Foot and Ankle Problems in the Pediatric Athlete

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UT kids
UT MEDICINE SAN ANTONIO
PEDIATRIC ORTHOPAEDICS & SPINE DEFORMITY

Disclosures

Grant Hogue, M.D., has no financial relationships to disclose

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Overview

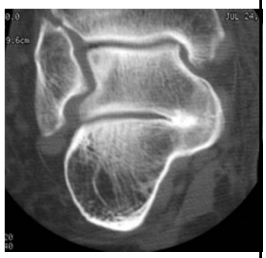
- Developmental Problems
  - Pes Planus
  - Tarsal Coalition
  - Adolescent Bunion
- Accessory Ossicles
  - Os Trigonum
  - Accessory Navicular
  - Medial Malleolus Ossification Center
- Acute Injuries
  - Fractures/Sprains/Tendon Subluxation
- Overuse Injuries
  - Stress Fractures/OCD
  - Tendonitis/Apophysitis

Developmental Problems

- Pes Planus
  - Flat foot common in children until age 6
  - Said to be "flexible" if arch reconstitutes when the child stands on their toes
  - Reported in up to 15% of the population
  - For athletes who are symptomatic an arch support to prevent excessive pronation is often helpful

Developmental Problems

- Tarsal Coalition
  - Fibrous, cartilaginous, or bony connection of two (or more) bones in the midfoot or hindfoot with presentation common during adolescence
  - Most are bilateral, but is reported to occur in <1% of the population
  - Most common are calcaneonavicular and talocalcaneal
  - Present with a history of multiple ankle sprains and vague pain that is insidious in onset



Tarsal Coalition

- Symptoms typically begin or are exacerbated during athletic training. Hence, a high occurrence is encountered in the young athlete
- PE will show limited subtalar motion
- Generally seen on plain radiographs
  - C sign for talocalcaneal
  - Oblique view for calcaneonavicular
- CT scan for perioperative planning

Tarsal Coalition – Treatment

- Conservative management with orthotics and temporary immobilization is often succesful
- Resection may be necessary for recalcitrant cases in order to restore mobility and decrease pain
- Not necessary to wait until skeletal maturity for resection

Developmental Problems- Adolescent Bunion

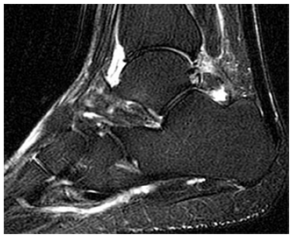
- Most common in female dancers
- Initial treatment includes wider shoes, bunion pads, orthotics
- If pain persists then boney realignment is necessary with osteotomy choices similar to the adult population
- Simple bunionectomy has an exceedingly low success rate

Accessory Ossicles

- Os Trigonum
  - Posterior talus has a separate ossification center that generally ossifies and fuses 1 yr after appearance (8-10 girls, 11-13 boys)
  - If fusion does not occur an os trigonum is formed
  - Present in ~10% of the population and generally asymptomatic
  - Can become symptomatic in athletes who actively plantarflex their ankle --- ballet, gymnastics, ice skaters, occ soccer players

Os Trigonum

- Will present with posterolateral ankle pain secondary to posterior impingment between the tibia and calcaneus
- Repetitive impingment can also cause hypertrophic capsulitis
- Pain reproduced with plantarflexion on exam
- If patient has concurrent posteromedial pain then a concurrent FHL tendonitis should be suspected



Os trigonum

Sports
- Dance
- Gymnastics
- Competitive cheering
- Martial arts

Os Trigonum - Treatment

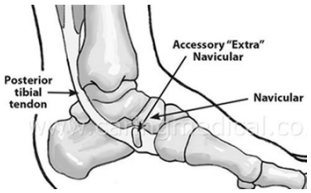
- Rest, NSAIDs, avoidance, PT, BUT pain usually returns once sporting is resumed. Especially with ballet dancers
- Resection often necessary in the competitive young athlete
- Medial or lateral approach to the posterior ankle
  - Use medial approach if addressing concurrent FHL tendonitis

Accessory Ossicles- Accessory Navicular

- Most common accessory bone in the foot and occurs on the medial, plantar border of the navicular
  - Insertion site of posterior tib tendon
- Reported in 4-14% of the population but <1% symptomatic
- Present in the adolescent athlete due to pressure over the bony prominence, tear in the synchondrosis, or posterior tib tendonitis

