# Crozer-Keystone Residency Manual

## Second Edition

## Original Author

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## Second Edition

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# Introduction

Dear Student:

In the pages that follow is useful information that will help make your externships, interviews and transition from student to resident a little bit easier. This information contained within is not the end all on the subject, but the tidbits that need to be on your "Mind's Fingertips".

This booklet is a useful guide on the need-to-know, need-to-keep information. Please use it as it was intended--a guide on the ever-changing world of medical information. My thanks go out to the Podiatric Surgical Residents at Crozer-Keystone Health System for the formation of this manual.

Sincerely,

William M. Urbas, DPM
Crozer-Keystone Residency Director

# Author's Introduction

This manual is NOT meant to replace "McGlamry's", the "Presbyterian Manual", the "Podiatry Institute Manual" or any other reference source. Those manuals are excellent resources and should be used to continue to learn the information. To this day, I still use those texts for information and reference.

This manual is based on questions I came across as an extern or a resident, either from my own questions or questions from a superior. I would write these questions down and after I looked up the answers, I would keep the questions with their answers in a log.

Later, as a resident, I was quizzing a student in order to get her ready for her interviews. The student asked me, "Why can't there be a book of these questions?" After that I started to put together the manual. I also added some additional items to complete the manual.

In no way, shape or form do I claim that the answers written here are the only answers possible, nor do I even claim that they are all 100% correct. These answers are the ones that I came up with when I researched the questions. It is up to you to go to the true references--not only to make sure that the answers are correct, but also to make sure that you understand why.

Therefore, the purpose of this manual is so that the reader can have some questions and answers so that he or she can go to the sources and really learn podiatry.

I am not able to provide all of my sources because when I started writing down the answers, I had no idea of turning it into a manual. However, my major sources are, "The Comprehensive Textbook of Foot Surgery", "The Presbyterian Manual" and "The Podiatry Institute Manual". A special thank you to my attendings and co-residents at the Crozer-Keystone Health Systems in Springfield, PA, especially Dr. Urbas our residency director, mentor and friend.

Good Luck and Happy Studying,

Brett Chicko, DPM

# Anatomy

**How many bones are in the foot?**
26 (not including sesamoids)

**How many joints are in the foot?**
35

**Name the accessory ossicles**

| | |
|---|---|
| Os Intermetatarsium | Between 1st cuneiform and 1st and 2nd metatarsal bases |
| Os Vesalianum | Proximal 5th metatarsal base |
| Os Tibiale Externum | Accessory navicular |
| Os Supranaviculare | Dorsal aspect of navicular |
| Os Peroneum | Sesamoid bone in PB tendon |
| Os Calcaneus Secondarius | Dorsal, anterior process of calc |
| Os Sustentaculi | Posterior aspect of sustentaculum tali |
| Os Trigonum | Posterior aspect of talus (Steida process) |
| Os Subtibiale | Distal to medial malleolus |
| Os Subfibulare | Distal to lateral malleolus |

**Name the avascular necroses**

| | |
|---|---|
| Renandier | Tibial sesamoid |
| Trevor | Fibular sesamoid |
| Theiman | Phalanges |
| Freiberg | Metatarsal heads |
| Iselen | 5th metatarsal base |
| Buschke | Cuneiforms |
| Kohler | Navicular |
| Lance | Cuboid |
| Diaz | Talus |
| Severe | Calcaneus |
| Blount | Proximal, medial tibial epiphysis |
| Osgood-Schlatter | Tibial tuberosity |
| Legg-Calve-Perthes | Femoral epiphysis |

**What attaches periosteum to bone?**
Sharpey fibers

**What are the different types of coalitions?**
Syndesmosis – fibrous
Synchondrosis – cartilaginous
Synostosis – osseous

**What is the difference between a coalition and a bar?**
Coalition – intra-articular fusion of two bones
Bar – extra-articular fusion

**What is the most common coalition in the foot?**
Distal and middle phalanx of 5th digit

**What is the most common coalition in the rearfoot?**
Talocalcaneal

**What is a Steida process?**
Enlarged Os Trigonum

**What is the only bone in the foot without any muscle origin or tendon insertion?**
Talus

**What are the plantar muscle layers of the foot from superficial to deep?**
1. Abductor hallucis, flexor digitorum brevis, abductor digiti minimi
2. Quadratus plantae, 4 lumbricals
3. Flexor hallucis brevis, adductor hallucis, flexor digiti minimi
4. 3 plantar interossei, 4 dorsal interossei

**What layer of the foot does FDL run?**
2nd layer – it is the origin of the lumbricals and the insertion of QP

**What deformity will result from cutting QP?**
Digits 4 and 5 will become adductovarus

**How is EDL attached to the proximal phalanxes?**
Sling wraps around capsule which attaches to plantar plate, DTML, and flexor tendon sheath thus attaching to plantar proximal phalanx. No direct insertion to proximal phalanx.

**What is the origin and insertion of the capsularis tendon?**
Origin – extensor hallucis longus muscle or tendon
Insertion – first metatarsophalangeal joint capsule

**What is the Master Knot of Henry?**
Fibrous connection between FHL and FDL tendons

**What structures attach to the fibular sesamoid?**
Plantar metatarsal-phalangeal ligament
Lateral metatarsal-sesamoidal ligament
Intersesamoidal ligament
Phalangeal-sesamoidal ligament
FHB tendon
ADH tendon

**Are the sesamoids capsular or extra-capsular?**
Capsular

**What is the Lisfranc ligament?**
Attaches lateral aspect of medial cuneiform to medial base of 2nd metatarsal

**What structures in the Lisfranc joint are not connected by ligaments?**
1st and 2nd metatarsals

**What is the spring ligament?**
Plantar calcaneonavicular ligament

**What ligaments compose the bifurcate ligament?**
Dorsal calcaneonavicular and calcaneocuboid ligaments

**Which is stronger – the lateral ankle ligaments or the deltoid ligament?**
Deltoid ligament

**What are the components of the deltoid ligament?**
Superficial – tibionavicular, tibiocalcaneal, posterior tibiotalar
Deep – anterior tibiotalar

**What tendons pass over the deltoid ligament?**
Tibialis posterior and FDL

**What are the lateral ankle ligaments?**
Anterior talofibular, calcaneofibular, posterior talofibular

**What angle do the ATFL and CFL create?**
105°

**What is the strongest lateral ankle ligament?**
Posterior talofibular

**Which ankle ligaments are extra-capsular? Which are capsular?**
Calcaneofibular ligament is extra-capsular, all others are capsular

**What tendons pass over the lateral ankle ligaments?**
Peroneus brevis and longus

**What ligaments support the ankle syndesmosis?**
Anterior-inferior tibiofibular ligament
Posterior-inferior tibiofibular ligament
Interosseous tibiofibular ligament

**What is the Bassett ligament?**
Anterior-inferior tibiofibular ligament

**What is another name for the flexor retinaculum?**
Laciniate ligament

**What is another name for the superior extensor retinaculum?**
Transverse crural ligament

**What is another name for the inferior extensor retinaculum?**
Cruciate crural ligament

**Where does plantaris insert?**
Medial aspect of tendo-Achilles into the calcaneus

**What is the incidence of peroneus quartus?**
7%

**What is the Hoke tonsil?**
Fibrous, fatty plug within the sinus tarsi

**What is pes anserinus?**
Insertion of sartorius, gracilis, and semitendinosus (anteromedial aspect of proximal tibia) where bursa may cause knee pain (pes anserinus bursitis)

**What is a Bakers cyst?**
Swelling of the bursa between the tendons of the medial head of the gastrocnemius and the semimembranosus muscles

**What is a fabella?**
Sesamoid bone occasionally found in tendon of lateral head of gastrocnemius

**What nerves form the sural nerve?**
Medial sural cutaneous nerve – branch of the tibial nerve
Sural communicating branch – branch of the lateral sural cutaneous nerve, which originates from the common peroneal nerve

**Does a neuroma lie dorsal or plantar to the deep transverse intermetatarsal ligament?**
Plantar

**Where do these muscles run in relation to the deep transverse intermetatarsal ligament?**
Interossei – dorsal
Lumbricals – plantar

**What layers of the foot do the plantar nerves run?**
Medial plantar nerve – in the 1st layer (between FDB and abductor hallucis)
Lateral plantar nerve – between the 1st and 2nd

**What is the innervation to the plantar muscles of the foot? Blood supply?**
(Never LAFF at A FAD)
N – medial plantar Nerve
L – 1st Lumbrical
A – ABH
F – FHB
F – FDB (innervated by both medial and lateral plantar nerves)
A – medial plantar Artery
F – FDB
A – ABH
D – 1st Dorsal interossei

**What are the branches of the femoral nerve?**
Nerve to femoral artery
Small muscular branch to pectineus
Anterior division (cutaneous)

- Anterior femoral cutaneous
- Nerve to sartorious
- Intermediate femoral cutaneous nerve
- Medial femoral cutaneous nerve

Posterior division (muscular)

- Saphenous nerve
- Infrapatellar branch
- Medial crural cutaneous nerve
- Nerve to rectus femorus
- Nerve to vastus medialus
- Nerve to vastus intermedialus
- Nerve to vastus lateralus

**What are the branches of the femoral artery?**
Superficial epigastric artery
Superficial circumflex iliac artery
Superficial external pudendal artery
Deep femoral (profunda femoris) artery
Medial femoral circumflex artery
Lateral femoral circumflex artery
Descending genicular artery
Femoral artery continues as the popliteal artery

**Trace the path of a drop of blood from left ventricle to the hallux**
Ascending aorta → aortic arch → descending aorta → thoracic aorta → abdominal aorta → common iliac artery → external iliac artery → femoral artery → deep femoral artery → popliteal artery → anterior tibial artery → dorsalis pedis → 1st dorsal metatarsal artery → 1st dorsal common digital artery → 1st dorsal proper digital artery

**What are the sources of blood supply to the talus?**
Essentially the 3 major blood supplies to the foot

- Superior surface of head and neck – artery of sinus tarsi and branch from anterior tibial artery or dorsalis pedis
- Medial side of body – artery of tarsal canal and posterior tibial artery
- Lateral turbercle – anastamosis of branch of peroneal artery with medial calcaneal branch

**What are the sources of blood supply to tendons?**
Myotendinous junction, paratenon, and at the insertion to bone

# Antibiotics

**What should you always consider before starting an antibiotic?**

- What is the most likely infecting organism?
- Have a gram stain and C&S been done? What are the results?
- Allergies?
- Kidney function (check BUN and Cr)? Many antibiotics are renally metabolized so it is imperative to make sure the kidneys are functioning properly.
- What medications is the patient currently taking? Be concerned of possible drug interactions.
- Any other reason you may or may not want to give the antibiotic?

