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Sports injuries: ankle

Developed by Rihana Kukkadi and Dr. Steve Mann for PedsCases.com.
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Introduction:

Hi, my name is Rihana and I'm a second-year medical student at Queen's University. This podcast was produced in collaboration with Dr. Mann, an orthopaedic surgeon at Queen's University. In this podcast, we will first work through an approach to paediatric ankle pain, including questions to explore on history, key aspects of the physical exam, appropriate investigations, and possible treatment options.
After listening to this podcast, you should be able to:

1. Identify key components of the history and physical exam when assessing a paediatric ankle injury
2. Discuss the differential diagnosis of common paediatric sports ankle injuries
3. Review the key investigations and approach to management for paediatric patients presenting with ankle pain.

This episode will not go into the detailed management of every ankle condition; instead, we will focus on differentiating between conditions needing conservative management, surgical intervention, or urgent assessment.

Anatomy review:

Before we get into our clinical case, let's review the relevant anatomy.
When people refer to the "ankle," they are typically talking about the tibio-talar joint, though the motion we associate with the ankle actually comes from two different joints. Plantarflexion and dorsiflexion occur at the tibio-talar joint, while inversion and eversion occur at the subtalar joint. The ankle is a synovial joint made up of these two articulations: the tibio-talar joint and the subtalar joint. Focusing on the tibio-talar joint first, which is also considered the 'true' ankle joint, this hinge joint consists of the distal ends of the tibia and fibula articulating with the talus. The distal tibia and fibula are bound together by strong tibiofibular ligaments to form the distal tibiofibular syndesmosis. This is an important structure that can be disrupted in high ankle sprains so keep this in mind for when we touch on it later in the episode. The stability of the ankle is based on these ligaments and the mortise formed by the tibia and fibula, creating a socket that the talus fits in. As a hinge joint, the primary motions are plantar flexion (~50 degrees) and dorsiflexion (~30 degrees). The subtalar joint, also known as the talocalcaneal joint, is a plane joint that allows for inversion and eversion. There is a greater range of motion associated with inversion as compared to eversion, 35 degrees inversion versus 20 degrees eversion, since the fibula as the more lateral bone in the lower leg extends further than the tibia. The interosseous talocalcaneal ligaments provide support for this joint. It's important to note that

the inversion and eversion motions we see are actually driven by the calcaneus and not the talus. The stability of the ankle can be divided into static and dynamic stability; static stability is provided by the medial deltoid ligament and the lateral ligament complex, where the lateral complex includes the anterior talofibular, calcaneofibular, and posterior talofibular ligaments. Dynamic stability comes from the posterior tibialis medially, responsible for inverting the foot, and the peroneus brevis and longus muscles laterally, which are responsible for everting the foot. (1)
When thinking about how ankle injuries in children and adolescents might differ from those seen in adults, we need to consider that children have growth plates that remain open until skeletal maturity. This is relevant since growth plates are weaker than solid bone, and injuries involving the physis can affect bone growth and development.

Clinical case introduction / History and physical

Now it's time to introduce our case.
Imagine you are a third-year medical student working on an emergency medicine rotation when a seven-year-old girl named Zoya comes in with her mother and is presenting with ankle pain.

Let's begin with questions we want to ask on our history:

1. Signs and symptoms: As with any history, we want to understand what the clinical presentation is. Is the patient experiencing any pain? If so, ask the sacred seven or use the 'OPQRST' acronym to elucidate the onset, location, quality, duration, aggravating & alleviating factors associated with the pain. More specific to MSK complaints, be sure to ask how the range of motion is affected, and if there is any numbness, weakness, tingling sensations, or instability. It is also important to ask if there are mechanical symptoms such as locking, feeling worse after activity, or inflammatory symptoms like morning stiffness or swelling.
2. Mechanism: Understanding how an injury occurred will help guide your differential. Is this a sudden traumatic high-energy injury that requires a rapid primary and secondary assessment? If this was something that came on gradually, was there a particular sport or movement that aggravated it? Were they able to continue moving after the injury and has that changed?
3. Past medical history: Learning about past medical conditions or surgeries will also help shape your differential and plan for this patient. Have they suffered previous injuries that are similar to what they're currently experiencing? If the presentation is different, how so? Is there a family history of orthopaedic or rheumatic disease?
4. Goals: Knowing about your patient's goals and activity levels can also help you. Does this child participate in many activities at a competitive level or is this their first time playing a sport?

Going back to our case, Zoya is complaining of diffuse lateral right ankle pain, which started immediately after inverting her ankle 2 hours ago while running during a soccer game. Zoya can limp but experiences more pain with weight bearing. She feels better when icing her ankle and has no previous history of sports injuries or relevant medical conditions. It's the end of the soccer season but Zoya and her mom are concerned about what this injury may do for the upcoming figure skating season.

