Musculoskeletal Conditions

In this session…

- Limb Length Discrepancy
- Medial Tibial Stress Syndrome
- Base of 5th Metatarsal Fracture
- Accessory Bones
- Lisfranc Injuries
- Ehlers-Danlos Syndrome

Limb Length Discrepancies

Limb Length Discrepancies

- The role of leg length discrepancy (LLD) both as a biomechanical impediment and a predisposing factor for associated musculoskeletal disorders has been a source of controversy for some time. LLD has been implicated in affecting gait and running mechanics and economy, standing posture, postural sway, as well as increased incidence of scoliosis, low back pain, osteoarthritis of the hip and spine, aseptic loosening of hip prosthesis, and lower extremity stress fractures.
    - Gurney B. Leg length discrepancy. In: Gait Posture. 2002 Apr;15(2):195-206.

Concerns

- Low back pain
  - Lowe, L. Leg length discrepancy and low back pain. In: *Massage Today,* 2008, 08(01).
- Increased exertion in ambulation
  - Gurney B, et al. Effects of limb-length discrepancy on gait economy and lower-extremity muscle activity in older adults. In: J Bone Joint Surg Am. 2001 Jun;83-A(6):907-15.
- Gait abnormalities
  - Perttunen JR, et al. Gait asymmetry in patients with limb length discrepancy. In: Scand J Med Sci Sports. 2004 Feb;14(1):49-56.
- Asymmetric limb loading (short limb sustains greater proportion of load and rate of loading)
  - White SC, Gilchrist LA, Wilk BE. Asymmetric limb loading with true or simulated leg-length differences. In: Clin Orthop Relat Res. 2004 Apr;(421):287-92.

Incidence and Significance of LLD

- Incidence:
  - 60%-90% of population has LLD
  - 23% of population has discrepancy > 1cm
    - Gross RH: Leg length discrepancy: how much is too much? Orthopedics 1:307-310, 1978
- No consensus on what is a significant LLD?
  - 3mm is significant
    - Subotnick SI: Leg-length discrepancies of the lower extremity. journal of Orthopaedic Sports and Physical Therapy 3;11-16, 1981
  - Anything less than 1.2cm is acceptable
    - Anderson IW: Modern Trends in Orthopaedics. New York, NY, AppletonCentury-Crofts, 1972

Leg Length Discrepancy

Types of LLD

- Structural (or Linear…or True)
- Functional
- Environmental

Signs of LLD

- Asymmetry in gait
- Pelvic tilt
- Scoliosis
- Knee flexion
- Unilateral foot pronation

Types of LLD

- Structural
  - Congenital leg length inequality
  - Damaged growth plate during childhood
  - Fractures
  - s/p THA or TKA
  - Post-polio

Types of LLD

- Functional
  - s/p THA or TKA
  - PTTD
  - Innominate (pelvic) rotation
  - Compensation for:
    - Muscle weakness and/or imbalance
    - Inflexibility at pelvis or in foot/ankle complex
    - Limited ROM at hip, knee or ankle
  - Scoliosis
  - Spinal DJD/OA
  - Hip OA

Figure 1: Functional LLD caused by tight left quadratus lumborum (Mediclip image, copyright 1998 Williams & Wilkins. All rights reserved).

Types of LLD

- Environmental
  - Crowning on road
  - Running on banked track
  - Excessive shoe wear

Types of LLD

- Other?
  - LLD in transfemoral amputee
    - Morgenroth DC, et al. Low-back pain in transfemoral amputees: is there a correlation with static or dynamic leg-length discrepancy? In: Am J Phys Med Rehabil. 2009 Feb;88(2):108-13.

Measurement Methods

- Direct
- Indirect
- Radiological
- Visual

Measurement Methods

- Direct – Tape measure
  - This method involves measuring the distance between the anterior superior iliac spine to the medial malleolus. Unfortunately, the direct method is difficult to reproduce and fails to take into account functional LLDs.