Accessory Navicular- Treatment

- Conservative tx with orthotics and trial of casting is usually quite succesful however resection is necessary in recalcitrant cases
- After resection/excision it is important to repair posterior tib insertion on the navicular proper



Accessory Ossicles- Medial Malleolus Ossification Center/Os subtibiale

- Medial Malleolus ossification center appears b/t 1-2 yrs of age and fuses by age 11-12
- Persistence into adulthood is uncommon, but can be a source of pain from microtrauma at the chondro-osseous jxn in young athletes

Os subtibiale -Tx

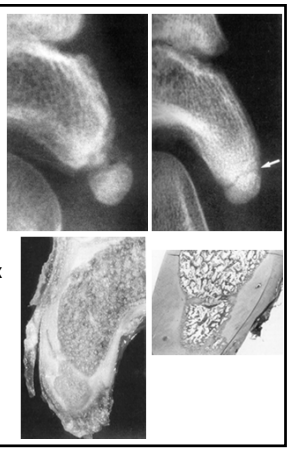
Usually unites

Traumatic vs. developmental

- Can become symptomatic after trauma or repetitive use

Treatment:

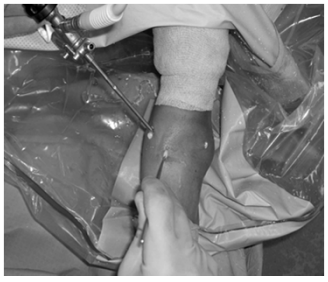
- Rest, time
- Rarely more
- Micheli: rest x 3 weeks→cast x 3 weeks → re cast → scope excision



Os subtibiale

Arthroscopic resection

- Accessory portal



Os subtibiale

Arthroscopic resection

- Pre-op

- Post-op

Acute Injuries- Physeal Fractures

- Distal tibial and fibular physes form a "plane of weakness" about the ankle
- Ligaments often stronger than physeal cartilage leading to increased risk of physeal injury over ligamentous sprain
- Goldberg: 31/53 fractures of the distal tibial physis occurred during sporting activity

Physeal Closure

Distal tibia physis closes:

- About age 12-15 yrs girls
- About age 13-17 yrs boys

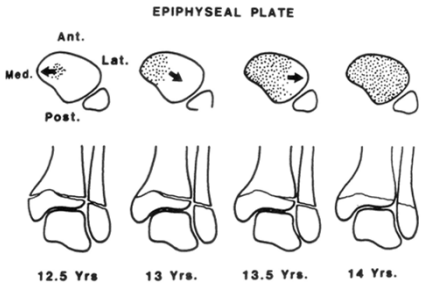
Medial malleolus extension appears ~10 yrs

Asymmetric closure over ~18 months

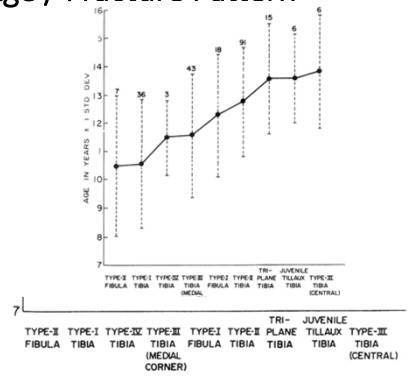
- Tibia physis closes in center first then medially and posteriorly.
- Anterolateral portion of physis is the last to close

Closure of the distal fibula physis follows distal tibia physeal closure by ~12-24 months

Distal Tibial Physeal Closure



Age / Fracture Pattern

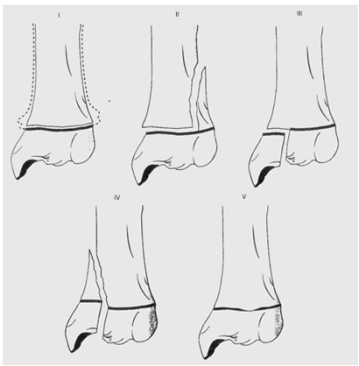


Spiegel P, et al. Epiphyseal fractures of the distal ends of the tibia and fibula. *J Bone Joint Surg Am.* 1978;60(8):1046-50.