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Physical
Now that we've collected more information, let's move on to the physical exam. Follow your protocol to conduct a primary and secondary assessment of the patient and be sure to conduct a neurovascular assessment to ensure that sensation and blood flow are intact. On general inspection, note if the patient appears well or unwell and get a set of vitals.
When focusing on the ankle specifically, we can use the Look, Feel, Move, then Special Tests approach. Be mindful that the patient's pain might limit aspects of your physical exam. Inspect the ankle and compare it to the unaffected side with the SEADS acronym, looking for swelling, erythema, atrophy, deformity, and scars. Observe the position of the ankle and the foot and if they deviate from the typical resting position which is 10 degrees ankle plantarflexion. (1) Then, palpate the ankle and surrounding structures, noting any tenderness, temperature disparities, or crepitus. Examine the patient's active range of motion followed by passive range of motion, including dorsiflexion, plantar flexion, inversion, and eversion. Test the strength of the ankle and foot muscles and perform a gait assessment. We will touch on special tests for the ankle in the following section when we review the differential diagnoses.

In Zoya's case, her right ankle appears to be swollen and bruised, particularly in the posterior aspect of the ankle and along the medial and lateral malleoli. There is tenderness on palpation of the distal fibula 3cm proximal to the tip of the lateral malleolus and along the lateral malleolus. All active motions, especially inversion, are diminished. The neurovascular exam yields a normal capillary refill of < 2 seconds and intact sensation.

Differential diagnoses:
After completing our history and physical exams, let's explore the differential diagnoses of sports-related ankle pain in pediatric populations**.** As with many musculoskeletal injuries, ankle injuries can be either acute or chronic. Acute injuries typically arise from a single traumatic event, while chronic injuries develop gradually and are frequently caused by overuse.
Let's begin with acute ankle injuries. At the top of your differential for acute ankle pain, you should be considering fractures.

- Recall that growth plates in children are weaker than the surrounding ligaments and tendons. So when there has been a traumatic event, growth plate fractures are more likely to occur as opposed to sprains and strains. Fractures should always be considered and ruled out before thinking of sprains in paediatric patients.
- When grading **physeal fractures**, we can use the Salter-Harris classification system. The higher the Salter Harris Type, the higher the risk for growth disruption. Type I injuries are isolated to the physis and do not injure the surrounding bone. You can think of each letter of SALTER corresponding to the injury type where 'S' is for Straight through the physis, seen in Type I injuries. 'A' of Salter refers to 'above', since Type II injuries involve the physis and the metaphysis (aka the portion above the physis). 'L' is for 'lower' indicating a type III injury where the physis and the epiphysis are involved. 'TE' stands for 'through everything', seen in Type IV injury where there's an extension of the fracture from the metaphysis, through the physis, and into the epiphysis. Since types 3 and 4 have fractures extending through the epiphysis, these are considered intra-articular fractures that will need reduction and internal fixation. Finally, R is for rammed, seen in type V injuries where there was a crush injury to the physis.

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- A Salter Harris type I fracture of the distal fibula is the most common fracture pattern in the ankle in pediatric cases. (2)
- Fractures of the **base of the fifth metatarsal** in children typically occur due to several mechanisms. These include participation in sports, with soccer being the most common, falls from a height, or twisting injuries of the ankle when the foot is fixed. Presentation includes pain and swelling that is localised to the base of the fifth metatarsal and a history of an inversion ankle injury.
- Two fracture patterns that are unique in paediatrics are **juvenile Tillaux and triplane ankle fractures**. They share a common mechanism of injury which is forced dorsiflexion and external rotation during sports or following trauma, causing avulsion of the anterior inferior talofibular ligament.
    - Tillaux fractures are typically seen in adolescents aged 12-16 and involve a Salter Harris type 3 fracture of the distal tibial epiphysis. (3)
    - Triplane fractures are named as such because they involve fracture lines along 3 different planes: a coronal fracture through the epiphysis, a sagittal fracture through the epiphysis and metaphysis, and a transverse fracture through the metaphysis.
        - We're reminded of the importance of getting multiple views on imaging since on an AP X ray of the ankle, the triplane fracture seems to be a Salter Harris type 3 fracture but on the lateral view, it looks like a Salter Harris type 2 injury. (2) Presentation includes pain, swelling, and deformity of the ankle.