Measurement Methods

- Direct Method

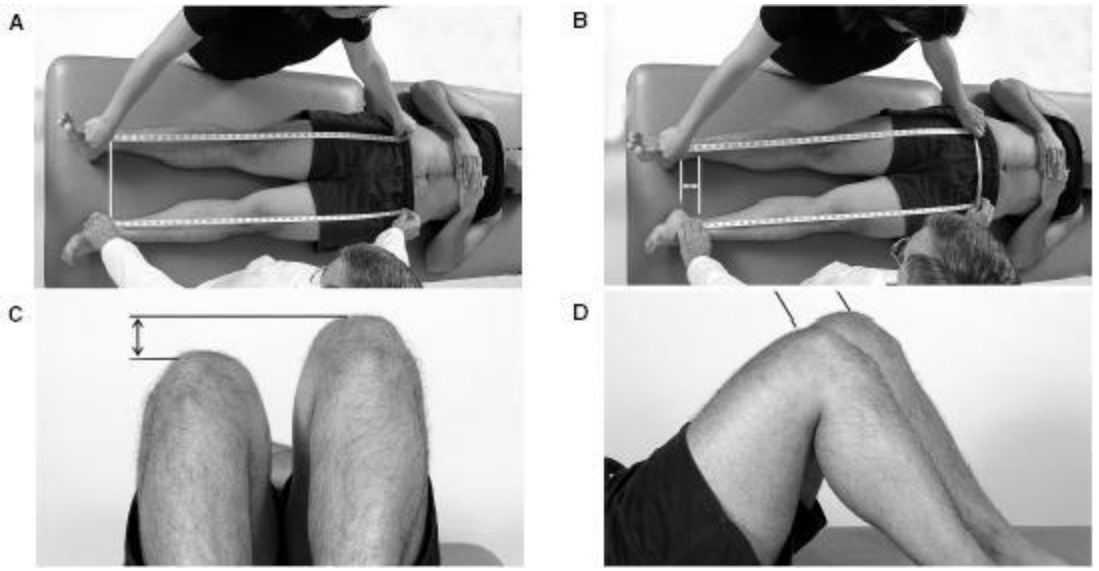

Figure 4-81

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A. Examiner should measure from one fixed bony point (i.e., ASIS anterior superior iliac spine) to another (i.e., medial malleolus) to find true leg length. **B.** True leg length discrepancy. **C.** tibial length discrepancy; **D.** femoral length discrepancy.

Measurement Methods

- Indirect – Pelvic leveling
  - Functional LLD can only be measured accurately via indirect method.
    - Ireland J, Kessel L. Hip adduction/abduction deformity and apparent leg-length inequality. *Clin Orthop.* 1980; 153:156-157.
    - Wagner H. Pelvic tilt and leg-length correction [in German]. *Orthopade*. 1990;19:273-277.
- Indirect method is superior to direct because it reduces pelvic tilt and levels the sacral base. It is also real and reproducible.
    - Caselli MA, Rzonka EC. Detecting And Treating Leg Length Discrepancies, In: Podiatry Today, 2002, 15(12).

Measurement Methods

- Radiological
  - Most accurate for structural LLD
  - Cannot effectively measure functional LLD

Measurement Methods

- Visual
  - Not reliable or accurate

Figure 2: Visual evaluation of LLD from a supine position.

Measurement Methods

- Accuracy
  - **Accuracy and precision of clinical estimation of leg length inequality and lumbar scoliosis: comparison of clinical and radiological measurements.**
    - (Friberg O, Nurminen M, Korhonen K, Soininen E, Mänttäri T - Research Institute of Military Medicine, Central Military Hospital, Helsinki, Finland)
  - The results of 196 clinical determinations of leg length inequality and postural pelvic tilt scoliosis in 21 patients were analysed and compared with reliable radiological measurements. Clinical methods proved to be inaccurate and highly imprecise, the observer error being +/- 8.6 mm for direct and +/- 7.5 mm for indirect measurement of leg length inequality, and +/- 6.4 degrees for the estimation of postural lumbar scoliosis. More than half (53%) of the observations were erroneous when the criterion of leg length inequality was 5 mm. Failure to determine the presence or absence of length inequality of more than 5 mm occurred in 54 measurements (27% of the total). In 12% of the direct and in 13% of the indirect measurements, the observers erred in deciding which leg was longer; discrepancies occurred even when radiological reading gave a leg length inequality of as much as 25 mm.
    - In: Int Disabil Stud. 1988;10(2):49-53.

Measurement Methods

- Accuracy
  - Friberg et al used the block method to determine the presence and degree of LLD in 21 patients with low back pain. The authors compared measurements obtained with the block method with those obtained from radiographs. The average intratester error when comparing radiographic with block-method measurements was 5.8 mm. The authors also reported that, approximately 13% of the time, the block-method measurements differed from the radiographic measurements in the determination of which leg was shorter.
    - Friberg O, Nurminen M, Korhonen K, et al: Accuracy and precision of clinical estimation of leg length inequality and lumbar scoliosis: Comparison of clinical and radiological measurements. Int Disabil Stud 10:49-53, 1988

Treatment Options / Criteria

- Surgical
  - <2cm – no action required
  - 2cm-6cm – shortening procedure to opposite limb
  - 6cm-15cm – lengthening procedure
  - >15cm – staged lengthening procedure
    - McCarthy JJ, MacEwan DG: Management of Leg Length Inequality in J South Orthop Assoc. 2001;10(2)

