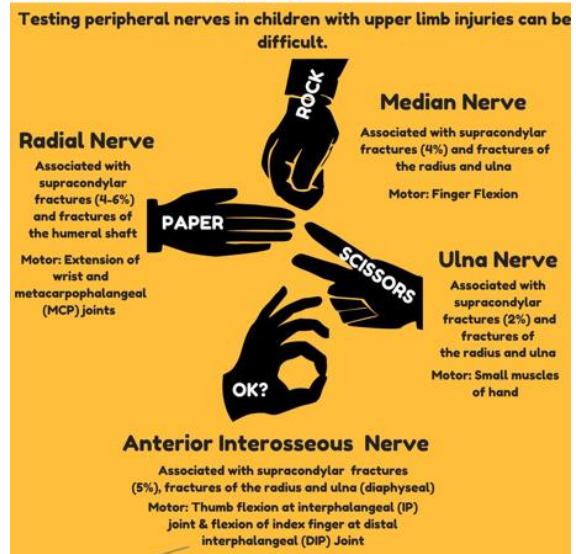
### Clavicle

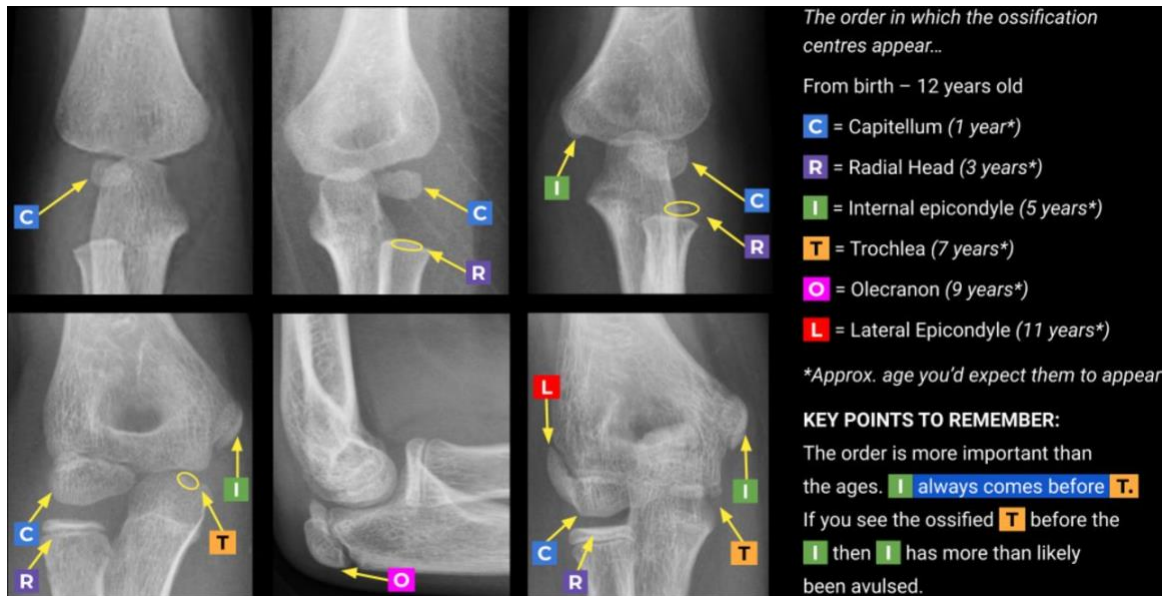
- **Typical age:** adolescence
- **Mechanism:** fall on outstretched arm or direct trauma to lateral aspect of the shoulder
- **Presentation:** pain at site of injury, most common in mid-shaft (> physeal or distal)
- **Exam:** tenderness over fracture site, bony deformity, perform careful neurovascular exam, assess for skin tenting (indicates impending open fracture)
- **Diagnosis:** XR clavicle 2 views (AP, axial)
- **Treatment:**
  - < 12 years old → sling immobilization with progression to ROM then strengthening exercises (almost all fractures in this age group are treated nonoperatively due to high remodeling potential)
  - ≥ 12 years old → indications for ORIF include open fracture, significant displacement, skin tenting, subclavian artery or vein injury, +/- significant shortening (controversial)
- **Referral criteria:** any clavicle fracture