## Name That Drug

| | |
|---|---|
| **Augmentin** | amoxacillin/clavulonic acid |
| **Zosyn** | piperacillin/tazobactam |
| **Unasyn** | ampicillin/sulbactam |
| **Timentin** | ticarcillin/clavulonic acid |
| **Zyvox** | linezolid |
| **Invanz** | ertapenem |
| **Cubicin** | daptomycin |
| **Tygacil** | tigecycline |
| **Bactrim** | trimethoprim/sulfamethoxazole (TMP/SMX) |
| **Rocephin** | ceftriaxone |
| **Avelox** | moxifloxacin |
| **Zithromax** | azithromycin |
| **Primaxim** | imipenem/cilastatin |
| **Synercid** | dalfopristin-quinupristin |
| **Cleocin** | clindamycin |
| **Flagyl** | metronidazole |

## Augmentin

**What is the dose?**
500 or 875 mg PO BID

**How much clavulonic acid is in Augmentin 500 mg? Augmentin 875 mg?**
Both have 125 mg

**What is the indication?**
PO antibiotic for outpatient therapy of polymicrobial infections

**What is the spectrum of activity?**
Staph (not MRSA), Strep, Enterococci, Gram negatives, anaerobes

**Does it cover Pseudomonas?**
No

## Zosyn

**What is the dose?**
3.375 g IV q6h
Renal dose – 2.25 g IV q6h
Alternate dose – 4.5 g IV q6h

**What is the indication?**
Approved for use in adults for the treatment of moderate to severe diabetic foot infections

**What is the spectrum of coverage?**
Staph (not MRSA), Strep, Enterococci, Gram negatives, anaerobes

**Does it cover Pseudomonas?**
Yes

## Unasyn

**What is the dose?**
3.0 IV q6h
Renal dose – 1.5 g IV q6h

**What is the indication?**
Empiric therapy for polymicrobial diabetic foot infections

**What is the spectrum of activity?**
Staph (not MRSA), Strep, Enterococci, Gram negatives, anaerobes

**Does it cover Pseudomonas?**
No

**What is an alternative for a patient with a PCN allergy?**
Clinda/Cipro
Levaquin
(there are others)

## Timentin

**What is the dose?**
3.1 g IV q4-6h

**What is the indication?**
Broad spectrum antibiotic for polymicrobial infections

**What is the spectrum of activity?**
Staph (not MRSA), Strep, Gram negatives, anaerobes

**Does it cover Pseudomonas?**
Yes

**What should you watch for?**
Increased $Na^+$ load (5.2 meq/gram)

## Penicillins

**Which cover Pseudomonas?**
(4th and 5th generations)
piperacillin, Zosyn
ticarcillin, Timentin
carbenicillin, mezlocillin, azlocillin

**What are IV alternatives for PCN allergic patients?**
clindamycin, vancomycin, Levaquin, Bactrim

**How are PNC's excreted?**
All are renally excreted except mezlocillin, azlocillin, piperacillin (the ureidopenicillins are 20-30% renal)

**What concern is there of a patient on both PCN and probenecid?**
Probenecid will increase duration of serum levels of PCN and most cephalosporins

## Cephalosporins

**What is the cross-reactivity of cephalosporins and PCN?**
1-10% (depending on whom you talk to)

**Are cephalosporins contraindicated for a patient with a PCN allergy?**
Many people will say yes, and according to Dr. Warren Joseph, "Cephalosporins should be avoided entirely in patients with a history of anaphylaxis to penicillin." However, he states that if there is a questionable allergy history (rash or upset stomach), "Cephalosporins can be used with little worry." Personally, I will give a cephalosporin to a patient with a PCN allergy if all he or she had was an upset stomach and I document this.

**How to treat serious hospital acquired Gram negative infections?**
3rd generation cephalosporins, aminoglycoside (i.e. Rocephin, gentamycin)

**What is the coverage of cephalosporins for each class?**
1st Generation
- Gram positive – Staph (not MRSA) and Strep
- Gram negative – Proteus, E. coli, Klebsiella, Salmonella, Shigella (PECKSS)
- Anaerobes – not Bacteroides

2nd Generation
- Gram positive – similar to 1st gen
- Gram negative – more coverage, H. influenza, Neisseria, Proteus, E. coli, Klebsiella, Salmonella, Shigella (HEN PECKSS)

3rd Generation
- Gram positive – less than 1st and 2nd gen
- Gram negative – expanded coverage, ceftazadime covers Pseudomonas

4th Generation
- Gram positive – similar to 1st gen
- Gram negative – similar to 3rd gen, including Pseudomonas
- No anaerobic coverage

**Name a couple cephalosporins for each generation**
1st Generation – cefazolin (Ancef), cephalexin (Keflex)
2nd Generation – cefaclor (Ceclor), cefuroxime (Ceftin)
3rd Generation – ceftriaxone (Rocephin), ceftazidime (Fortaz), cefdinir (Omnicef)
4th Generation – cefepime (Maxipime)

**How are they excreted?**
Renally except for ceftriaxone (renal/hepatic) and cefoperazone (hepatic)

## Vancomycin

**What is the main indication?**
MRSA

**What is its spectrum of activity?**
All Gram positives, including MRSA and MRSE

**What is the dose?**
1 g IV q12h with slow infusion

**When are levels drawn?**
Peak taken 30 min after the 3rd dose
Trough taken 30 min before the 4th dose

**What should the peaks and troughs be?**
Peak 15-30 mg/mL
Trough <10 mg/mL

**How do you adjust the dose?**
If the peak is too high, decrease the dose
If the peak is too low, increase the dose
If the trough is too high, increase the interval between doses
If the trough is too low, decrease the interval between doses

**What happens when you infuse too quickly?**
Red Man syndrome – erythema and pruritis to the head, neck, and upper torso. It is caused by an anaphylactoid reaction where histamine is released by mast cells. (A different Red Man syndrome is associated with excessive Rifampin that causes a bright reddish-orange pigmentation of the skin.)

**How can you decrease the risks of Red Man syndrome?**
Slow infusion over one hour

**How do you treat Red Man syndrome?**
Antihistamines (Benadryl 25-50 mg IV q2-4h) until symptoms resolve
Symptoms are self-limiting

**What are other side effects?**
Ototoxicity and nephrotoxicity

**Does the duration a patient has been on vancomycin increase the risks of side effects?**
Yes. Vancomycin has a reservoir effect: the more often a patient receives vancomycin, the higher the chance of getting either ototoxicity or nephrotoxicity. Therefore, use vancomycin carefully; it is a powerful drug with severe side effects.

**When should PO vancomycin be used?**
Treatment of Pseudomembranous colitis (125 mg PO q6h)

## Bactrim

**What is the dose?**
One tab PO BID

**How much is in the single strength tablet? Double strength?**
Single strength – TMP 80 mg / SMX 400 mg
Double strength (DS) – TMP 160 mg / SMX 800 mg

**How does it work?**
Trimethoprim and sulfamethoxazole inhibit folate synthesis in bacteria which prevents DNA replication

**What is the spectrum of activity?**
Broad spectrum covering Gram positives (MRSA) and Gram negatives

**Does it cover Pseudomonas?**
No

**What allergy should be avoided?**
Sulfa

**What are the side effects?**
Hemolytic anemia, hypersensitivity

**What are the contraindications?**
Patient on oral hypoglycemic or with G6PD deficiencies

## Zithromax

**What is the dose?**
250 mg PO, two tabs on the first day then one tab for the next four days

**What is the spectrum of activity?**
Staph, Strep, and some anaerobes (but not bacteroides)

**Can you give it to a patient with a PCN allergy?**
Yes

**What is the half-life?**
68 hours

## Primaxin

**What is the dose?**
500 mg IV q6-8h (most common) or 1 gm IV q6-8h

**What is the spectrum of activity?**
Very broad spectrum including most Gram positive, Gram negative, and most anaerobes

**Does it cover MRSA? Pseudomonas?**
No and no

**What is a side effect?**
Seizure in patients with history of seizures
1% risk with 500 mg dose, 10% risk with 1 g dose

**How does it work?**
imipenem – antibiotic
cilastatin – renal dehydropeptidase inhibitor, which prevents imipenem from being metabolized by the kidneys