Pedorthic Treatment Options / Criteria

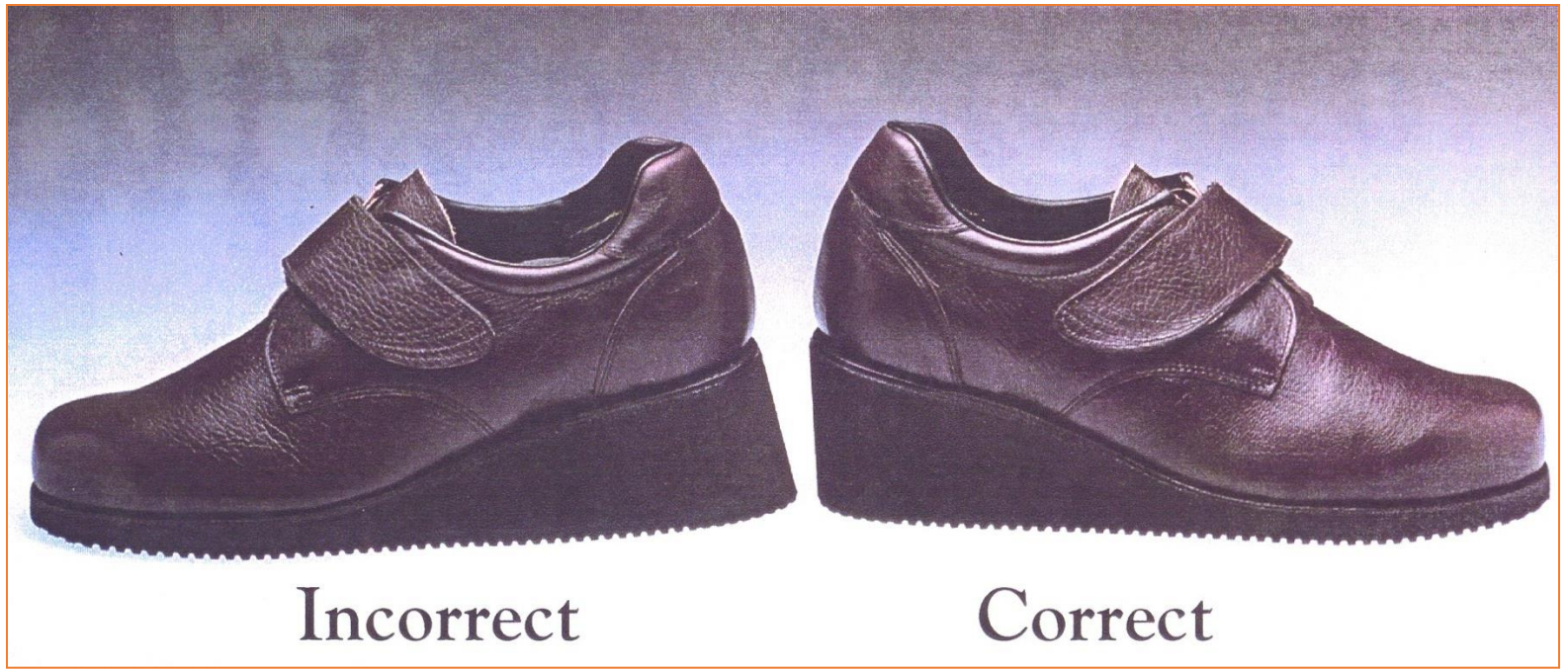
- No intervention necessary when LLD >.5cm
  - Brady RJ, et al. Limb length inequality: Clinical implications for assessment and intervention. In: J Orthop Sports Phys Ther. 2003 May;33(5):221-34.
- Correct approximately half the measured discrepancy
  - Baylis WJ, Rzonca EC. Functional and structural limb length discrepancies: evaluation and treatment. In: Clin Podiatr Med Surg. 1988 Jul;5(3):509-20.
  - Caselli MA, Rzonka EC. Detecting And Treating Leg Length Discrepancies, In: Podiatry Today, 2002, 15(12).
- The longer the patient has had LLD, the less correction they will tolerate
- Keep in mind that most people have at least a mild congenital LLD. Human bodies are simply not symmetrical.

Pedorthic Treatment

- Shoe lifts can improve pain and restore functional gait
  - Golightly YM, et al. Changes in pain and disability secondary to shoe lift intervention in subjects with limb length inequality and chronic low back pain: a preliminary report. In: J Orthop Sports Phys Ther. 2007 Jul;37(7):380-8.
- Internal heel lift
  - ≤ ½”
  - Pro: Movable from-shoe-to-shoe
  - Con: Promotes Achilles contracture
- External sole extension
  - > ½”
  - Pro: Keeps forefoot:rearfoot level
  - Con: Not transferrable from-shoe-to-shoe
- Combination

