The Pediatric Athlete

Financial Disclosure

Dr. Kaye E. Wilkins, DVM, MD has no relevant financial relationships with commercial interests to disclose.

Athletic injuries involving the Ankle and Foot
First we need to examine the differences in musculoskeletal system between these:

Athletes

Characteristics of his bony structure
His bony structure must be adapted for:

Growth

Thus, the basic process of growth of normal bone goes from:

New Bone (weak) → Quantity
↓
Mature Bone (strong) → Quality
Thus, the pediatric athlete’s bone is composed of:

- **Physis**
- **Metaphysis**
- **Diaphysis**

There is a modification in the architecture of the organ that allows it to expand in length?

The physis is composed of cartilage which has an expandable matrix.

**What is the downside of this structural construct?**
It fails easily with tension and sheer stresses

So much for the basics. Let us discuss some of the specific pediatric athletic issues of the ankle and foot.

We will Focus mainly on:
1. The Soft tissue injuries
2. The Bony disruptions

This variation in different matrices results in unique fracture patterns

- Torus Fracture
- Greenstick Fracture
This variation in different matrices results in unique fracture patterns

Physeal Fracture

Soft Tissue injuries of the Ankle
- Sprains of the lateral ligament complex

Usually the result of combination of two forces

1. Severe inversion of foot and ankle
2. External rotation of the leg

Combined with:

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The bone of the ankle and foot are held together with numerous ligaments.

The main ankle ligaments involved are:
- Anterior talo-fibular lig.
- Calcaneal-tibial lig.

Clinical appearance:
- Lateral ankle tenderness
- Severe swelling in the ankle

Classification of acute Ankle sprains based on the degree of injury to the Anterior Talo-Fibular Ligament (ATFL):
- Grade I: Simple stretching of the ATFL.
- Grade II: Partial rupture of the ATFL.
- Grade III: Complete rupture of the ATFL.
How important is this injury?

Many authors have reported ankle injuries as the most common injury seen in adolescent athlete.


Notice the predominant injuries were sprains.


Top 5 Ankle injuries in the girls by high school sport, 2005-2006 school year

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How are we going to treat this injury in the skeletally immature athlete?

**NO**

*The use of the cast delays resumption of motion and strength.*

**Rigid Immobilization**
Instead we need to apply

- **Rest**
- **Ice**
- **Compression**
- **Elevation**

**Treatment**

What two basics things need to be accomplished?

**Support + Mobility**

- Air Cast
- or
- Ankle Splint

- Don't forget Rehabilitation

**Rehabilitation**

- **Home**
  - Bicycling
  - Formal specific exercises

- Often it may be best to have a coach in the form of:
  - Physical Therapist
  - High School trainer

Often poor compliance

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Bony injuries to the Pediatric Ankle

Almost all involve the distal Tibia

In The Pediatric Athlete the Physes determine the fracture patterns

Fracture patterns totally bony
Fracture patterns influenced by the physes

Prior to Physeal closure there are four distal tibial and fibular fracture patterns in the Skeletally Immature Athlete

Let us examine
The Dias Tachdjian Classification of these four types
The four Dias-Tachdian Fracture Patterns

Let us examine the specifics of each type

Supination    Pronation    Supination    Supination
Inversion     Eversion      Eversion      Eversion
             External      External      External
             Rotation      Rotation      Rotation

These are the
Pediatric Counterpart of
The Lauge-Hansen Classification

Let us examine the specifics of each type.

Supination Inversion

There are the two stages of the Supination-Inversion Type

Stage I          Stage II
What is the overall deformity of this fracture pattern?

![Image of a fracture pattern]

What are the clinical findings?

**Stage I**

**Physical exam:**
- Local tenderness
- Swelling
- Over Fibular Physis

**Xray:**
- Acute:
  - deep soft tissue swelling over fibular physis

**Pediatric Ankle Sprain?**

**Treatment?**

**Stage I**

What two basics things need to be accomplished?

**Support + Mobility**
- Air Cast
- Ankle Splint
What’s the major complication with these injuries?

**Chronic Weakness**

*We need to treat these injuries the same as ankle sprains*

Remember!!
Even pediatric patients need rehabilitation

What is significant about Stage II injuries?

**Remember!**
This is a crushing injury

Complete avulsion fibular physis

S-H III or IV medial malleous

Remember
This is a **CRUSHING** injury

CT Cut
What are the stages of treatment?

First, obtain a satisfactory reduction

If treated with a cast alone, this may result
Because, there are vertical shear forces acting at the fracture site.

How are these shear forces best neutralized?

Need compressive forces

Trans-Epiphysseal Screw (Percutaneous)

The fracture pattern has the highest rate of complications!!

Why??

Remember!

This is a crushing injury.
A not uncommon outcome

10 y.o. male treated with cast

1yr. P.I. mature bridge formation

Next is the

Pronation
Eversion
External Rotation

What's unique about the fibula fracture?

What is the pathology associated with this fracture pattern?

Tibia:
- bony injury?
- S-H I/II avulsion fracture pattern
- soft tissue injury?

Large periosteal flap attached to distal fragment

Diaphyseal Greenstick Pattern

Tibia:
What is the overall deformity of this fracture pattern?

How can most of the fractures be treated?

What if they are unstable?