### Supracondylar

- **Pathology:** fracture of distal humerus
- **Typical age:** average age 4 - 8 years, may occur up to 12 years of age
- **Mechanism:** hyperextension injury via fall on outstretched hand (>> direct impact onto flexed elbow)
- **Presentation:** pain, refusal to use arm
- **Classification:** modified Gartland classification
  - Type 1: nondisplaced
  - Type 2: angulation present, but a posterior bony hinge remains intact
  - Type 3: complete displacement, no bony hinge
- **Exam:** tenderness, swelling, decreased ROM, assess for neurovascular deficits (5-10%)
  - Sensory exam
    - Median: palmar surface of the index finger
    - Radial: first dorsal web space
    - Ulnar: palmar surface of the little finger
  - Motor exam
    - Median: rock
    - Anterior interosseous nerve (branch of median, most commonly affected): A-OK
    - Radial: paper
    - Ulnar: scissors
- **Diagnosis:** XR elbow 2-3 views (AP and lateral, + oblique view if allowed by pain)
  - Anterior humeral line (red line): abnormal suggests supracondylar fracture with distal fragment (including the capitellum) displaced posteriorly
  - Radiocapitellar line (green line): abnormal suggests radial head dislocation
  - Posterior fat pad: indicates large effusion, suggests fracture
  - Displaced anterior fat pad (sail sign): indicates joint effusion, can be seen in various elbow injuries including fractures and other injuries
  - Remember ossification centers (can compare to contralateral side if unsure)
- **Treatment:**
  - Type 1: long arm cast, elbow flexed  $\leq 90$  degrees, for ~3-4 weeks
  - Type 2: long arm cast vs. closed reduction and percutaneous pinning
  - Type 3: surgical repair with closed reduction and percutaneous pinning, emergently in the presence of vascular compromise or compartment syndrome
- **Referral criteria:** any supracondylar fracture
  - Type 1: within a week, in clinic
  - Type 2 or 3: same day, in the ED



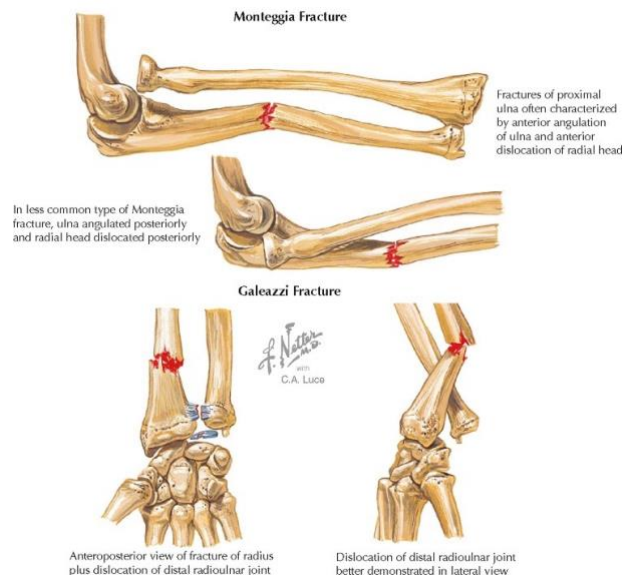


### Distal Radius and Distal Ulna

- **Pathology:** ranges from buckle/torus to greenstick to completely displaced +/- angulated
- **Typical age:** pre-adolescence
- **Mechanism:** fall on outstretched hand
- **Presentation:** wrist pain, refusal to use wrist/hand, most common pediatric fractures
- **Exam:** tenderness localized to the wrist, pain with passive and active ROM of the forearm, wrist, and/or hand, variable level of swelling depending on fracture type
  - Evaluate for concomitant injuries: scaphoid, elbow
- **Diagnosis:** XR wrist 2-3 views (AP and lateral)
  - Obtain 2 views of the entire forearm including wrist AND elbow if the fracture involves bone proximal to the metaphysis or if there is forearm pain
- **Treatment:**
  - Buckle/torus: inherently stable, can treat with simple prefabricated wrist splint for 3-4 weeks (vs. cast if concerned about adherence)
  - Greenstick: closed reduction (degree of allowed angulation depends on age) and casting for 4-6 weeks
  - Displaced: closed reduction followed by splint, split cast, or percutaneous pin
- **Referral criteria:**
  - Buckle / torus: if symptoms persist after 3 to 4 weeks of immobilization
  - Greenstick: any greenstick distal radius or ulna fracture
  - Displaced: any displaced distal radius or ulna fracture, emergently if open, neurovascular compromise, or suspected compartment syndrome