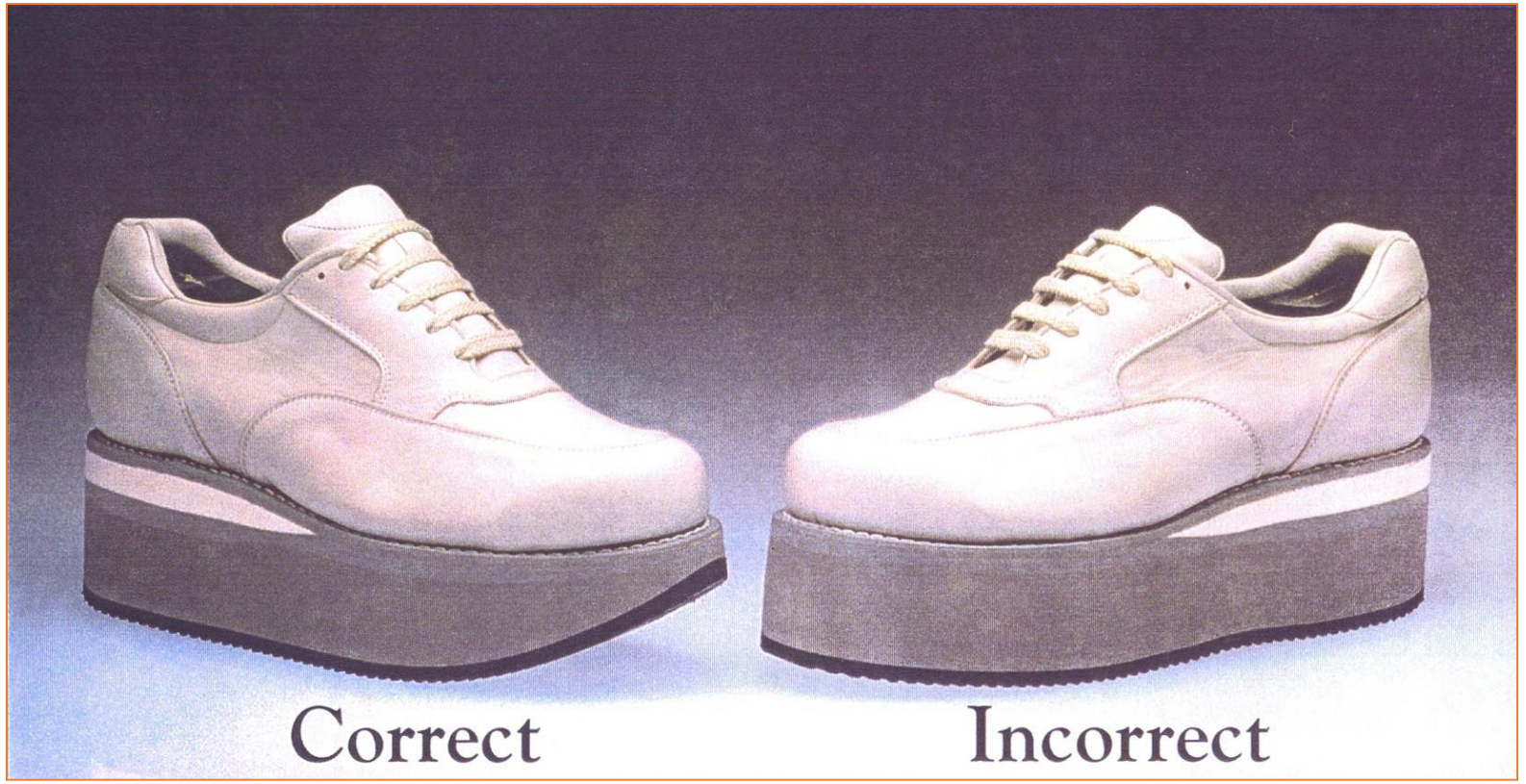
Shoe Modifications

- Heel Extension



Shoe Modifications

- Full Sole Extension



Medial Tibial Stress Syndrome

Shin Splints

- Medial Tibial Stress Syndrome (MTSS)
- Periostitis - inflammation of the membrane that envelops the tibia
- Two pathophysiological theories:
  - Inflammation of the periosteum because of excessive traction of the tibialis posterior or soleus, supported by bone scintigraphy findings of a broad linear band of increased uptake along the medial tibial periosteum.
  - Bony overload injury, with resultant microdamage and targeted remodeling.
- Tibial stress fractures can be difficult to distinguish from MTSS and are likely part of the same continuum of tibial bone stress injury.

Shin Splints

- Clinical Presentation
  - History*
    - Increasing pain during exercise related to the medial tibial border in the middle and lower third
    - Pain persists for hours or days after cessation of activity
    - Pain decreases with running (early stage)
    - Differentiate from exertional compartment syndrome, for which pain increases with running
    - Earlier onset of pain with more frequent training (later stages)
  - Physical Exam*
    - Intensive tenderness of the involved medial tibial border, more than 5 cm
    - Pes planus
    - Tight Achilles tendon
    - A "one-leg hop test" is a functional test, that can be used to distinguish between medial tibial stress syndrome and a stress fracture: a patient with medial tibial stress syndrome can hop at least 10 times on the affected leg where a patient with a stress fracture cannot hop without severe pain.
    - Provocative test: pain on resisted plantar flexion

* Adapted from physio-pedia.com

Shin Splints

- Bonanno DR, Murley GS, Munteanu SE, Landorf KB, Menz HB. Effectiveness of foot orthoses for the prevention of lower limb overuse injuries in naval recruits: a randomised controlled trial. Br J Sports Med. 2018 Mar;52(5):298-302. doi: 10.1136/bjsports-2017-098273. Epub 2017 Oct 22. PMID: 29056595.
  - **Methods:** This study was a participant-blinded and assessor-blinded, parallel-group randomised controlled trial. Three-hundred and six participants aged 17-50 years who undertook 11 weeks of initial defence training at the Royal Australian Navy Recruit School (Cerberus, Australia) were randomised to a control group (flat insoles, n=153) or an intervention group (contoured, prefabricated foot orthoses, n=153). The combined incidence of medial tibial stress syndrome, patellofemoral pain, Achilles tendinopathy and plantar fasciitis/plantar heel pain during the 11-week training period were compared using incidence rate ratios (IRR). Data were analysed using the intention-to-treat principle.
  - **Conclusion:** Prefabricated foot orthoses may be beneficial for reducing the incidence of lower limb injury in naval recruits undertaking defence training.

Pedorthic Management

- Pedorthic intervention should focus on primarily two things:
  - Shock attenuation on heel strike
  - Prevention of overpronation

- Footwear:
  - Make sure patient is using activity appropriate footwear and foot type appropriate footwear.
  - For example, MTSS can be brought on or exacerbated by jogging for exercise in flat-bottomed court shoes.

- Foot orthoses:
  - Consider semirigid total contact style FO with viscoelastic polymer under heel.
  - Rigid foot orthoses not recommended.