Classification Anatomic

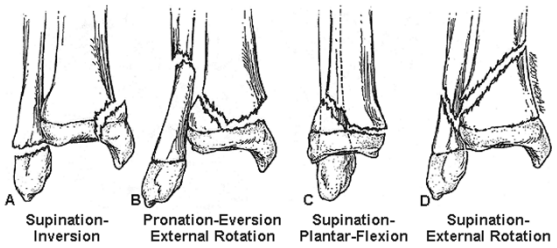
Salter-Harris

- High interobserver correlation
- Correlated with outcomes
- Higher number correlates with greater chance of growth disturbance



Classification - Ankle Fractures; Dias-Tachdjian

Mechanism of injury:



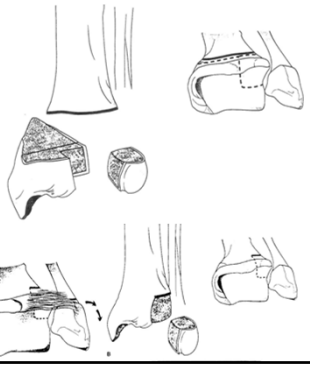
Dias L, Tachdjian M. Physeal injuries of the ankle in children: classification. *Clin Orthop Relat Res.* 1978;136:230-3.

13yo M SH IV of tibia, SH I of fibula


Football injury. Supination-inversion type. Attempted to practice for 2 DAYS before seeing a physician.

"transitional fractures"

- Triplane and tillaux
  - Triplane
    - Fracture appears to be in multiple planes
    - May be 2, 3 or 4 part fractures
  - Tillaux
    - Fracture of the anterolateral epiphysis



Triplane Fractures

Combination of Salter II and III fractures: usually near end of growth (Complex type IV fracture)

Anterior epiphyseal fracture with large posteriomedial metaphyseal fragment…fibula may also be fractured

Triplane Fractures

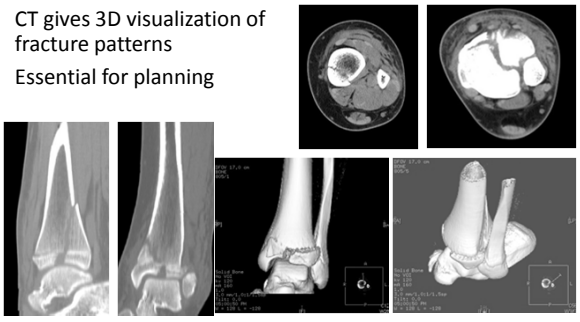
Displaced Triplane Fractures (>2 mm)

- Anatomic reduction required
- If closed reduction successful
  - Cast: consider a long leg cast with 30° of knee flexion and foot internally rotated, if unstable
- If closed reduction unsuccessful => ORIF
  - Reduction/internal fixation done in step-wise fashion with small fragment or 4.0 cannulated screws
- Postop - SLC x 3-4 wks, then SLWC x 3 wks

Adequate Imaging Helps

CT gives 3D visualization of fracture patterns

Essential for planning



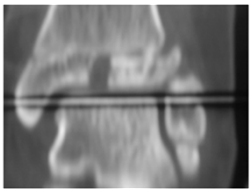
Triplane Fracture

Surgical Correction


"Transitional" Fractures

Juvenile Tillaux fractures

- Patients tend to be older than those with triplane fx
- Fibula prevents marked displacement: may be subtle
- Local tenderness at anteriolateral joint line
- Mortise view essential
- May need CT scan
- Although literature based on small series, excellent results with anatomic reduction noted



Tillaux Fractures Treatment

Non-displaced

- Cast (NWB) x 3 wks, then SLWC x 3-4 wks
- CT scan after cast placement may be needed to assure no displacement
- Radiographs in cast to assure no re-displacement in cast
- Follow-up x-rays obtained every 6-12 months for 2 to 3 yrs to assess for growth arrest

Tillaux Fractures Treatment

Displaced (>2mm) Tillaux fxs

- Anatomic reduction required
- If closed reduction achieved
  - Long leg cast with knee flexed 30 degrees and foot internally rotated if unstable
- If closed reduction unsuccessful
  - Attempt closed reduction under anesthesia
  - If still unsuccessful, may use k-wires to joystick Tillaux fragment (percutaneously or open)
  - Fixation with small fragment or 4.0 cannulated screws
- Postop - SLC x 3-4 wks, then SLWC x 3 wks

Tillaux Fracture Example

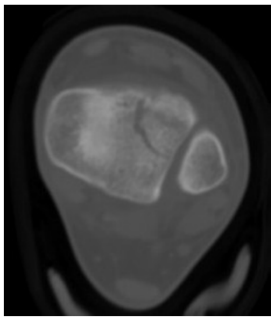
Child with ankle pain:

- Fracture difficult to see

Tillaux Fracture Example

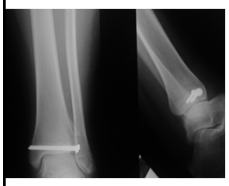
CT shows a Salter III ("Tillaux") fracture of the distal tibia

- Tillaux fractures occur near the end of growth as medial portion of distal tibial physis closes before the lateral side closes



Tillaux Fracture Example

Post-operative and healed x-rays after hardware removal: no residual deformity



Sprains

- Ankle sprains reported to make up as much as 25% of athletic injuries
- High grade ankle sprains unusual in the skeletally immature (ligament stronger than bone/physis)
- Physeal fracture until proven otherwise
- Most common is similar to adults
  - Inversion-plantarflexion with sprain of the ATFL and calcaneofibular ligaments
- These lower grade ankle sprains respond well to conservative mgmt with treatment mimicking adults models

Treatment options

Ankle sprains:

- Non-operative care
- RICE
  - Rest
  - Ice
  - Compression
  - Elevation
- Immobilization
  - Lace-up ankle brace
  - Stirrup brace
  - Fracture-boot
    - Possibly more recurrence than lace-up brace
  - Cast
- Physical therapy – early

Treatment options

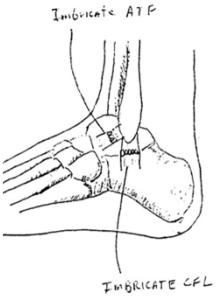
- Operative mgmt

Surgical techniques

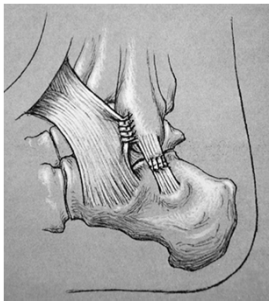
- **Brostrum**
  - Direct late repair of lateral ankle ligaments
  - Torn ends of ATFL shortened and repaired
- **Gould modification of Brostrum**
  - Mobilization and reattachment of lateral portion of extensor retinaculum to fibula after imbrication of ATFL and CFL
  - Provides additional stability
  - Gold standard – 85-95% successful
- **Modified brosturm + Split Evans**
  - Augment brostrum repair with anterior 1/3 slip of PB (girard, FAI 1999)
- **Chrisman-Snook Reconstruction**
  - **Good outcomes**
  - **Higher complication rate**

Repair and plication

Broström



Gould modification



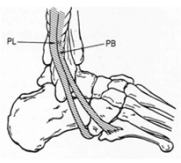
Gould N. Foot Ankle 1980

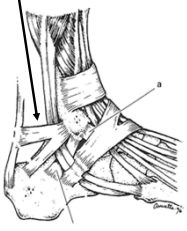
Peroneal Tendon Subluxation

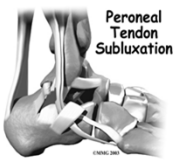
- uncommon but potentially disabling in young athletes
- Often overlooked as a cause of persistent lateral ankle pain after trauma
- Among reported cases in the skeletally immature >90% are the result of athletics
  - Skiing, skating, basketball, soccer, football

Peroneal tendon instability

Superior peroneal retinaculum







Peroneal tendon instability

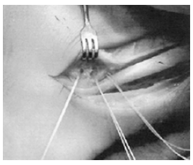
Mechanism
- Ankle dorsiflexed
- Hindfoot everted

Acute presentation:
- Very similar to lateral ankle sprain

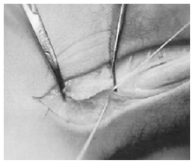
Chronic presentation
- Visible
- Audible Snap
- Palpable snap

Peroneal tendon instability

Non-operative Care
- Recognize the acute injury
- Immobilize
- Therapy
- 50% successful?