### Monteggia and Galeazzi

- **Pathology:**
  - Monteggia: fracture of the ulna with dislocation of proximal radio-ulnar joint
  - Galeazzi: fracture of the distal radius with dislocation of distal radio-ulnar joint
- **Typical age:** less common in children than adults, but typically occurs between 4-10 years of age
- **Mechanism:** fall on outstretched hand
- **Presentation:** pain in forearm and elbow
- **Exam:** tenderness to palpation, +/- deformity, swelling, and/or neurologic deficits in Monteggia fracture (posterior interosseous nerve, ulnar nerve)
- **Diagnosis:** XR 2-3 views (AP and lateral) of the forearm, elbow, and wrist
- **Treatment:** depends on fracture type and pattern → refer!
- **Referral criteria:** any Monteggia or Galeazzi fracture, emergently if open, neurovascular compromise, or suspected compartment syndrome



### 3) Lower Extremity Fractures

#### Toddler

- **Pathology:** oblique fracture of the distal tibial shaft with no injury to the fibula
- **Typical age:** usually between 9 months and 6 years of age
- **Mechanism:** occurs with minimal trauma, usually during a trip and fall while running or playing or foot gets caught (i.e. on slide), can also be unwitnessed
- **Presentation:** pain, limping or refusal to walk, no swelling, bruising, or deformity
- **Exam:** tenderness over the mid-lower tibia
- **Diagnosis:** XR (AP and lateral views) of tibia may show a faint oblique fracture line through distal metaphysis, but XR often appears normal
  - Consider oblique view to help visualize fracture
- **Treatment:** immobilization in long-leg cast and non weight-bearing for 6 weeks, can consider CAM walking boot for non-displaced or occult fracture
  - Heals completely within 6 to 8 weeks
- **Referral criteria:** can be managed by PCP if comfortable with casting
  - Refer to orthopedics for casting as necessary

#### 5<sup>th</sup> Metatarsal

- See [5<sup>th</sup> Metatarsal Tuberosity Avulsion Fracture](#)

#### Distal Fibula

- See [Salter-Harris I Distal Fibula Fracture](#)

## 4) Splinting Techniques and Resources

### *Additional Resources for Pediatric Fractures*

- Pediatric Orthopaedic Society of North America (POSNA): brief physician study guides on different types of pediatric fractures and other common orthopedic conditions
  - <https://posna.org/Physician-Education/Study-Guide>
- Orthobullets: brief review pages on different types of pediatric fractures and other common orthopedic conditions
  - <https://www.orthobullets.com/>

### *Emergency Medicine Residents' Association Splinting Guide*

# SPLINTING TECHNIQUES

## BASELINE MATERIALS

- Stockinette
- Splinting material
- Plaster
  - Upper extremity: 8–10 layers
  - Lower extremity: 10–12 layers
- Fiberglass
- Padding
- Elastic bandaging
- Bucket/receptacle of water (the warmer the water, the faster the splint sets)
- Trauma shears

## BASELINE PROCEDURE

Measure and prepare the splinting material.

- Length: Measure out the dry splint on the contralateral extremity
- Width: Slightly greater than the diameter of the limb



**1**



**2**



**3**



**4**



**5**

**1**  
Apply the stockinette to extend 2" beyond the splinting material.

**2**  
Apply 2–3 layers of padding over the area to be splinted and between digits being splinted. Add an extra 2–3 layers over bony prominences.