Base of 5th Metatarsal Fracture

Jones Fracture

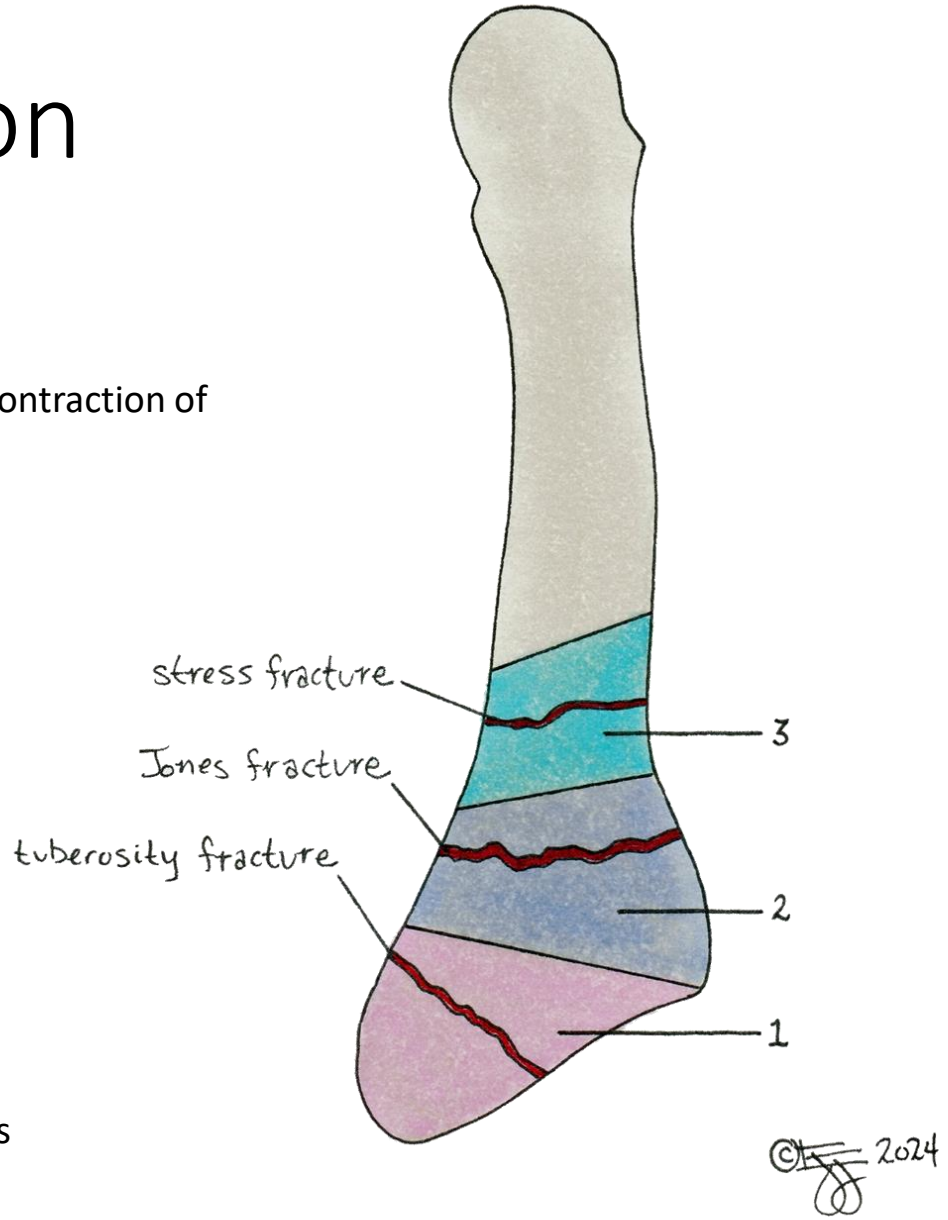
- 5th metatarsal base fractures are among the most common fractures of the foot and are predisposed to poor healing due to the limited blood supply to the specific areas of the 5th metatarsal base.
- Diagnosis is made with plain radiographs of the foot.
- Treatment can include protected weight bearing, immobilization or surgery depending on location of fracture, degree of displacement, and athletic level of patient.

Jones Fracture

- Incidence
  - Frequent injury encountered in primary care setting
  - Base of 5th metatarsal fractures account for 25% of all metatarsal fractures
  - 90% are zone 1 fractures
- Demographics
  - Athletes, military recruits, and manual laborers

Base of 5th MT Fracture
Torg Anatomic Classification

- Zone 1
  - "PseudoJones" fracture
  - Proximal tubercle avulsion
  - Due to long plantar ligament, lateral band of the plantar fascia, or contraction of the peroneus brevis
  - May extend into cubometatarsal joint
  - Nonunion uncommon
- Zone 2
  - True Jones fracture
  - Metaphyseal-diaphyseal junction
  - Involves the 4th-5th metatarsal articulation
  - Vascular watershed area
  - Acute injury
  - Increased risk of nonunion (15-30%)
- Zone 3
  - Proximal diaphyseal fracture
  - Distal to the 4th-5th metatarsal articulation
  - Stress fracture in athletes
  - Associated with cavovarus foot deformities or sensory neuropathies
  - Increased risk of nonunion