Treatment of unstable fractures
What is the most common complication associated with this fracture pattern?

Interposed periosteum
Other Soft Tissues
- posterior tibial tendon
Posterior tibial N.V. bundle

12 y.o. male playing soccer

Almost open
PEER pattern

Exam under Gen Anesthesia

Incomplete reduction due to interposed periosteum

Best reduction
Thus an open reduction is required

Distal proximal tibial fracture surface

Interposed periosteum inhibiting the reduction

What happens if the interposed periosteum remains?

Producing a valgus ankle

What are the stages of the Supination External Rotation fracture pattern

Stage I

S-H I or II Fracture Distal Tibia
Note in the pediatric age group the fibula fails AFTER the tibial!!

and the anterior tib-fib ligament usually remains intact

Spiral Fracture Distal Fibular Metaphysis

Stage II

What is the overall deformity of this fracture pattern?

What is the overall deformity of this fracture pattern?

An extreme example of the rotational malalignment!!

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How are most of these fractures treated?

Internally Rotate Distal Fragment To Close Fragments

What are the complications with this fracture pattern?

1. Rotatory deformity due to incomplete correction
2. Physeal arrest (rare)

Supination Plantar Flexion

What are its' components?
What is the overall deformity of this fracture pattern?

POSTERIOR

TRANSLATION

How are most of these fractures treated?

Closed reduction
Reverse the deformity
Stabilization

Translocation
location

What are the manipulative procedures?

Pushing posterior against the distal tibia
If severely swollen or unstable:
Stabilize with percutaneous screws
The most common **Complication** is:

*inter-posted periosteum*

There are the two special fracture patterns seen in adolescents:

*Juvenile Tilleaux*  *Triplane Fracture*

Why do these fracture patterns occur in this age group?

*Due to early closure of the medial tibial physis*
**What’s the pathology associated here?**

- Fragment Pulled off by Anterior Tib-fib ligament
- Fragment Pulled off Ant-Lat

**What can be a diagnostic pitfall with this fracture pattern?**

- Diagnosis can be easily overlooked
  - Fragment best seen on Mortise (oblique) View

**How can most of these fractures be managed?**

- Stabilize with screw placed percutaneously
What are the three planes in a triplane?

- Coronal Metaphysis
- Horizontal Physis
- Vertical (Sagittal) Epiphysis

Radiographic evaluation

Is this a Tilleaux or a triplane?

How are these fractures best evaluated?

It is the lateral view that determines that the fracture is a triplane pattern.
How are these triplane fractures managed?

The A-P view demonstrates only the two fragments.

What can one tell from the plain X-rays?

The A-P view demonstrates only the two fragments.

You need a lateral view to see the third metaphyseal fragment.

What other information do you need?
Need to see the alignment of the fracture planes

C-T of the epiphysis

Demonstrates

In what plane?

What other images are needed?

Metaphyseal Images

What’s the fracture plane here?

First put joystick pins to accomplish the reduction

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When the fracture is closed
pass one deeper

Triplane Fractures

A-P Screws to secure coronal metaphyseal fragment

Trans-epiphyseal screw To secure Tillaux fragment

Arthrogram to confirm Articular congruity

The final result

Conditions

Involving the foot in the Pediatric Athlete
Rare, Because of the flexibility of the pediatric foot
Forces applied to the foot are transferred to:
- Tibia
- Ankle and knee
- Fibula

As a result, Fractures of the foot are usually minor in origin

Let us review those fractures that usually just require simple immobilization and observation
Stress Fractures of the calcaneus

Lot of pain when running

Two weeks later, you can see the enosteal callous typical of a stress fracture

Base of 5th Metatarsal (Metaphysis)

Line fracture is perpendicular

Warn: That the fracture line will spread!!
Metatarsal (Neck)

Wait!! These have the potential to remodel

6 months later

Phalanx Fractures

Usually simple

Treatment simple as well

Some may a simple need manipulation
Fractures with major consequences

Fortunately, these are rare as athletic injuries.

They are rare in the pediatric age group, because these bones contain considerable cartilage.

Talus Fractures

Mechanism of Injury

Forced Dorsiflexion

Anterior lip of the tibia forced against the neck of the talus

Pronation
14 year old female cheerleading fall.

Post Operative Avascular Necrosis

30% even without displacement

High incidence of complications
Immediate Post Operative

Function almost normal

Thirteen Months Later

Calcaneal Fractures

Rare Incidence
Falls from Heights

Always check the Spine

These often require Surgical Intervention

Following Open Reduction

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Sometimes there are seemingly simple fractures that may need surgical intervention.

Reduction must be perfect

Another indication for Surgery

Avulsion Fracture-Great Toe

Jones’ 5th Metatarsal diaphyseal fracture

Healing facilitated with compressive intramedullary screw

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These can lead to persistent pain which may affect athletic performance

Chronic micro tears
Calcaneal Apophysis

Treat with achilles stretching and strengthening and heel cups

Minor Chronic failures of bone-tendon junctions
Usually more of a nuisance factor, rarely affects function

Accessory Navicular Failure

Both of these conditions require only simple reassurance and symptomatic care

Usually resolves by fusing with main mass

Fractures are perpendicular to the shaft

I hope this information will be of value should I injure my ankle or foot!!!

Thanks for your attention

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