**3**  
Lightly moisten the splinting material. Place it and fold the ends of stockinette over the splinting material.

**4**  
Apply the elastic bandaging.

**5**  
While still wet, use palms to mold the splint to the desired shape.

**6**  
Once hardened, check neurovascular status and motor function.

## POSTERIOR LONG ARM SPLINT



### INDICATIONS

- Olecranon fractures
- Humerus fractures
- Radial head and neck fractures

### CONSTRUCTION

- Start at posterior proximal arm
- Down the ulnar forearm
- End at the metacarpophalangeal joints

### APPLICATION

- Cut hole in stockinette for thumb
- Elbow at 90°
- Forearm neutral position with thumb up
- Neutral or slightly extended wrist (10–20°)

## VOLAR SPLINT



### INDICATIONS

- Soft tissue injuries of the hand and wrist
- Carpal bone fractures
- 2nd–5th metacarpal head fractures

### CONSTRUCTION

- Start at palm at the metacarpal heads
- Down the volar forearm
- End at distal forearm

### APPLICATION

- Cut hole in stockinette for thumb
- Forearm in neutral position with thumb up
- Wrist slightly extended (10–20°)
- Like holding a can

## SUGAR TONG SPLINT



### INDICATIONS

- Distal radius and ulna fractures

### CONSTRUCTION

- Metacarpal heads on the dorsal hand
- Around elbow
- End at volar metacarpal phalangeal joints

### APPLICATION

- Cut hole in stockinette for thumb
- Elbow at 90°
- Forearm neutral with thumb up
- Slightly extended wrist (10–20°)

## DOUBLE SUGAR TONG SPLINT



### INDICATIONS

- Complex and unstable forearm and elbow fractures

### CONSTRUCTION

- Forearm splint: as above
- Arm splint
  - Start at anterior proximal humerus
  - Around elbow
- End at posterior proximal humerus

### APPLICATION

- Cut hole in stockinette for thumb
- Elbow at 90°
- Forearm neutral with thumb up
- Slightly extended wrist (10–20°)

## RADIAL GUTTER SPLINT



### INDICATIONS

- Fractures and soft tissue injuries of index and 3rd digits
- Fractures of the neck, shaft and base of the 2nd and 3rd metacarpals

### CONSTRUCTION

- Starts at mid-forearm
- Down the radial forearm
- End mid-distal phalanx of 2nd and 3rd digits

### APPLICATION

- Cut hole in stockinette and splinting material for the thumb
- Hand in position of function
- Forearm in neutral position
- Wrist slightly extended
- MCP 50° of flexion
- Proximal interphalangeal and distal interphalangeal joints 5°–10° flexion

## THUMB SPICA SPLINT



### INDICATIONS

- Injuries to scaphoid, lunate, thumb and 1st metacarpal
- Gamekeeper's/Skier's thumb
- De Quervain tenosynovitis

### CONSTRUCTION

- Start at mid-distal phalanx of thumb
- End at mid-forearm

### APPLICATION

- Cut hole in stockinette for thumb
- Cut wedges on both sides of splinting material at MCP joint
- Forearm in neutral position with thumb in wineglass position

## ULNAR GUTTER SPLINT



### INDICATIONS

- Fractures and soft tissue injuries of 5th digit
- Fractures of the neck, shaft, and base of 4th and 5th metacarpals

### CONSTRUCTION

- Start at mid-forearm
- Extend down ulnar forearm
- End at mid-distal phalanx
- Include the 4th and 5th digits

### APPLICATION

- Hand in position of function
- Forearm in neutral position
- Wrist slightly extended
- MCP 50° of flexion
- Proximal interphalangeal and distal interphalangeal joints 5–10° flexion
- If boxer's fracture: flex the metacarpal phalangeal joints to 90°



## MALLET FINGER

### INDICATION

- Mallet Finger

### CONSTRUCTION

- Splint only the distal interphalangeal joint

### APPLICATION

- Splint distal interphalangeal joint in hyperextension
- DIP must remain in continuous extension for 6–8 weeks