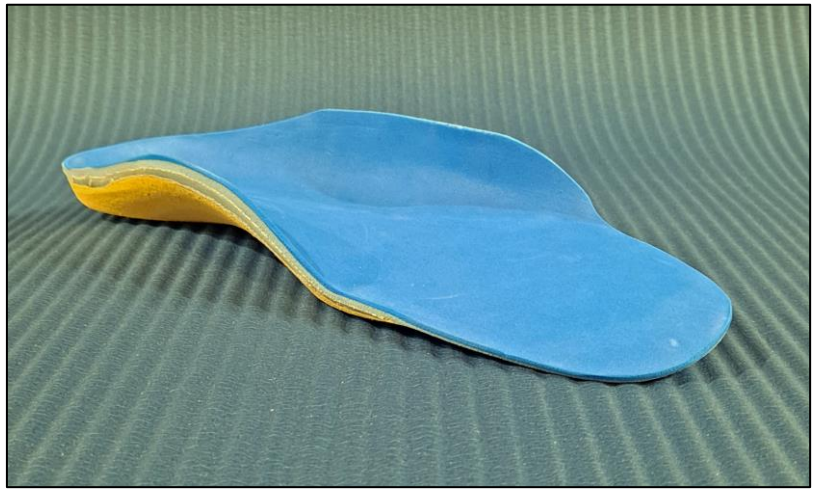


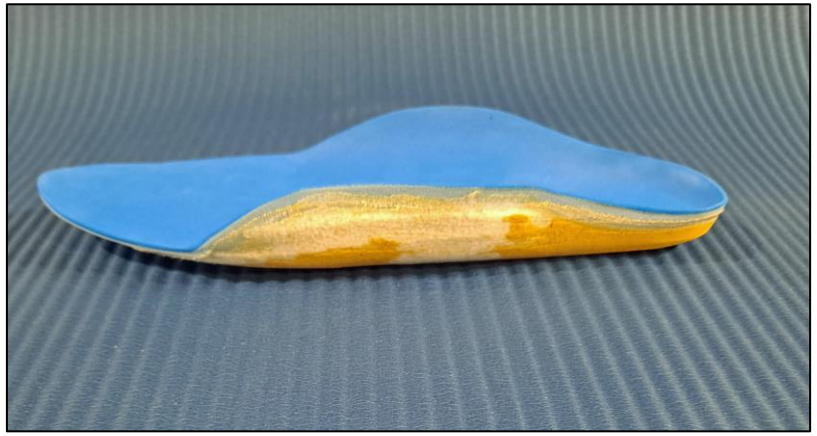
Base of 5th MT Fracture
Torg Radiographic Classification

- Type I
  - Acute
  - Narrow fracture line without intramedullary sclerosis
- Type II
  - Delayed union
  - Widened fracture line with intramedullary sclerosis
- Type III
  - Nonunion
  - Widened intramedullary canal with no callus

Pedorthic Management

- Generally speaking, pedorthic intervention is not used for acute fracture.
- Rather it is used once fracture is either well on its way to being healed, or completely healed. Primary treatment is immobilization or surgery.
- Foot orthosis to protect and splint fracture site is used to prevent further insult to the fracture site and allow patient to return to work/athletics.
- Stiff soled shoe recommended. +/- Double rocker sole.