**Which antibiotic is nicknamed "Gorillamycin"?**
imipenem (because of its very broad of spectrum activity)

## Invanz

**What is the dose?**
1 g IV q24h

**What is the indication?**
Approved for use in adults for the treatment of moderate to severe diabetic foot infections

**What is the spectrum of activity?**
Gram positive, Gram negative, and anaerobes

**Does it cover Pseudomonas?**
No

**What class is Invanz?**
It is a structurally unique 1-β-methyl-carbapenem related to β-lactams

## Zyvox

**What is the dose?**
400-600 mg PO/IV q12h

**What is an indication?**
Oral Zyvox may be used for outpatient treatment of MRSA infections

**What is the spectrum of activity?**
All Gram positives, including MRSA and VRE

**What is a major side effect?**
Thrombocytopenia (check CBC)

**Why isn't it used more often?**
It is expensive

## Quinolones

**What are some common quinolones?**
ciprofloxacin (Cipro), levofloxacin (Levaquin), moxifloxacin (Avelox)

**What is the dose of Cipro?**
250-750 mg PO q12h
200-400 mg IV q12h

**What is the dose of Levaquin?**
250-500 mg PO/IV q24h

**What is the dose of Avelox?**
400 mg PO/IV q24h

**What is the spectrum of activity?**
Gram negative, including Pseudomonas
Cipro – limited Gram positive
Levaquin and Avelox – better Gram positive

**What are side effects?**
Tendonitis and tendon ruptures

**Who should not be given quinolones?**
It is contraindicated in children with open growth plates. Risk of cartilage degeneration.

## Aztreonam

**What is the dose?**
1-2 g IV q8h

**What is the spectrum of activity?**
Gram negative aerobes and pseudomonas (its main indication)

**What are the major side effects?**
None

**Why isn't it used more often?**
It is expensive

## Aminoglycosides

**What are some major aminoglycosides?**
Gentamycin, Tobramycin, Amikacin

**What is the spectrum of activity?**
Gram negative aerobes

**What are the side effects?**
Ototoxicity – irreversible
Nephrotoxicity – reversible
Neuromuscular blockade – prevented by slow infusion

**What are the doses, peaks, and troughs?**

| | Dose | Peak (µg/mL) | Trough (µg/mL) |
|---|---|---|---|
| Gent and Tobramycin | 3-5 mg/kg q8h | 6-10 | 2 |
| Amikacin | 15 mg/kg q8h | 20-30 | <10 |

**How to dose gentamycin?**

1. Loading dose is 2 mg/kg for Gent and Tobra (7.5 mg/kg for Amikacin)
2. Determine creatinine clearance (CC)

$$CC = \frac{(140 - \text{Age}) \times \text{Weight (in kg)}}{72 \times \text{Serum Creatinine}}$$

   For females, multiply the CC by 0.85
3. Maintenance dose is adjusted for CC (e.g. If the CC is 0.75, then the patient has 75% kidney function. Give 75% of a normal dose.)

## Clindamycin

**What is the dose?**
600-900 mg IV q8h or 150-300 mg PO BID

**What is the spectrum of activity?**
Most Gram positive and most anaerobes

**What is a side effect?**
Pseudomembranous colitis

**How is clindamycin metabolized?**
Liver

## Flagyl

**What is the dose?**
500 mg PO TID

**What is the spectrum of activity?**
Some Gram positive anaerobes and most Gram negative anaerobes

## MRSA

**What antibiotics cover MRSA?**
PO – linezolid, Minocycline, Cipro/rifampin, Bactrim/rifampin
IV – vancomycin, linezolid, minocycline, Cipro/rifampin, Bactrim/rifampin, Synercid, tigecyclin, telavancin
Topical – Bactroban

**What are the only FDA-approved drugs for treating MRSA?**
vancomycin
linezolid
daptomycin
tigecyclin
telavancin (Vibativ)

## VRE

**How do you treat VRE?**
linezolid or dalfopristin-quinupristin

**What is the only PO therapy for VRE?**
linezolid

# Pseudomonas

**What drugs cover Pseudomonas?**
Aztreonam
Aminoglycosides – gentamycin, tobramycin, amikacin
Cipro
Ceftazidime, cefepime
Timentin
Zosyn

# Polymicrobial Infections

**What are some empiric therapies for polymicrobial foot infections?**
Vanco/Zosyn, Clinda/Cipro, Vanco/Invanz

**What are the only FDA-approved drugs for treating diabetic foot infections?**
(The 3 Z's)
Zosyn
Zyvox
Invanz

# Antibiotic-Associated Diarrhea

**What are two main causes of antibiotic-associated diarrhea?**
Pseudomembranous colitis – Clostridium difficile
Non-specific colitis – Staph aureus

**How to you test for Clostridium difficile?**
Order "check stool for C diff"

**What is the most common cause of Clostridium difficile colitis?**
clindamycin (though any antibiotic can cause it)

**How do you treat Clostridium difficile colitis?**
Vanco 125 mg PO q6h
Flagyl 500 mg PO TID

# Miscellaneous

**What antibiotics are metabolized by the liver?**
(3 C's and 1 E)
Clindamycin
Cefoperazone
Chloramphenicol
Erythromycin

**Can antibiotics affect PT/INR?**
Yes. Antibiotics can affect normal flora, which alters Vitamin K. Therefore, the PT/INR can increase.

**What can β-lactams cause?**
Leukopenia

**What is the MOA of aminoglycosides? Macrolides?**
Aminoglycosides bind to bacterial 30s ribosomes inhibiting protein synthesis
Macrolides bind to bacterial 50s ribosomes inhibiting protein synthesis
(A boy at 30 does not become a Man until 50)

**What antibiotics can be safely used with PMMA beads?**
Vancomycin, gentamycin, tobramycin, cefazolin
The curing of PMMA is exothermic, therefore the antibiotic must be not be heat-labile

**What open fractures should be treated with antibiotics?**
Grades 2 and 3

# Bugs and Drugs

## Gram Positives

**What are Gram positive, catalase positive cocci in clusters?**
Staphylococcus aureus

**DOC for Staph?**
Keflex or Ancef

**Alternative for Staph?**
clindamycin, Levaquin, Vancomycin, Azithromycin, dicloxacillin, nafcillin

**Alternative for Staph if PCN allergy?**
clindamycin, Levaquin, Vancomycin, Azithromycin

**What if the organism is resistant to methicillin?**
MRSA (methacillin-resistant Staph aureus)

**DOC for MRSA?**
Vanco IV, Bactrim PO (if sensitive)

**Alternative for MRSA?**
Synercid or linezolid

**Topical DOC for MRSA?**
Bactroban

**DOC for Strep?**
Keflex or Ancef

**What are Gram positive, catalase negative cocci that are in pairs or chains?**
Streptococcus

**DOC for Strep?**
Keflex or Ancef

**Alternative for Strep?**
clindamycin, Levaquin, vancomycin

**Alternative for Strep in PCN allergy?**
clindamycin, Levaquin, vancomycin

**DOC for Enterococcus?**
amoxicillin or vancomycin

**Alternative for Enterococcus?**
Augmentin, linezolid

**What if the organism is resistant to vancomycin?**
VRE (vancomycin-resistant Enterococcus)

**DOC for VRE?**
linezolid or Synercid

**DOC for Diptheroids?**
vancomycin

## Gram Negatives

**What is a short, Gram negative rod?**
Escherichia coli

**DOC for E. coli?**
Keflex or Ancef

**Alternative for E. coli if PCN allergy?**
Cipro or Levaquin

**DOC for Proteus?**
Keflex or ampicillin

**Alternatives for Proteus if PCN allergy?**
Cipro or Levaquin

**DOC for E/C/S/M group?**
Quinolone (Cipro or Levaquin)

**Alternatives for E/C/S/M group?**
3rd generation cephalosporin, Aztreonam, Bactrim

**What is a small Gram negative rod with pili and polar flagella?**
Pseudomonas aeruginosa

**DOC for Pseudomonas?**
Cipro

**Alternative for Pseudomonas?**
3rd gen cephalosporins, Aztreonam, Zosyn, Timentin

**How does Pseudomonas typically present?**
blue-green purulence with grape-like odor

**What Gram negative spirochete causes Lyme disease?**
Borrelia burgdorferi

**DOC for Lyme disease?**
doxycyline or Rocephin

**Alternative for Lyme disease?**
amoxicillin

## Anaerobes

**DOC for Bacteroides?**
Augmentin, Zosyn, Unasyn, Timentin

**Alternatives for Bacteroides if PCN allergy?**
clindamycin/Cipro, Primaxin, Flagyl

**What is a large, Gram positive, anaerobic, "racquet-shaped" rod that forms spores?**
Clostridium perfringens

**DOC for Clostridium?**
Penicillin, imipenem, clindamycin, tetracycline

**What are two soft tissue clinical manifestations caused by Clostridium?**
Anaerobic cellulitis and gas gangrene

**Why is gas gangrene a surgical emergency?**
It rapidly progresses to shock and renal failure and is fatal in 30% of cases

## Less Common Organisms

**DOC for Aeromonas?**
Cipro PO/IV

**Alternative for Aeromonas?**
Bactrim

**DOC for Pseudomonas cepacia?**
Bactrim

**Alternative for Pseudomonas cepacia?**
Ceftazidime

**DOC for Necrotizing Fasciitis?**
Primaxin

**DOC for superficial thrombophlebitis?**
Timentin

**DOC for Gonorrhea?**
Ceftriaxone or PCN if sensitive

**DOC of Cutaneous Larva Migrans?**
Promethia under occlusion

## Miscellaneous

**What organisms may form gas in soft tissue?**
Gram positive – Clostridium perfringens, Staphylococcus, Streptococcus, Peptostreptococcus
Gram negative – Bacteroides, E. coli, Klebsiella, Serratia