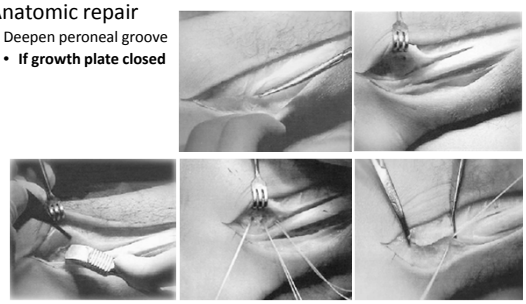
Surgery
- Repair
- Reconstruction



Ferran et al. Sport Med 2006

Peroneal tendon instability

Anatomic repair
- Deepen peroneal groove
  - **If growth plate closed**



Oliva, F Bull Hosp Joint Dis 2006

Peroneal tendon instability

Pediatric reconstruction:
- Modified Chrisman-Snook
  - Split peroneus brevis
  - Through the epiphysis
  - Into the calcaneus

Forman & Micheli. Foot & Ankle. 2000

Overuse Injuries

- Repetitive, unrepaired microtrauma manifests as “overuse” injuries
- In the growing athlete the bones may grow more swiftly than the muscle-tendon units, resulting in poor flexibility and overuse injuries
- Stress fractures, tendonitis, muscle strains, and apophysitis all have a common denominator: the structure involved is stressed beyond the limits of its ability to repair.

Overuse Injuries- Stress Fractures

- Present with mechanical pain that increases with activity and decreases with rest
- Risk factors
  - Female
  - Caucasian
  - Sudden increase in training intensity
  - Menstrual irregularity
  - Tibia vara and dec hip ROM
- Tibia, femoral neck, distal fibula, calcaneus, and metatarsals

Overuse Injuries- Stress Fractures

- Diagnosis
  - Clinical diagnosis backed up with advanced imaging
    - **MRI or Bone Scan**
- Treatment
  - Conservative mgmt is the mainstay of treatment
  - Rest and immobilization as needed

Overuse Injuries- Tendonitis

- Overuse tendonitis occurs in the tendons spanning the ankle joint for several reasons
  - Training errors
  - Imbalance
  - Footwear
  - Growth spurt
  - Sudden increase in training intensity
- Most common
  - FHL
  - Peroneals
  - Achilles

Overuse Injuries- Tendonitis

- Treatment
  - Conservative treatment with correcting technique, icing, stretching, and strengthening
  - Tenosynovectomy needed infrequently for recalcitrant cases

Sever's disease/Aphophysitis

Calcaneal apophysitis

- 8% of all overuse injuries in children and adolescents

  Gillespie H. *Curr Sports Med Rep.* 2010;9(5):265-268.
- Typically 8-12 yo
  - Open apophysis required

  Stricker PR. Apophysitis. In: Puffer JC, *ed. 20 Common Problems in Sports Medicine*.New York: McGraw-Hill; 2002:353-366.
- Males 2-3x more than girls

  Frush TJ. *Sports Health*.2009;1(3):201-211.
- 60% bilateral

  Canale ST. Osteochondroses and related problems of the foot and ankle. In: DeLee JC, Drez D Jr, Miller MD, *eds. DeLee and Drez's Orthopaedic Sports Medicine. Principles and Practice.*3rd ed. Philadelphia, PA: Saunders Elsevier; 2010:2142-2170.

Sever's disease

Typical history

- Pain brought on by activity
- Improves with rest, ice, NSAIDs
- Returns with activity
- No pain at rest
- When pain resolves has no pain with weight bearing

Sever's disease

Differential diagnosis of heel pain:

- Calcaneal tumor
  - Benign and malignant
- Calcaneal stress fracture

Radiographs

- Pain with weight bearing
- Parent's request
- Findings: nothing
  - Sclerosis and fragmentation vs. normal development of the apophysis

Sever's disease

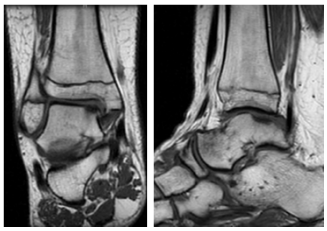
Treatment
- Rest, ice, NSAIDs
- Activity modification
- Achilles tendon stretching
- Pad the shoe cleat
- Temporary use of heel cups if desperate
  - Tuli's heel cups
  - Tuli's cheetahs

Have to get serious to improve the pain
- Many wait to finish the season

Recurrence possible/common until skeletally mature

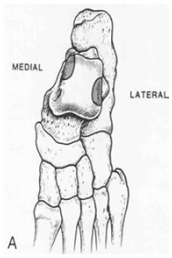
Osteochondral Lesion of the Talus (OLT)

Osteochondritis dissecans (OCD) of the talus
- Injury to the surface of the talus
- Cartilage and subchondral bone
- Conservative treatment not very successful
  - Prolonged
  - Risks cartilage