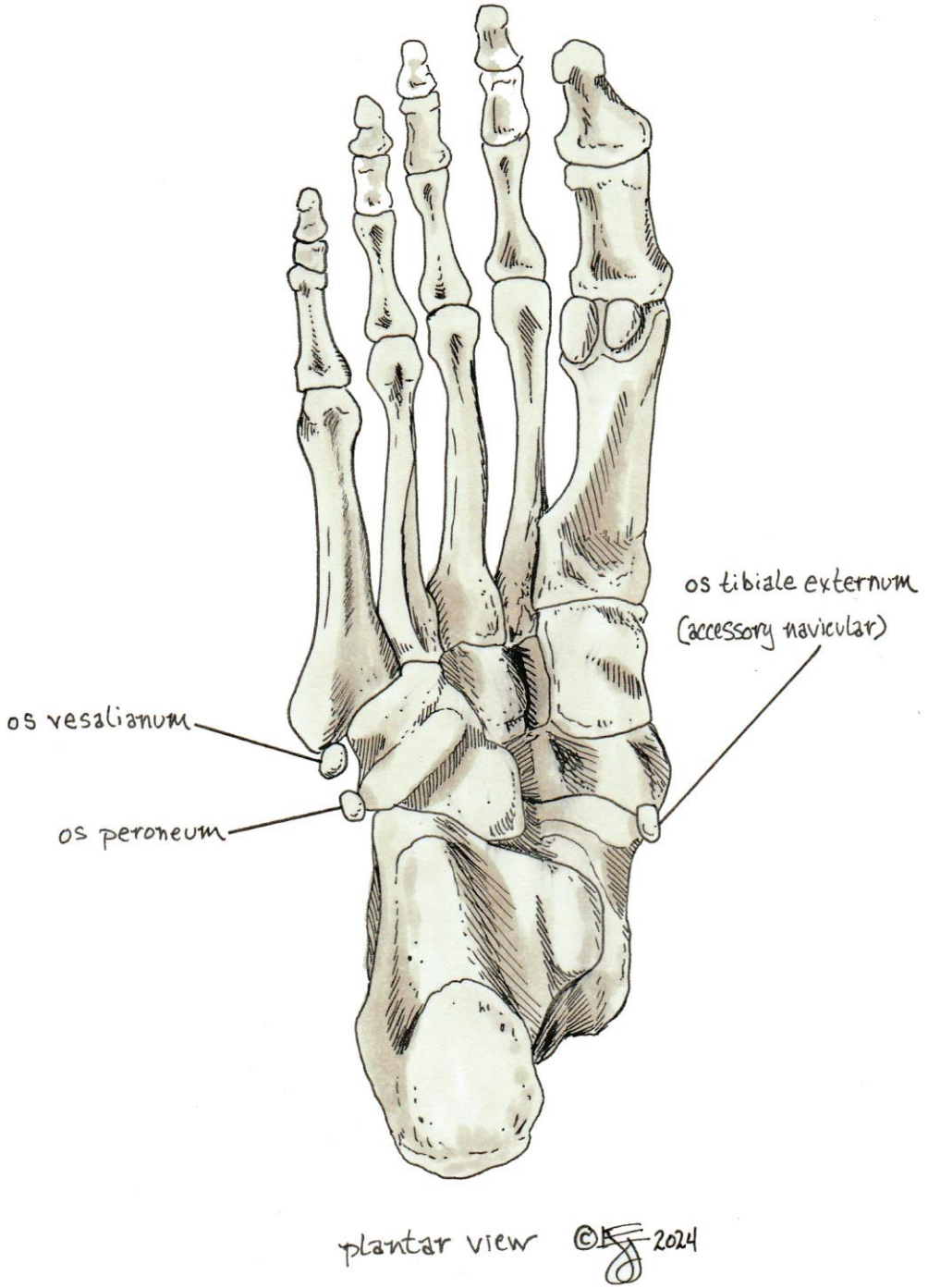




Accessory Bones

- Most common
  - Os tibiale externum (Accessory navicular)
    - Prox to navicalar on medial side of foot
    - 10-21% of population
  - Os peroneum
    - Lateral aspect of cuboid
    - 9-20% of population
  - Os vesalianum
    - Between 5th MT and cuboid
    - 1-2% of population
  - Os trigonum
    - Just posterior to talus
    - 10-25% of population

  - Most are asymptomatic



https://www.orthobullets.com/foot-and-ankle/7049/lower-extremit

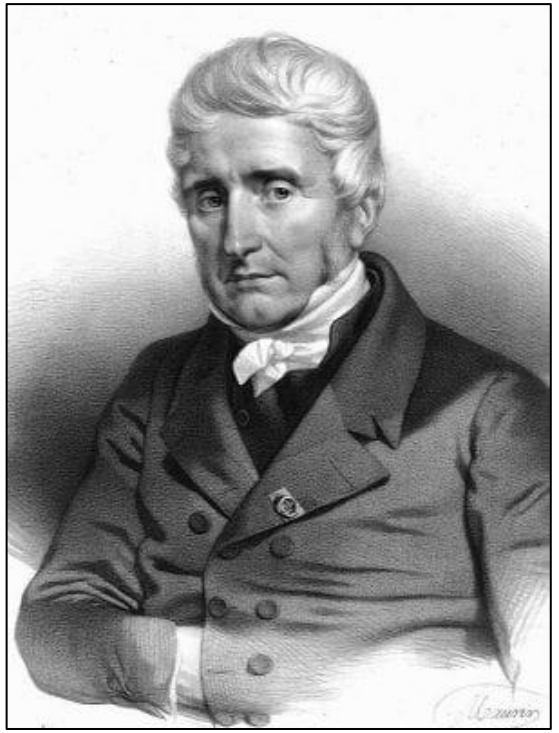
Painful Accessory Navicular

- Most are asymptomatic
- Can become irritated if they are prominent and patient has a flatfoot deformity
- May also become symptomatic in relation to an insult to the posterior tibial tendon as it may be embedded in the tendon
- Pedorthic management includes:
  - Properly fitted shoes with quarters/collars that pass either above or below the affected area, +/- padded collars
  - Total contact foot orthosis
    - Control overpronation to reduce tension on PTT
    - Provide cushion and offloading

Lisfranc Injuries

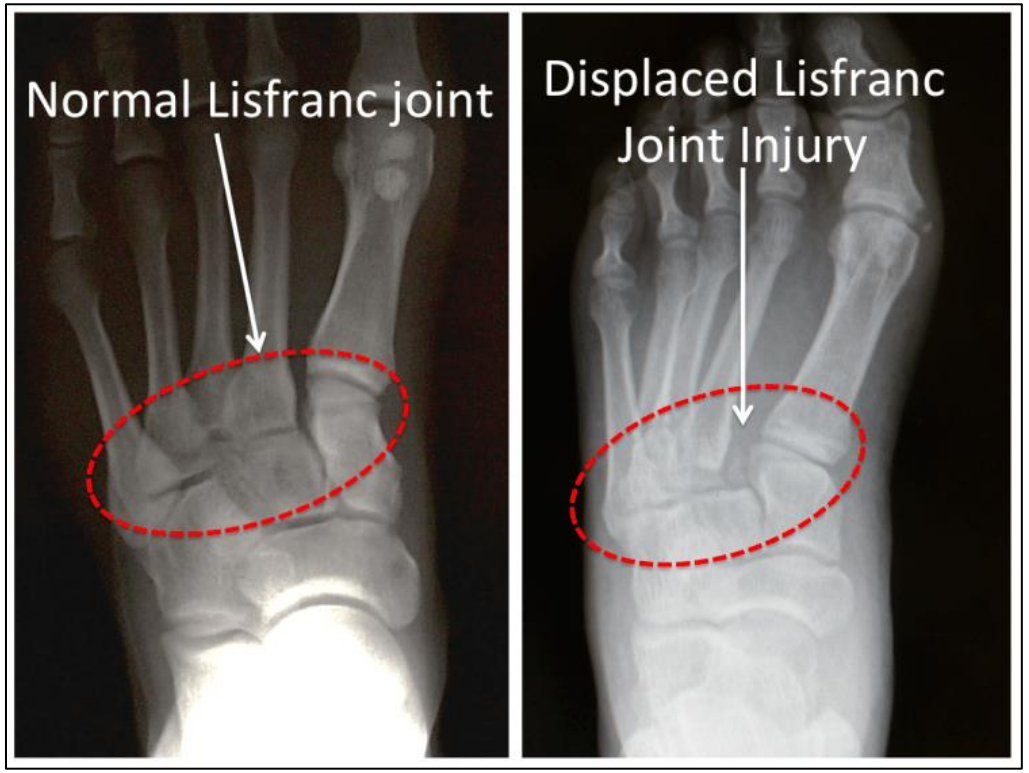
Lisfranc Injury

- Midfoot fracture dislocations are named after French surgeon Jacques Lisfranc de St. Martin, who served in the Napoleonic army in the 1800s and observed midfoot injuries in cavalry soldiers. He also described a disarticulation amputation through this joint.
- The term *Lisfranc injury* describes a broad spectrum of foot injuries involving the tarsometatarsal joint complex.
- Injuries to this area include sprain, subluxation, joint widening with or without a fracture, dislocation, and crush injury.
- Varies in severity; typically, a result of trauma, such as from sports activities, falls, and motor vehicular crashes.
- Lisfranc joint injuries are uncommon and often misdiagnosed and mismanaged. Up to 20% of the cases are missed initially.