**What are some anaerobes?**
Gram positive – Actinomyces, Clostridium, Peptostreptococcus
Gram negative – Bacteroides, Fusobacterium

**What is the drug of choice (DOC) for a patient with diabetes and a PCN allergy?**
clindamycin

**DOC for severe limb-threatening infection?**
Primaxin

**What are most common organisms of bite wounds?**
Human – Eikenella corrodens
Cat and dog – Pasteurella multocida

**What is Gram negative rod is associated with dog bites?**
DF-2

**DOC for cat and dog bites?**
Augmentin

**What are the most common organisms causing cellulitis?**
Staph and Strep

**Which type of Strep can cause impetigo, cellulitis, and erysipelas?**
Group A Strep

**What is the difference between cellulitis and erysipelas?**
Cellulitis – confined superficial infection
Erysipelas – superficial infection that extends into the lymphatics

**What is the most common organism that causes acute hematogenous osteomyelitis?**
Staphylococcus aureus (adults), Gram negative rods (elderly)

**What is the most common organism that causes osteomyelitis following a puncture wound?**
Pseudomonas aeruginosa

**What is an anaerobic Gram positive filamentous bacteria?**
Actinomyces

**What organism may be found following a puncture wound in the ocean?**
Vibrio vulnificus

**What type of bacteria is gonorrhea?**
Gram negative diplococci

**What is gonorrhea cultured on?**
Chocolate agar

**What is the treatment for gonorrhea?**
Ceftriaxone

**If a patient is currently on an antibiotic, how long should it be stopped before taking a wound culture?**
At least 48 hours (if possible)

# Labs

## CBC

**What is in a CBC?**
WBC, hemoglobin, hematocrit, platelets

**What are normal lab values for CBC?**
*Note:* normal values vary between labs

| | |
|---|---|
| WBC | 4.8-10.8 k/µL |
| Hemoglobin | ♂ 14.0-18.0 g/dL, ♀ 12-16 g/dL |
| Hematocrit | ♂ 42-52%, ♀ 37-47% |
| Platelets | 145-400 k/µL |

**With an infection, what is expected to happen to the WBC count after surgery?**
Eventually it should go down, but in post-op days 1-2, the WBC may actually increase a bit. This is may occur because surgery activates the body's reaction to the infection.

**What should be done if the patient's WBC is over 10?**
First, decide if the patient has an infection

- If there is an infection, then antibiotics and possible incision and drainage (I&D) should decrease the WBC count
- If there is not an infection, then the cause must be determined. Is the increase acute or chronic? Is there another source of infection (other than the foot)? Is the patient on corticosteroids? Is there a combination of medical conditions causing this?

**What to do if platelets are low (under 150-350 k/mL)?**
Can transfuse platelets, but this is not commonly done

**What are the minimum levels for hemoglobin and hematocrit for elective surgery?**
Hemoglobin 10 gm/dL and Hct 30%

**What should be done if the Hemoglobin/Hematocrit (H/H) is below 10/30?**
If necessary, transfuse 1-2 units of packed red blood cells (PRBC)

**What is the condition called?**
Anemia

**What are causes of microcytic, hypochromic anemia?**
Iron deficiency, thalassemias, lead poisoning

**What are causes of macrocytic, megaloblastic anemia?**
Vitamin $B_{12}$/folate deficiency

**Following a transfusion of PRBC, when will changes in the H/H be seen?**
Approximately 3 hours. Therefore, order new labs to be drawn 4 hours after last unit given.

# BMP

**What is in a BMP?**
Sodium, potassium, chloride, carbon dioxide, BUN, creatinine, glucose

**What is in a CMP?**
BMP with ALP (alkaline phosphatase), ALT (alanine amino transferase, also called SGPT), AST (aspartate amino transferase, also called SGOT), bilirubin, albumin, total protein, calcium

**What are normal values for BMP?**
*Note:* normal values vary between labs

| | |
|---|---|
| Sodium | 135-146 mmol/L |
| Potassium | 3.5-5.1 mmol/L |
| Chloride | 96-106 mmol/L |
| $CO_2$ | 24-32 mmol/L |
| BUN | 10-20 mg/dL |
| Creatinine | 0.7-1.3 mg/dL |
| Glucose | 70-110 mg/dL |

**What do $Na^+$, $K^+$, Cl and $CO_2$ tell you?**
These electrolytes indicate nutritional status

**What should be done if $Na^+$ is low?**
Give NSS or regular salt

**What should be done if $K^+$ is too low?**
Hypokalemia may cause cardiac arrhythmias, muscle weakness, paresthesias, cramps
Manage hypokalemia

- Give K-Dur (potassium chloride supplement)
- Give potassium-rich foods (i.e. banana)

**What should be done if the $K^+$ is too high?**
Hyperkalemia may cause cardiac arrhythmias, lethargy, respiratory depression, coma
Order EKG
Manage hyperkalemia

- Calcium gluconate
- Sodium bicarbonate
- Dextrose with insulin
- Kayexalate

**What do BUN and creatinine indicate?**
Renal function

**What should be done if the creatinine is too high?**
Consult renal if creat is over 1.5 for a couple of results
*Note:* creat may be increased after muscle breakdown or loss

**Which is a more important indicator – BUN or creatinine?**
Creat is more important, because BUN is influenced by hydration state. If the BUN is high but creat is normal, then the patient is most likely dehydrated and rehydration should correct the BUN. However, if both BUN and creat are high, then the patient most likely has renal damage.

## PT/PTT/INR

**What do PT/PTT/INR tell you?**
The coagulable state of the patient. If the levels are high, it will take longer for the patient to develop a clot and stop bleeding. It requires blockage of only one pathway to anticoagulate the patient.

**What are normal values for PT/PTT/INR?**
*Note:* normal values vary between labs

| | |
|---|---|
| PT | 11.7-14.5 sec |
| INR | 0.9-1.1 |
| PTT | 23-36 sec |

**What can cause an elevated PT/INR?**
Coumadin
Malnutrition
Alcoholism
Antibiotics
Vitamin K disorders

**What does INR stand for? Why was it developed?**
International Normalized Ratio
There are different methods to determine PT, and thus each lab has a different normal value for PT. INR was devised to standardize all the results.

**If the patient is on Coumadin for anticoagulation, what should the INR be?**
Intense anticoagulation 2-3

**What causes the PTT to be high?**
Heparin

**Which pathway does PTT check?**
Intrinsic ("PITT")

**Which pathway does PT check?**
Extrinsic ("PET")

# Medicine

**What are reasons for post-op fever?**
Wind (12-24 h)
- Atelectasis (from muscle relaxers)
- Post-op hyperthermia

Water (~24 h)
- UTI

Walk (~48 h)
- DVT
- PE

Wound (~72 h)
- Post-op infection

Wonder drug (anytime)
- Drug fever

**What are treatments of post-op fever?**
Wind
- Encourage incentive spirometer
- Chest x-ray

Water
- Straight catheter
- Urine analysis (UA) with Gram stain, culture and sensitivity
- Treat with antibiotics if necessary

Walk
- Heparin or Lovenox protocol
- Use SCDs, TEDs, or get patient out of bed

Wound
- X-ray, Gram stain, culture and sensitivity, blood cultures
- Begin antibiotic

Wonder drug
- D/C drug
- Give reversal drug if necessary

**When do fever peaks occur?**
Between 4-8 pm

**What part of the brain regulates the body's temperature?**
Hypothalamus

**What is malignant hyperthermia?**
A side effect of general anesthesia – tachycardia, hypertension, acid-base and electrolyte abnormalities, muscle rigidity, hyperthermia

**What is the treatment for malignant hyperthermia?**
Dantrolene (for muscle relaxation) 2.5mg/kg IV x l, then 1 mg/kg IV rapid push q6h until symptoms subside or until max dose of l0 mg/kg

**If a risk of malignant hyperthermia is suspected, what pre-operative test may be performed?**
CPK – elevated in 79% of patients with malignant hyperthermia

## Anesthetics

**What is the mechanism of action for local anesthetics?**
Block $Na^+$ channels and conduction of action potentials along sensory nerves

**What is the toxic dose of lidocaine (Xylocaine)?**
300 mg plain (4.5 mg/kg)
500 mg with epi (7.0 mg/kg)

**What is the toxic dose of bupivacaine (Marcaine)?**
175 mg plain (2.5 mg/kg)
225 mg with epi (3.2 mg/kg)

**How to convert percentage of solution to mg/mL?**
Move decimal point of percentage one place to right
(e.g. 1% solution has 10 mg/mL)

**What are the side effects of lidocaine and bupivacaine associated with systemic exposure?**
CNS effects – initial excitation (dizziness, blurred vision, tremor, seizures) followed by depression (respiratory depression, loss of consciousness)
Cardiovascular effects – hypotension, bradycardia, arrhythmias, cardiac arrest

**What can be given to help reverse local anesthetic-induced cardiovascular collapse?**
Intravenous fat emulsion (Intralipid)

**Is there a risk with intra-articular injections of bupivacaine?**
Studies have shown chondrocyte death following prolonged exposure to bupivacaine