## FINGER SPLINTS

### INDICATION

- Phalanx fractures
- Tendon repairs

### CONSTRUCTION

- Splint across fractured phalanx or repaired tendon

### APPLICATION

- If tendon repair: splint in flexion or extension, depending on tendon repaired

## POSTERIOR KNEE SPLINT



### INDICATIONS

- Patients with legs too large for knee immobilizer
- Angulated fractures
- Injuries that require urgent operative fixation

### CONSTRUCTION

- Start just inferior to buttocks crease
- Down the posterior leg
- End approximately 6cm above the malleoli

### APPLICATION

- Slightly flexed knee

## POSTERIOR ANKLE & STIRRUP SPLINTS



### INDICATIONS

- Grade 2–Grade 3 ankle sprains
- Fractures of distal fibula and tibia
- Reduced ankle dislocations
- Can add stirrup splint for unstable ankle fractures

### CONSTRUCTION—POSTERIOR ANKLE

- Start at plantar surface of the metatarsal heads
- Extend up posterior leg
- End at the level of the fibular head

### CONSTRUCTION—STIRRUP

- Laterally, start 3–4cm below the level of fibular head
- Extend under the plantar surface of foot
- End at medial and lateral side of leg to just below fibular head

### APPLICATION

- Place with the patient in the prone position
- Ankle at 90°
- Place posterior ankle splint first

## SPLINTING COMPLICATIONS

- Compartment syndrome
- Ischemia
- Neurologic injury
- Thermal injury
- Pressure sores, skin breakdown
- Infection
- Dermatitis
- Joint stiffness

## RESOURCES

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### AUTHOR

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### ILLUSTRATOR

Matthew Holt  
Bodyrender

Eiff MP, Hatch RL. Fracture Management for Primary Care. Philadelphia, PA: Elsevier/Saunders, 2012.

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## 5. Additional Reading, References, and Image Sources

### A. Recommended Reading

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  - <https://pediatrics.aappublications.org/content/pediatrics/138/3/e20162148.full.pdf>
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  - <https://pediatrics.aappublications.org/content/pediatrics/138/2/e20160922.full.pdf>
- In addition to those listed above, other American Academy of Pediatrics Council on Sports Medicine and Fitness publications:
  - [https://pediatrics.aappublications.org/council\\_on\\_sports\\_medicine\\_and\\_fitness](https://pediatrics.aappublications.org/council_on_sports_medicine_and_fitness)

### B. Additional Reading

- American Academy of Pediatrics, Preparticipation Physical Evaluation Monograph, 5th Edition, 2019.
- Drezner JA, et al. AMSSM Position Statement on Cardiovascular Preparticipation Screening in Athletes: Current Evidence, Knowledge Gaps, Recommendations, and Future Directions. *Clin J Sport Med*. 2016;26(5):347-61.
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#### D. Image Sources

##### Section 2: Preparticipation Physical Evaluation, in order of appearance

- PPE Physical Examination Form: American Academy of Pediatrics, Preparticipation Physical Evaluation Monograph, 5<sup>th</sup> Edition, 2019.
- Table 6A-5 Significance of Abnormal Heart Murmurs: American Academy of Pediatrics, Preparticipation Physical Evaluation Monograph, 5<sup>th</sup> Edition, 2019.
- Table 2 Medical Conditions and Sports Participation: Rice SG, AAP Council on Sports Medicine and Fitness. Medical Conditions Affecting Sports Participation. *Pediatrics.* 2008;121(4):841-8.
- Musculoskeletal screening examination: Miller SM, et al. The Sports Preparticipation Evaluation. *Pediatrics in Review.* 2019;40(3):108-28.
- Figure 6G-14 Single-Leg Squat Test & Figure 6G-15 Vertical Jump Maneuver: American Academy of Pediatrics, Preparticipation Physical Evaluation Monograph, 5<sup>th</sup> Edition, 2019.
- PPE History Form, selected questions: American Academy of Pediatrics, Preparticipation Physical Evaluation Monograph, 5<sup>th</sup> Edition, 2019.
- Box 8-2 Findings to screen for when performing physical examination on athletes with a disability: American Academy of Pediatrics, Preparticipation Physical Evaluation Monograph, 5<sup>th</sup> Edition, 2019.

### Section 3: Overuse and Chronic Injuries, in order of appearance

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