Lisfranc Injury

- A simple Lisfranc injury can be easily mistaken for a sprain, especially if the injury is a result of a straightforward twist and fall.
- However, injury to the Lisfranc joint is not a simple sprain that should be "walked off" or expected to heal quickly.
- Even a simple Lisfranc injury is a severe injury that may take many months to heal and may require surgery to treat.



Lisfranc Injury

- Mechanism of injury:
  - A low-energy Lisfranc injury can happen with a simple twist and fall. It is commonly seen in football and soccer players when one player lands on the back of another player's foot while the foot is flexed downward in the push-off position. Plantarflexion weakens the dorsal foot ligaments, making the metatarsal bases and plantar capsule vulnerable to rotational injuries.
  - More severe injuries occur from direct trauma, such as a fall from a height or a motor vehicle collision. In these high-energy Lisfranc injuries, the immense impact produces a crush injury at high risk for acute complications such as multiple fractures, an open fracture, joint dislocation/subluxation, compartment syndrome, wound dehiscence, and vascular disruptions.

Lisfranc Injury - Staging

Myerson

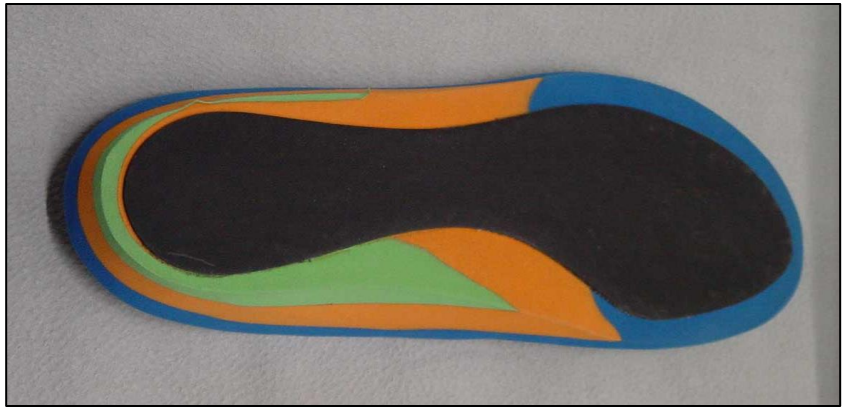
- Type A:
  - Total lateral or dorsoplantar incongruity, with all 5 metatarsal bases displaced in the same direction
- Type B: isolated incongruity
  - B1: medial M1 displacement
  - B2: lateral or at least 1 of the lateral 4 metatarsals is displaced
- Type C
  - C1: partial divergent
  - C2: total divergent
- Type D
  - D1: distance between C1 and M2 is 2 mm or less (does not require operative fixation)
  - D2: distance between C1 and M2 is greater than 2 mm (requires surgery)
    - D2L: purely ligamentous
    - D2B: with bone avulsion

Lisfranc Injury

- Management ranges from immobilization to surgical intervention depending on the nature and severity of the injury.
- Most candidates for nonoperative Lisfranc injury treatment recover in 2 to 4 months, though some patients can take up to 6 months.
- Up to 60% of patients experience posttraumatic osteoarthritis.
- It has the potential to be a permanently disabling injury
- Inadequately managed Lisfranc injuries can lead to chronic pain, instability, arthritis, or long-term foot dysfunction.
- Each Lisfranc injury case is unique, requiring an individualized treatment plan based on injury severity, patient characteristics, and functional goals.

Pedorthic Management

- For a mild, low-energy Lisfranc injury, pedorthic management would include:
  - Reinforced semi-rigid total contact insert
  - Rocker sole with extended steel shank (or carbon fiber footplate in shoe under FO)
- Goal of treatment is to stabilize, splint and protect the injury site.



Ehlers-Danlos Syndrome

- Ehlers-Danlos syndrome (EDS) is a group of hereditary connective tissue disorders that manifests clinically with skin hyperelasticity, hypermobility of joints, atrophic scarring, and fragility of blood vessels. It is a genetic disorder affecting collagen formation and function. It affects virtually every organ system, which can result in significant morbidity and mortality. Complications of this disease include arterial rupture, organ rupture, *joint dislocation*, chronic pain, and fatigue, among many others.

Ehlers-Danlos Syndrome

- With hypermobile joints comes the increased risk of joint subluxation and dislocation. Prevention is the most crucial aspect of medical management as each injury increases the likelihood of recurrence and complications such as osteoarthritis. Prevention revolves around robust patient counseling regarding limiting at-risk activities like contact sports or weightlifting.
- Usually, the goal of pedorthic intervention is joint stabilization and support.
  - Reinforced semirigid TCO
  - UCBL
  - SCFO (Arizona-type AFO)

The End