Now let's move to ankle <u>sprains</u>

- Recall that a sprain refers to a ligament that has been stretched or torn, partially or completely.
- In ankle sprains, it is the lateral ligaments that are most commonly injured. Recall from our anatomy review that the lateral ligament complex includes the anterior talofibular, calcaneofibular, and posterior talofibular ligaments. Of these ligaments, the most commonly injured in paediatric populations is the anterior talofibular ligament, followed by the calcaneofibular ligament. (2) These sprains occur following inversion and external rotation of the ankle and clinical presentation typically includes pain, swelling, bruising of the ankle, and difficulty or inability to bear weight.
- Sprains can be graded from grade 1 to grade 3, increasing in severity. In grade 1 sprains, the ligaments have been stretched but there is no tear and no instability. Grade 2 sprains involve partial tearing of the ligaments and there may be mild instability. In grade 3 tears, the tears are severe and involve complete tearing of the ligaments with significant instability. (2)
- <u>The anterior drawer test</u> is a useful special test to assess the stability of the ankle joint. In this test, the tibia is stabilised while applying an anterior force to the hindfoot to test the resistance to anterior subluxation of the talus, which is primarily based on the integrity of the anterior talofibular ligament. (2)
- Syndesmotic ankle sprains also known as high ankle sprains refer to ligament injuries to the distal tibiofibular syndesmosis. High-speed sports involving sudden direction

changes and jumping, such as soccer, hockey, and basketball, can result in external foot rotation while the ankle is dorsiflexed which disrupts the syndesmosis. (2)

- A special test used for high ankle sprains and syndesmotic ligament injuries is the external rotation test. In this test, the lower leg is stabilized and the foot is externally rotated. A positive test result produces pain upon rotation. (1)

The next few diagnoses we'll discuss can be acute or chronic, depending on the mechanism of injury.

Let's begin with **os trigonum syndrome.**

- This syndrome presents with posterior ankle pain and swelling, caused by the presence of an extra bone behind the talus. Activities involving plantar flexion in particular can irritate or compress the bone, including activities like dance, soccer, and diving. Os trigonum syndrome can develop after an acute injury or repetitive microtrauma to the area. Patients will have a diminished range of motion, particularly in plantar flexion. (2)

Tendon injuries can also cause ankle pain and can be acute or chronic.

- Peroneal tendinopathy refers to chronic overuse injuries causing non inflammatory degeneration of the tendon due to repetitive stress and microtears. It's often linked to running or playing sports and is associated with recurrent lateral ankle sprains. Symptoms typically include swelling and tenderness along the posterolateral aspect of the ankle and painful snapping sensations along the lateral malleolus during passive plantarflexion and inversion. (1)
- Achilles tendinopathy presents with pain along the Achilles tendon, and can develop due to repetitive stress on the tendon leading to inflammation, degeneration, and eventual microtears. There is pain with resisted plantar flexion and the mechanism of injury is often associated with running and jumping activities. (1)

The next two conditions, **stress fractures** and **osteochondritis dissecans**, are chronic conditions that should be considered although they are less common compared to the other causes of ankle pain.

- Stress fractures in the bones of the foot or lower leg tibia & fibula can lead to ankle pain. Repetitive microtrauma to the bone can occur in sports that are high impact and repetitive, often involving running and jumping. Note that stress fractures in children are less common than in adults. (1)
- Osteochondritis dissecans (OCD) involves the formation of osteochondral lesions causing avascular necrosis and separation of the articular cartilage from the underlying bone. In the ankle, OCD affects the talus. The pain associated with OCD is persistent, worsening with weight-bearing activities or physical activity, and improves with rest. The patient may describe a catching or locking sensation and a limited range of motion. OCD is more common in older children and adolescents involved in repetitive impact sports like running and gymnastics. The exact pathophysiology of OCD is unknown but overuse and vascular insufficiency are thought to contribute to its development. (3)

Imaging:

Now let's move on to investigations that can be done. While not every patient who presents with an ankle injury needs an X ray, we can consider following validated Ankle Rules to reduce the

number of unnecessary radiographs. The Ottawa Ankle Rules are well known and validated for their use in *adult* patients; however, the low risk ankle rule (LRAR) was specifically designed for use in pediatric patients and is commonly used in North America, and is very sensitive for identifying high-risk fractures. (4) This clinical rule states that if a child presents with a low-risk injury upon examination, characterised by tenderness and swelling isolated to the distal fibula and/or the adjacent lateral ligaments below the tibial anterior joint line, it may not be necessary to perform an X-ray to rule out a clinically significant ankle injury. Instead, the low-risk injuries can be managed conservatively, with bracing & crutches as needed for pain and return to activities as tolerated by the patient. It's important to note that while the low risk ankle rule is widely used and holds significance, the decision to obtain radiographs is ultimately influenced by clinical judgement and centre-specific policies. When imaging is performed, always be sure to get at least two views, considering AP, lateral, and mortise views.
Note that stress radiographs are typically not needed for the management of ankle injuries. While they can be valuable for identifying widening of the Lisfranc joint, these injuries are rare in children. Regarding ankle sprains, the benefit of stress radiographs is unclear so their current role in clinical practice is yet to be established. (2)
If soft tissue injuries involving the tendons or ligaments are suspected, ultrasound can be useful.