**In what age group should bupivicaine be avoided?**
Children <12 year of age

**How are amides (lidocaine and bupivacaine) metabolized?**
Liver

**How are esters (Novocain) metabolized?**
Plasma pseudocholinesterase

**What is the only local anesthetic with vasoconstriction?**
Cocaine

**How is cocaine metabolized?**
Plasma pseudocholinesterase (just like other esters)

**Can local anesthetics cross the placental barrier?**
Yes

**What does MAC (as in MAC with local) stand for?**
Monitored anesthesia care

**For anesthesia, what cannot be given to a patient with an egg shell injury?**
propofol (Diprivan)

## Pain Medications

**Pain management with a codeine allergy?**
(STUD or STTUUDDD-N)
S – Stadol
T – Toradol
T – Talwin
U – Ultram
D – Darvon
D – Darvocet
D – Demerol
N – Nubain

**First choice for oral?**
Darvocet N-100 one tab PO q4-6h prn pain

**First choice for non-narcotic oral?**
tramadol (Ultram) 50 mg one to two tabs PO q4-6h prn pain, max daily dose of 400 mg per day

**First choice for non-narcotic IV?**
Toradol 30-60 mg IV

**Choice narcotic IV pain med?**
Demerol
*Note:* many hospitals, including our own, do not use Demerol due to its side effects

**Name two non-narcotic analgesics**
ketoralac (Toradol), tramadol (Ultram)

# Drugs and Usual Doses

**What schedule are these drugs?**

| | | |
|---|---|---|
| Percocet | II | high potential for abuse – requires narcotic script |
| Vicodin | III | moderate potential for abuse |
| Tylenol #3 | III | moderate potential for abuse |
| Darvocet | IV | low potential for abuse |

**Percocet 5/325?**
oxycodone/acetaminophen (5 mg/325 mg)
1-2 tabs PO q4-6h prn pain

**Roxicet?**
oxycodone/acetaminophen (5 mg/325 mg/5 mL)
Essentially a liquid form of Percocet that is good for pediatric patients

**What is the difference between Percocet and Percodan?**
Percocet has 325 mg of acetaminophen and Percodan has 325 mg of ASA

**Vicodin 5/500?**
hydrocodone/acetaminophen (5 mg/500 mg)
1-2 tabs PO q4-6h prn pain

**Tylenol #3?**
codeine/acetaminophen (30 mg/300 mg)
1-2 tabs PO q4-6h

**Darvocet-N 100?**
propoxyphene/acetaminophen (100 mg/650 mg)
1 tab PO q4h prn pain

**Ultram?**
tramadol 50 mg
1-2 tabs PO q4-6° prn pain

**Toradol?**
ketorolac 10 mg
30 mg IV q6h
1 tab PO q4-6h prn pain
An NSAID not to be used more than 5 days due to possible significant side effects

**Darvon?**
propoxyphene
1 tab PO q4h prn pain

**OxyContin?**
oxycodone extended release

**Morphine sulphate?**
2-4 mg IV q2-6h prn mod-severe pain
For very painful dressing change or bedside debridement – 2 mg IV x one dose

**MS Contin?**
morphine sulfate extended release (15-30 mg)
1 tab PO q8-12h prn pain

**Dilaudid?**
hydromorphone
2-8 mg PO q3-4h prn severe pain
1-4 mg IV q4-6h prn severe pain
This drug is very strong

**Demerol?**
meperidine
Our hospitals do not use this due to its side effects

## Acetaminophen

**What therapeutic effects are seen with acetaminophen?**
Analgesic and anti-pyretic

**What is the maximum daily dose?**
4 g

## NSAIDs

**What therapeutic effects are seen with most NSAIDs?**
Analgesic, anti-pyretic, and anti-inflammatory

**What pathway do NSAIDs work on?**
Cyclooxygenase (COX)
NSAIDs nonselectively inhibit both COX-1 and COX-2 pathways

**What is the most common side effect of NSAIDs?**
GI disturbance (except with COX-2 inhibitors, because COX-1 protects the stomach lining)

**What is the only FDA-approved COX-2 inhibitor?**
celecoxib (Celebrex)
Others were withdrawn due to increased risk of heart attack and stroke

**Which NSAIDs only have anti-inflammatory effects?**
indomethacin, tolmetin

**Do NSAIDs decrease joint destruction?**
No, they only decrease inflammation

**Do NSAIDs affect bone healing?**
NSAIDs and COX-2 inhibitors may inhibit bone healing via their anti-inflammatory effects

**What NSAID causes irreversible inhibition of platelet aggregation?**
aspirin

**What NSAID does not inhibit platelet aggregation?**
The COX-2 inhibitor, Celebrex

**What is the only IV NSAID?**
ketorolac (Toradol)

**Which NSAID is often given during surgery or immediately post-op to decrease pain and inflammation?**
Toradol 30 mg IV

**What are the NSAIDs with the least nephrotoxicity?**
Celebrex, Relafen, Lodine

**What is the effect of NSAIDs on asthma?**
Can increase symptoms of asthma

**What are the safest NSAIDs for a patient with asthma?**
Diclofenac, ketoprofen

**Which NSAIDs treat collagen vascular disease?**
Ibuprofen, sulindac, tolmetin

**Which NSAIDs are not renally cleared?**
Indomethacin, sulindac

**What are the cardiovascular effects of NSAIDs?**
Can cause vasoconstriction and increase blood pressure

**Which NSAIDs have the least cardiovascular effects?**
Diclofenac, ketoprofen

**Which NSAIDs are the most hepatotoxic?**
Ibuprofen, naproxen, diclofenac

**What should be given for an indomethacin overdose?**
Benadryl – decreases serotonin and histamine release

**What is Arthrotec?**
diclofenac/misoprostol – an NSAID with protection for the stomach

**What is the anti-inflammatory dose of ibuprofen?**
1200-3200 mg/day in divided doses

**What NSAIDS work on both the lipooxygenase and cyclooxygenase pathways?**
Ketoprofen and diclofenac

**What is the difference between Cataflam and Voltaren?**
Cataflam is diclofenac potassium and has an immediate release
Voltaren is diclofenac sodium and has a delayed release

**What are the only pro-drugs for NSAIDs?**
nabumetone and sulindac

**What is the only nonacidic NSAID?**
nabumetone

**Which NSAIDs have fewer pulmonary problems?**
ketoprofen and diclofenac

**What are some once a day NSAIDs?**
celecoxib (Celebrex), piroxicam (Feldene), oxaprozin (Daypro), nabumetone (Relafen), others

**What drugs do NSAIDs interact with and what are the effects?**
Coumadin – increases action of Coumadin
Sulfonylureas – increases action of sulfonylureas
Corticosteroids – increases GI risk
Anti-epileptics – increases anti-epileptic toxicity
Antihypertensives – antagonizes antihypertensive meds
Digoxin – increases digoxin's effect
Methotrexate – decreases methotrexate's clearance
Lithium – decreases lithium's clearance
Probenecid – increases concentration of NSADs

## Anticoagulation

**What are causes of acute arterial occlusion?**
Embolism – detached thrombus, air, fat, or tumor
Thrombus – occlusion of vessel by plaque or thickened wall
Extrinsic occlusion – traumatic, blunt, penetrating

**What is the triad of pulmonary embolism?**
Dyspnea
Chest pain
Hemoptysis (although tachycardia is more common)

**What tests can be ordered to diagnose a PE?**
Chest X-ray
Ventilation perfusion scan
Pulmonary angiography

**What is Virchows triad?**
Venous stasis – tourniquet, immobilization
Endothelial wall damage/abnormality – surgical manipulation, trauma, smoking
Hypercoagulability – birth control, coagulopathy, history of DVT

**What does the Virchow triad predict?**
Risk of DVT
Previous DVT is #1 risk factor for having another DVT

**What are risks factors for DVT?**
(I AM CLOTTED)
I – immobilization
A – arrhythmia
M – MI (past history)
C – coagulable states
L – longevity (old age)
O – obesity
T – tumor
T – trauma
T – tobacco
E – estrogen
D – DVT (past history)

**How is a DVT diagnosed clinically?**
Pain, heat, swelling, erythema of unilateral limb
Positive Pratt sign – squeezing of posterior calf causes pain
Positive Homan sign – abrupt dorsiflexion of foot causes calf pain
Pulmonary embolism

**What tests can be ordered to diagnose a DVT?**
Doppler ultrasound
Venogram
D-Dimer

**For long term DVT prophylaxis, what drugs can be ordered? Why?**
Heparin – works right away
Coumadin – takes 3-5 days and causes an initial transient hypercoagulable state

**What are treatments for a DVT?**
Thrombolytic agents
Heparin 5000 Units IV bolus, then 1000 Units IV q1h and monitor PTT

**How to dose Heparin for perioperative DVT prophylaxis?**
5000 units SC 2h prior to surgery
5000 units SC q12h until patient ambulates

**What is the half-life of heparin?**
1.5 hour

**How does heparin work?**
Intrinsic pathway
Potentiates antithrombin III 100-fold, which inhibits the serine protease in the clotting cascade

**How is heparin reversed?**
Protamine sulfate 1 mg per 100 units of heparin

**What is enoxaparin (Lovenox)?**
Low molecular weight heparin

**How to dose Lovenox for perioperative DVT prophylaxis?**
30 mg SC q12h for 7-10 days (adjust dose to q24h for renal patients)