Osteochondral Lesion of the Talus (OLT)

Medial (70%)
- 64% trauma
- Deeper
- Posterior
- Plantarflexion, inversion, ER

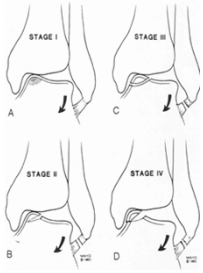


Lateral (20%)
- 100% trauma
- Shallow/wafer
- Anterior
- Dorsiflexion, inversion, IR

Berndt & Hardy. JBJS, 1959
Canale. JBJS, 1980.
Flick & Gould. Foot & Ankle, 1985.

Osteochondral Lesion of the Talus (OLT)

Berndt and Hardy Classification



Berndt & Hardy. JBJS. 1959

OCD

Keep it simple

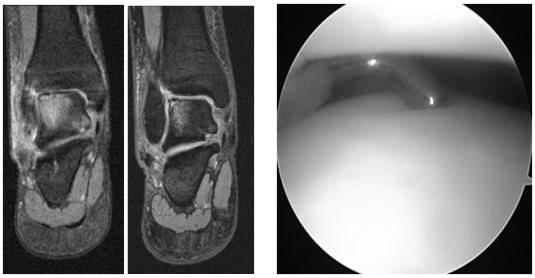
Osteochondral Lesion of the Talus (OLT)

Cartilage surface intact Cartilage NOT intact

Osteochondral Lesion of the Talus (OLT)

Cartilage surface intact

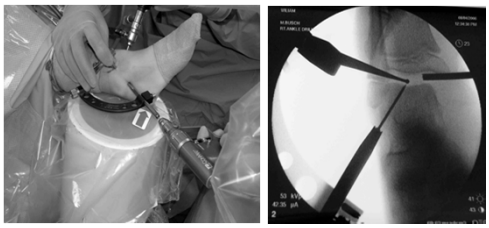
- Retroarticular drilling



Osteochondral Lesion of the Talus (OLT)

Cartilage surface intact

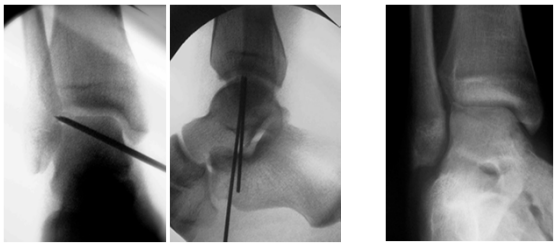
- Retroarticular drilling



Osteochondral Lesion of the Talus (OLT)

Cartilage surface intact

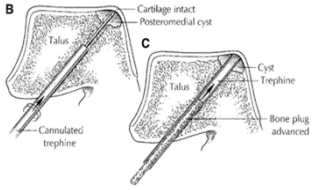
- Retroarticular drilling



6 weeks post-op

Osteochondral Lesion of the Talus (OLT)

Cartilage surface intact

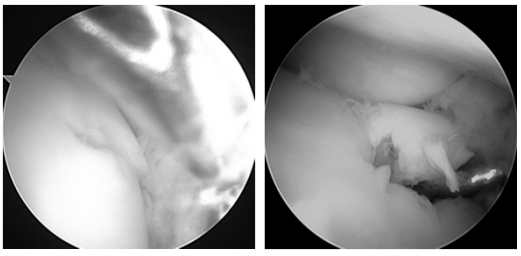


Barnes & Ferkel. Foot Ankle Clin N Am, 2003

Osteochondral Lesion of the Talus (OLT)

Cartilage NOT intact

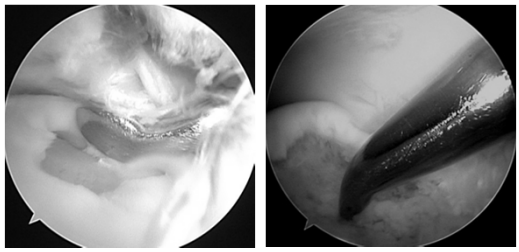
- Debridement
- Marrow stimulation (microfracture)



Osteochondral Lesion of the Talus (OLT)

Cartilage NOT intact

- Debridement
- Marrow stimulation (microfracture)



Osteochondral Lesion of the Talus (OLT)

Cartilage NOT intact

- Debridement
- Marrow stimulation (microfracture)

18 months post-op

Acknowledgments

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