Management:
Following the necessary investigations, management will depend on the diagnosis of the ankle pain.
Going back to ankle fractures,

- General principles include non-operative management with immobilisation using casts or splints. Fractures requiring surgery include injuries with vascular compromise, intra articular involvement, comminuted fractures, and open fractures. It's also important to monitor and follow up on any growth disturbances that may arise following physeal fractures.
- For Salter Harris type 1 fractures of the distal fibula, which are the most common type of ankle fracture seen, immobilisation in a weight-bearing short leg cast or walking boot for 3-4 weeks is appropriate. (2)
- For avulsion fractures of the base of the 5th metatarsal (also known as the dancer's fracture), conservative management is the mainstay with brief immobilisation in a short-leg cast or walking boot for 1-2 weeks. After this period, patients can typically start weight-bearing as tolerated and transition back to a regular shoe as their pain improves. Return to full activity can occur when pain resolves and range of motion return to normal. (2)
- It's also valuable to distinguish between avulsion fractures of the base of the 5th compared to the Jones fracture, which is less common in pediatric populations but more serious. These fractures occur at the metaphyseal-diaphyseal junction and have a higher risk of non-union, requiring strict non-weight-bearing for at least 6 weeks and the possibility of surgery if healing is delayed or complications come up.
- Juvenile tillaux and triplane fractures are intra articular fractures, so will typically require surgical fixation. (2)

In the case of ankle sprains,

- The RICE protocol is initially used: Rest, Ice, Compression, and Elevation is aimed at controlling inflammation and pain. For grade 1 and 2 injuries, early mobilisation is key as functional rehabilitation has been found to be more effective than immobilzation. As Grade 3 injuries are more severe and associated with a complete tear of the ligaments, introducing a period of immobilization with a cast or a boot is preferred, followed by rehabilitation. Rehabilitation should focus on exercises promoting range of motion, balance, and strengthening of ligaments. Analgesia for paediatric patients should include NSAIDs & acetaminophen. Returning to pre-injury levels of activity typically takes from a couple of weeks for grade 1 injuries to 3 months for grade 3 injuries.
- For high ankle sprains, treatment differs based on the stability of the ankle. If there is no instability, treatment is similar to that of general ankle sprains, but the patient should be made aware that high ankle sprains typically take longer to heal If imaging detected instability, surgery is recommended. (2)

For os trigonum syndrome, initial treatment is conservative with analgesia, ice, activity modification, and physical therapy. For more severe cases, temporary immobilization can be useful, or surgery when conservative measures fail. (2) Tendinopathies also are treated with analgesia, ice, activity modification, and physical therapy.

Before we conclude, let's jump back to our case. Based on Zoya's presentation and clinical judgement, AP and lateral radiographs of the ankle were obtained. The radiographs showed a Salter Harris type I fracture of the distal fibula, a pattern consistent with Zoya's mechanism of injury (which involved an inversion force applied to the ankle during her soccer game). You determine that since Zoya is stable and her neurovascular status is intact, management of a Salter Harris type I fracture of the ankle will involve immobilisation and symptom management. You explain to Zoya and her mom how Zoya will be placed in a short-leg, weight-bearing cast or a walker boot for about 3–4 weeks to allow for proper healing. You advise them to avoid excess weight-bearing activities and ice the joint to reduce swelling and discomfort. You emphasise the importance of adhering to this treatment plan so that Zoya and her mother understand the potential impact of the injury on her figure skating season. You suggest making follow-up appointments to monitor Zoya's progress and ensure healing of the fracture.

And with that, we conclude our podcast on pediatric sports ankle injuries. Let's review our key take-home points:

1. Assessing a paediatric patient with ankle pain requires a thorough history including the mechanism of injury and past medical history, followed by a comprehensive physical exam
2. During the physical exam, be sure to assess for neurovascular compromise and any life-threatening injuries before focusing on managing the ankle pain
3. The differential diagnoses for paediatric ankle pain include acute fractures, sprains, tendon injuries, and less common conditions like os trigonum syndrome, stress fractures, and osteochondritis dissecans.
4. Plain X-rays are essential for diagnosing fractures while ultrasound may be helpful for soft tissue injuries
5. Management of pediatric ankle injuries depends on the specific diagnosis but may involve immobilization with casts or splints, physical therapy, and pain management.

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6. Return to full activity varies depending on the severity of the injury, ranging from a couple of weeks for mild sprains to many months for severe fractures

Thanks so much for listening!

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