**What is the half-life of Lovenox?**
4.5 hours

**What are the advantages of using Lovenox vs. regular Heparin? Disadvantages?**
Advantages – Lovenox has longer plasma half-life with significant anticoagulation in trough
Disadvantages – increased post-op complications when used with spinal/epidural anesthesia

**How do you check Lovenox?**
There is no test for the effects of Lovenox

**How is Lovenox reversed?**
Recombinant Factor VII

**How to dose Coumadin?**
5-10 mg PO daily for 3-4 days then adjust for INR

**What is the half-life of Coumadin?**
20-60 hours

**How long before Coumadin is therapeutic?**
3-5 days

**How does Coumadin work?**
Extrinsic pathway
Interferes with clotting factors II, VII, IX, X

**How is Coumadin reversed?**
Vitamin K
Fresh frozen plasma

**What are the INR values?**
Normal l
Intense anticoagulation 2-3

**What are levels of heparin and Coumadin for DVT/anticoagulation prophylaxis?**
Heparin – maintain 2-3 times normal PTT
Coumadin – maintain 2 times normal INR

**What nonpharmacologic measures are used for perioperative DVT prophylaxis?**
Early ambulation – most important
TEDs – thromboembolic deterrent stockings
SCDs – sequential compression devices

**What is a surgical treatment for a patient with prior DVTs or recurrent PEs?**
Greenfield filter

**What level of the body is a Greenfield filter inserted?**
Inferior vena cava below the renal veins

**What is Pletal?**
cilostazol

**What is Trental?**
pentoxifylline

**What is an indication for Pletal or Trental?**
Intermittent claudication

## CRPS

**What is CRPS?**
Complex regional pain syndrome (previously known as RSD – reflex sympathetic dystrophy) is a progressive disease of the autonomic nervous system causing constant, extreme pain that is out of proportion to the original injury

**What are the different types and causes of CRPS?**
CRPS Type I (reflex sympathetic dystrophy)

- Nerve injury cannot be immediately identified
- Spontaneous pain not limited to single nerve distribution
- Abnormal response in sympathetic nervous system
- Abnormal reflex leading to vasomotor instability and pain

CRPS Type II (causalgia)

- Distinct, "major" nerve injury has occurred
    - Trauma
    - Peripheral nerve injury
    - Drugs – anti-TB, barbiturates, cyclosporine
- Continued pain not necessarily limited to injured nerve distribution

**What are the stages of CRPS?**

1. Acute – early (0 to 8-20 weeks)
    - Constant pain out of proportion (intense burning)
    - Possible edema, muscle wasting
    - Hyperhidrosis
    - Pain increased by light touch, movement, emotion
2. Dystrophic – mid (2-6 months, possibly up to 1 year)
    - Increased edema that is indurated (brawny edema)
    - Constant pain by any stimulus
    - Skin is cool pale and discolored
    - X-ray shows diffuse osteoporosis
3. Atrophic – late (over 6-12 months)
    - Intractable pain spreads proximally to involve entire limb
    - Decreased dermal blood flow causing cool, thin shiny skin
    - Fat pat atrophy
    - Joint stiffen, may proceed to ankylosis

**What are radiographic findings of CRPS?**

Periarticular, mottled, irregular bony demineralization (30-60% of cases) and cortical thinning

**What are bone scan findings of CRPS?**

The 3-phase bone scan has sensitivity of 96% and specificity of 98%. A normal scan does not exclude the diagnosis. The findings of the bone scan are based on the phase.

1. Acute
    - Increased flow and blood pool activity in the affected extremity
    - Increased activity particularly in a periarticular distribution on delayed images
2. Dystrophic
    - Flow and blood pool abnormalities begin to normalize
    - Increased activity on delayed images persists
3. Atrophic
    - Flow and blood pool activity can be normal or decreased (in about 1/3 of patients)
    - Normal or decreased activity is commonly seen on delayed images, however, persistent increased delayed activity has been reported (up to 40%)
    - Decreased flow in advanced stages may be related to disuse, which is a common feature of post-hemiplegic CRPS

**What are treatments of CRPS?**
Anti-inflammatory drugs
Antidepressant drugs
Local peripheral nerve blocks
Paravertebral sympathetic ganglion blocks
Physical therapy

# Diabetes

**For diabetic patients, who gets diabetic ketoacidosis and who gets diabetic coma?**
Type I (IDDM) – DKA
Type II (NIDDM) – coma

**What are signs of hypoglycemia?**
Nervousness, tachycardia, diaphoresis, nausea, headache, confusion, tremor, seizures, coma

**What are signs of hyperglycemia?**
Polyuria, polydipsia, weight loss

**What is the function of a biguanide?**
Antihyperglycemic (not hypoglycemic)

**What is a typical supplemental insulin scale?**

| BG (mg/dL) | Low | Medium |
|---|---|---|
| <120 | 0 | 0 |
| 121-150 | 1 | 2 |
| 151-180 | 2 | 4 |
| 181-210 | 3 | 6 |
| 211-240 | 4 | 8 |
| 241-270 | 6 | 10 |
| 271-300 | 8 | 12 |
| 301-350 | 10 | 14 |
| 351-400 | 12 | 16 |
| >400 | call physician | |

**What are the only FDA-approved drugs for treating diabetic neuropathy?**
duloxetine (Cymbalta)
pregabalin (Lyrica)

# Osteoarthritis

**What are clinical findings of OA?**

- Pain relieved with rest
- Stiffness aggravated with activity
- Crepitus with motion
- Asymmetric joint swelling

**What are radiographic findings of OA?**

- Asymmetric joint space narrowing
- Broadening and flattening of articular surfaces
- Osteophytes at joint margins
- Subchondral sclerosis

# Gout

**What is the most common inflammatory arthritis in men over 30?**
Gout

**What are the stages of Gout?**

1. Asymptomatic hyperuricemia
2. Acute gouty arthritis
3. Intercritical gout
4. Chronic tophaceous gout

**What are clinical findings of gout?**

- Asymmetrical, monoarticular arthritis
- Sudden onset of red, hot, and swollen joint
- Excruciating pain with acute attack
- Tophaceous deposits
- Most commonly affects 1st MPJ

**What are radiographic findings of gout?**

- Radiographic findings appear late in the disease after multiple attacks
- Bone lysis in acute stages
- Periarticular swelling with preserved joint space
- Tophi at joint margins
- Rat bite – punched-out, periarticular erosions
- Cloud sign – tophaceous material
- Martel sign – periarticular overhanging shelves of bone

**What are laboratory tests for gout?**

- Uric acid – males >7 mg/dL, females >6 mg/dL, though may be normal during attack
- Synovial fluid analysis provides a more accurate diagnosis

**What would a joint aspirate of gout show?**
Needle-shaped monosodium urate crystals that are negatively birefringent under polarized light (CPPD are rhomboid-shaped and positively birefringent)

**What is a martini sign?**
Histology showing a PMNC engulfing a crystal

**If gout is suspected, what should a specimen be sent in?**
One in formaldehyde (dissolves gouty tophi) and one in alcohol (does not dissolve gouty tophi)

**How to treat acute and chronic gout?**
Acute
- Colchicine
- NSAIDS – indomethacin
- Corticosteroids
- ACTH

Chronic
- Colchicine (prophylactically)
- Allopurinol
- Uricosurics – probenecid, sulfinpyrazone

**What is the dose colchicine?**
0.6 mg PO q1h until symptoms resolve, GI side effects occur, or max dose of 6 mg reached

**What is the max daily dose of colchicine?**
6 mg

**Can allopurinol, probenecid or sulfinpyrazone be used for acute gout?**
No, because they may cause an initial hyperuremia

**How to determine if patient is an overproducer or underexcretor?**
Take a 24 hour uninalysis

**Which is more common – to be an overproducer or an underexcretor?**
Underexcretors make up approx 90%

**What medication should be given if the patient is an overproducer? Underexcretor?**
(Over-Achieving, Under-Paid)
Overproducer → Allopurinol
Underexcretor → Probenecid

# Rheumatoid Arthritis

**What are clinical findings of RA?**
- Symmetric, progressive, polyarticular, and degenerative inflammatory arthritis
- Age of onset between 3-4$^{th}$ decades
- Females > males
- Pain first thing in morning
- Stiffness after rest and reduced with activity
- Rheumatoid nodules (25%)
- Nail fold infarcts, splinter hemorrhages
- Swan neck deformities – flexed DIPJ and extended PIPJ
- Boutonniere deformities – extended DIPJ and flexed PIPJ
- Other – bullous dermatosis, Raynaud phenomenon, vasculitis

**What are laboratory findings of RA?**

- Rheumatoid factor – positive
- RBC – slight to moderate anemia
- WBC – elevated in acute cases and normal to decreased in chronic
- ESR & CRP – moderate to marked elevation
- Synovial fluid analysis – elevated WBCs with cloudy fluid

**What are radiographic findings of RA?**

- Clinical symptoms may present several years prior to radiographic findings
- Peri-articular edema
- Periosteal elevation and ossification
- Marginal erosions
- Subluxation and contractures (Swan neck deformities)
- Fibular deviation of digits
- Osteoporosis
- Symmetric joint space narrowing and destruction (late stage finding)

**What causes the fibular deviation of digits?**

Erosive changes of medial plantar metatarsal heads compromises the integrity of medial collateral ligaments leading to lateral deviation of digits

**What is pannus?**

Granulation tissue that secretes chondrolytic enzymes which break down articular cartilage

# Psoriatic Arthritis

**What are clinical findings of PA?**

- Polyarthritis including DIPJ involvement
- Sausage digits
- Psoriatic skin changes
- Nail lesions

**What are laboratory findings for PA?**

- HLA-27 – positive
- Rheumatoid factor – negative

**What are radiographic findings of PA?**

- Erosions with bony proliferation
- Symmetric narrowing of joint space
- Increased periosteal activity
- Pencil-in-cup appearance
- Osteopenic changes

# Reiter Syndrome

**What are clinical findings of RS?**

- Polyarticular, asymmetric arthritis of lower extremity (mostly affects small bones of feet, ankle, knee, SI joint)
- Most affects males
- Capsulitis with digital edema
- Bony erosions
- Reiter Syndrome Triad (can't see, can't pee, can't climb a tree)
    - Conjunctivitis
    - Urethritis
    - Arthritis
    - Also keratoderma blenorrhagicum

**What are laboratory findings for RS?**

- HLA-27 – positive
- Rheumatoid factor – negative
- ESR – elevated
- Synovial fluid analysis – Pekin cells

**What are radiographic findings of RS?**

- Fluffy periosteal reactions
- Large, bilateral heel spur formation
- Inflammation and widening of Achilles tendon insertion
- Deossifications

# Ankylosing Spondylitis

**What are clinical findings of AS?**

- Mostly males affected
- Bilateral sacroiliitis – low back pain and stiffness
- Heel pain
- Peripheral joint pain

**What are laboratory findings for AS?**

- HLA-27 – positive
- Rheumatoid factor – negative

**What are radiographic findings of AS?**

- Irregular joint widening with erosions
- Reactive sclerosis
- Bony ankylosis
- Sacroiliac joint fusion
- Bamboo spine

# Septic Arthritis

**What are clinical findings of SA?**

- Painful, hot, swollen joint
- Systemic signs of fever, N/V, tachycardia, confusion

**What are laboratory findings for SA?**

- WBC – elevated with left shift
- ESR – elevated
- CRP – elevated
- Blood cultures – positive
- Synovial fluid analysis – elevated WBC with cloudy white or gray color

**What are radiographic findings of SA?**

- Normal in early stages
- Joint effusion
- Juxta-articular osteopenia

**What are etiologies of SA?**

Contiguous, hematogenous, direct implantation, surgical contamination

**What is the most common offending organism of SA?**

All ages – Staphylococcus aureus
Neonates – Streptococcus and Gram negatives
Children – H. influenza
Teenagers – Neisseria gonorrhea
Puncture wounds – Pseudomonas aeruginosa
Adults with sickle-cell – Salmonella

**What is the treatment for SA?**

Needle drainage of joint
Open arthrotomy if osteomyelitis, joint implant, or chronic infection
Initial joint immobilization followed by passive ROM
Appropriate IV antibiotics for 2 weeks followed by 2-4 weeks of oral antibiotics

# Other Diseases

**What is brachymetatarsia?**

Premature closure of epiphyseal plate of metatarsal resulting in a short metatarsal
Usually the 4$^{th}$ metatarsal is affected

**What are some conditions associated with brachymetatarsia?**

Downs syndrome
Turners syndrome
Cri du chat
Pseudo- or pseudopseudohypoparathyroidism
May be idiopathic

**What is the maximum length that a metatarsal may be acutely lengthened for correction of brachymetatarsia?**
1 cm graft allows acceptable stretching of neurovascular structures

**If more than 1 cm of lengthening is required, what procedure may be performed?**
Callus distraction with Mini-Rail fixation

**How much lengthening is typically achieved with callus distraction?**
1 mm per day (0.25 mm q6h)

**What is achondroplasia?**
Dwarfism – all bones short with tibia undergrowth and fibular overgrowth causing genu varum

**What is fibular hemimelia?**
Aplasia or hypoplasia of the fibula

**What is DISH?**
Diffuse Ideopathic Skeletal Hyperostosis – characterized by multiple ossifications at tendinous or ligamentous insertions

**What is Apert syndrome?**
Multiple bony coalitions

**What is Paget disease?**
Osteitis deformans – abnormal bony architecture caused by increased osteoblastic and osteoclastic activity. More common in elderly.

**What malignant bone degeneration may be seen with Paget disease?**
Osteosarcoma

**What are the stages of Paget?**
1. Destructive – osteolytic
2. Mixed – osteolytic and osteoblastic
3. Sclerotic – osteoblastic

**What are the stages of Charcot?**
1. Acute or destructive
2. Coalescence
3. Remodeling

**What conditions are associated with positive HLA-B27?**
Ankylosing spondylitis, Reiter disease, psoriatic arthritis, reactive arthritis, enteropathic arthropathies

**What are components of CREST syndrome?**
Calcinosis
Raynauds phenomenon
Esophageal dysmotility
Sclerodactyly
Telangiectasias

**What is the treatment of cutaneous larva migrans?**
Promethia under occlusion

**What is the treatment for Lyme disease?**
Doxycycline 100 mg PO daily or Rocephin l g IV daily

**DOC for necrotizing fasciitis?**
Primaxin 250-1000 IV q6-8h (most commonly 500 mg IV q8h)

**What is Felty syndrome?**
Rheumatoid arthritis, splenomegaly, leukopenia

**What is mycosis fungoides?**
Cutaneous T-cell lymphoma that can resemble eczematoid or psoriasis

**What is erythrasma?**
Chronic, superficial infection of intertriginous skin caused by Corynebacterium minutissimum. Interdigital lesions appear as maceration.

**What is ecthyma?**
Ulcerative pyoderma of the skin often caused by Streptococci. Infection extends into dermis and is characterized by ulcers with overlying crusts.

**What is cellulitis?**
Acute spreading infection of dermal and subcutaneous tissue commonly caused by group A Strep or Staph aureus. Affected area is erythematous, warm, edematous, and tender.

**What is erysipelas?**
Superficial infection that extends into the lymphatics. Lesions are erythematous, indurated with sharply-demarcated margins, and have erythematous, ascending streaks.

**What is lymphangitis?**
Inflammation of the lymphatics as a result of a distal infection

**What is psoriasis?**
Hereditary disorder with chronic scaling papules and plaques in areas of body related to repeated minor trauma. Positive Koebner phenomenon and Auspitz sign. Also present are joint pain and nail changes including pitting, beau lines, oil spot, subungual hyperkeratosis, and discoloration.

**What is lichen planus?**
Inflammatory dermatosis involving skin or mucous membranes with pruritic, violaceous papules clustered into large, flat-topped lesions with distinct borders. Lesions possibly covered with Wickham striae (white streaks). Ridges, onycholysis, subungual hyperkeratosis, and discoloration.

**What is another name for menopausal lipoma?**
Juxtamalleolar lipoma

**What is the main screening test if AIDS is suspected?**
ELISA (Enzyme Linked Immunosorbent Assay)

**What test should be performed to confirm the diagnosis of AIDS?**
Western blot

## Miscellaneous Drugs

**What are some effects of steroids?**
Anti-inflammatory
- Decreases production of prostaglandins, cytokines, and interleukins
- Decreases proliferation and migration of lymphocytes and macrophages

Metabolic
- Decreases osteoblast activity

**What are differences between phosphate and acetate-based steroids?**
Phosphate-based – soluble with shorter half-life
- Minimize inflammatory reaction and edema

Acetate-based – insoluble with longer half-life
- May delay inflammatory process or healing and can mask infection

**What is a common complication following steroid injection?**
Steroid flare – hypersensitivity reaction. Apply ice.

**How are glucocorticoids metabolized?**
Metabolized in the liver and secreted in urine

**What is diazepam?**
Valium, a benzodiazepine, is an anxiolytic/anticonvulsant/muscle relaxant

**How to reverse diazepam?**
Flumazenil (Romazicon) for benzodiazepine reversal
0.2 mg IV over 15 seconds, then 0.2 mg IV prn over 1 minute up to 1 gram total

**What are drugs for insomnia?**
(BE HARD)
B – Benadryl
E – estazolam
H – Halcion
A – Ambien
R – Restoril
D – Dalmane
Most commonly used are Benadryl 25 mg PO qhs or Ambien 5 mg PO qhs

**What drugs leave a metallic taste in the mouth?**
Flagyl, Lamisil

**What is given for a Tylenol overdose?**
acetylcysteine (Mucomyst)

**What can cause Gray Baby Syndrome?**
Chloramphenicol

**What is chloramphenicol?**
An antimicrobial

# Clinical Podiatry

**What are the clinical patterns of tinea pedis? What are common infecting organisms?**
Chronic (moccasin or papulosquamous)
- Trichophyton rubrum

Acute (interdigital or vesicular)
- Trichophyton mentagrophytes

Ulcerative
- Trichophyton mentagrophytes with Pseudomonas or Proteus

**What are the clinical patterns of onychomycosis? What are common infecting organisms?**
Distal subungual onychomycosis (DSO) ~ 90%
- Most common
- Trichophyton rubrum

Proximal subungual onychomycosis (PSO) ~ 1%
- Seen in immunocompromised patients
- Trichophyton rubrum

Superficial white onychomycosis (SWO) ~ 10%
- Trichophyton mentagrophytes

Candidal onychomycosis
- Candida albicans

**What test confirms tinea pedis or onychomycosis?**
Potassium hydroxide (KOH) preparation of skin or nail specimen
Septate hyphae confirms diagnosis

**Who does Lamisil work?**
Inhibits ergosterol synthesis

**What is phenol?**
Carbolic acid

**During a P&A procedure, why is alcohol used after phenol?**
Phenol is soluble in alcohol, and the alcohol will irrigate excess phenol from the nail groove

**For a nail avulsion, what can be done for anesthesia if the patient is allergic to all local anesthetics?**
Saline block (pressure induced block)
Pressure cuff
Benadryl block (blocks histamine release)

**In evaluating a bunion, what does the position of the tibial sesamoid indicate? Why isn't the fibular sesamoid evaluated?**
The tibial sesamoid indicates the abnormal affects of the adductor and flexor brevis tendons. Once the fibular sesamoid reaches the intermetatarsal space, it travels in the frontal plane (as opposed to transverse), therefore the tibial sesamoid is a more reliable indicator of deformity.

**What are some causes of hallux varus?**
Congenital
- Clubfoot
- Metatarsus adductus

Traumatic
- MPJ dislocation
- Fracture

Iatrogenic
- Overcorrection of intermetatarsal angle
- Excessive resection of medial eminence or staking the head
- Fibular sesamoidectomy
- Overaggressive capsulorrhaphy
- Bandaging too far into varus

**What is staking the head?**
Excessive resection of the 1st metatarsal head with cutting into the sagittal groove may lead to hallux varus

**Describe the types of hammertoes**
Flexor stabilization
- Most common
- Stance phase
- Flexors overpower interossei
- Pronated foot

Extensor substitution
- Swing phase
- Extensors overpower lumbricals
- Anterior cavus, ankle equinus, anterior compartment muscle weakness

Flexor substitution
- Least common
- Stance phase
- Deep compartment muscles overpower interossei
- Supinated, high arch foot or weakened Achilles

**What is the result of accidentally severing the quadratus plantae?**
Adductovarus deformity of digits 4 and 5 as the pull of FDL is unopposed

**What are differences between flexible, semi-rigid, and rigid deformities?**
Flexible – reducible when NWB and WB
Semi-rigid – reducible when NWB only
Rigid – non-reducible

**What is a Haglund deformity?**
Pump bump

**What x-ray measurements evaluate a Haglund deformity?**
Parallel pitch lines
Fowler & Philip
Total angle

**What is the Silfverskiöld test?**
Determines gastroc vs. gastroc-soleus
Positive test
- Dorsiflexion of the foot to neutral or beyond with the knee in flexion
- Gastroc equinus

Negative test
- Lack of dorsiflexion of the foot to neutral with knee in flexion and in extension
- Gastroc-soleus equinus

**What is the Lachman test?**
Determines if there is a plantar plate tear or rupture. While stabilizing the metatarsal, a dorsal translocation of the proximal phalanx greater than 2 mm is suggestive of rupture.

**What is the Mulder sign?**
Identifies a Morton neuroma by a palpable click when compressing metatarsal heads and palpating the interspace

**What is the Sullivan sign?**
Separation of digits caused by a mass within the interspace

**What is Q angle?**
Angle between the axis of the femur and the line between the patella and tibial tuberosity

**What to do if patient has edema with a cast?**
If edema goes down in AM → gravity edema → normal
If edema does not go down in AM → abnormal

**What is Raynaud phenomenon?**
Recurrent vasospasm of digits usually in response to stress or cold

**What are the stages of Raynauds Phenomenon?**
White → blue → red

- Pallor – spasm of digital arteries
- Cyanosis – deoxygenation of blood pools
- Rubor – hyperemia

**What is an ABI?**
Ankle Brachial Index – compares ankle to arm pressures
Normal 1
Intermittent claudication 0.6-0.8
Rest pain 0.4-0.6
Ischemic ulcerations <0.4

**What may falsely elevate the ABI?**
Vessel calcifications/non-compressible vessels

**What other tests are typically performed with an ABI?**
Segment pressures

- Measured at high thigh, above the knee, below the knee, ankle, midfoot, and toe
- Normal 70-120 mm Hg
- Drop between segments >30 mm Hg indicate disease in vessel above

Pulse volume recordings (PVRs)

- Normal waveforms are triphasic
- Waveforms are widened and blunted with severe disease

**What is the most common type of skin cancer?**
Basal cell carcinoma – found on sun-exposed parts of the body

**What skin cancer may appear cauliflower-like?**
Squamous cell carcinoma – found on sun-exposed parts of the body

**What is the most common type of melanoma?**
Superficial spreading melanoma – found on any part of the body

**Most malignant?**
Nodular melanoma – may be misdiagnosed as pyogenic granuloma

**Most benign?**
Lentigo melanoma – typically found on back, arms, neck, and scalp

**Typically found on the palms, soles, and nail beds?**
Acral lentiginous melanoma

**What is a Hutchinson sign?**
Pigment changes in the eponychium seen with subungual melanoma

**What is the most common vascular proliferation?**
Hemangioma

**What vascular malignancy appears as red-blue plaques or nodules and has a high incidence in AIDS?**
Kaposi sarcoma

**What conditions may be associated with plantar fibromatosis?**
Ledderhose disease
Dupuytren contracture
Peyronie disease

**What is another name for congenital convex pes valgus?**
Vertical talus

**What are radiographic findings of CCPV?**
Calcaneus in equinus, plantarflexed talus, dorsally dislocated navicular, increased talo-calc angle

**What additional radiographic study should be obtained for neonates with CCPV?**
Lumbosacral films

## Coalitions

**What are three coalitions of the rearfoot?**
Talocalcaneal, calcaneonavicular, and talonavicular

**What percentage of tarsal coalitions are bilateral?**
50%

**Which is most symptomatic?**
C-N

**Asymptomatic?**
T-N

**Which is most common?**
T-C > C-N > T-N

**Which T-C facet is most commonly fused?**
Medial > anterior > posterior

**What are the ages of fusion?**
T-N (3-5 years)
C-N (8-12 years)
T-C (12-16 years)

**What are clinical symptoms of tarsal coalitions?**
Pain
Limited ROM of STJ and possibly MTJ
Peroneal spastic flatfoot

**What are radiographic findings of tarsal coalitions?**
- Rounding of lateral talar process
- Talar beaking due to increased stress on talonavicular ligament
- Asymmetry of anterior subtalar facet
- Narrowing or absence of middle and posterior subtalar facets
- Halo sign – circular ring of increased trabecular pattern due to altered compressive forces
- Anteater sign – C-N coalition in which calcaneus has elongated process on lateral view
- Putter sign – T-N coalition in which neck of talus unites with broad expansion of navicular

**The anterior facet is best seen by which radiographic views?**
Medial oblique, Ischerwood

**The middle and posterior facets are best seen by which radiographic view?**
Harris Beath

**What are treatments for symptomatic tarsal coalitions?**
- Orthotics or supportive therapy
- Immobilization
- NSAIDs
- Badgley – surgical resection of coalition or bar with interposition of muscle belly
- Isolated fusion or triple arthrodesis

# Clubfoot

**What are the 3 components of clubfoot?**
FF adductus, RF varus, ankle equinus

**What ligaments/capsules are contracted?**
Posterior
- Posterior tib-fib
- Posterior talo-fib
- Lateral calcaneofibular
- Syndesmosis

Medial
- Superficial deltoid
- Tibionavicular
- Calcaneonavicular
- Talo-Navic, Navic-Cunei, and Cunei-1$^{st}$ MT joints
- Spring ligament

**What muscles/tendons are contracted?**
Posterior
- Achilles tendon
- Plantaris tendon

Medially
- PT, FDL, and FHL
- Abductor hallucis

Anteriorly
- Tibialis anterior

**What is the technique for correction of clubfoot called?**
Ponseti technique
- Serial casting
- First correct the FF and RF deformities, and then correct ankle equinus
- During manipulation, pressure is applied to the head of the talus (not the calcaneus)
- 4-8 casts, percutaneous Achilles tenotomy (last cast for 3 weeks), occasional TA transfer, and D-B bar brace until age 3 y/o to prevent relapse

**What is the most accepted theory about clubfoot?**
Germ plasma defect-malposition of head and neck of talus

**What is the Simon rule of 15?**
For clubfoot, children <3 years → talo-navicular subluxation
T-C angle is <15° and talo-1$^{st}$ metatarsal angle is >15°

# Biomechanics

## 1st Ray/Bunion Evaluation

**Hallux interphalangeal angle**
Normal 0-10°

**DASA (distal articular set angle)**
Normal 7.5°

**PASA (proximal articular set angle)**
Normal 7.5°

**Types of joint deformities**
Congruent – joint lines are parallel
Deviated – joint lines intersect outside joint
Subluxed – joint lines intersect inside joint

**Types of bunion deformities**
Structural
- Bony deformity
- Abnormal PASA and DASA
- PASA + DASA = HA

Positional
- Soft tissue deformity with subluxed or deviated joint
- Normal PASA and DASA
- PASA + DASA < HA

Combined
- Elements of both structural and positional with subluxed or deviated joint
- Abnormal PASA and DASA
- PASA + DASA < HA

**Hallux abductus angle**
Normal 10-15°

**IM angle (intermetatarsal angle)**
Normal 8-12°
Head procedure if mild 10-13°
Shaft procedure if moderate 14-17°
Base procedure if severe 18-21°
Lapidus procedure if hypermobile 1st ray

**Metatarsus adductus angle**
Normal <20°

**True IM angle**
True IM angle = (metatarsus adductus angle - 15) + IM angle

**1st Metatarsal protrusion distance**
Normal +/- 2 mm compared to the 2nd metatarsal

**Tibial sesamoid position**
Normal 1-3

**ROM 1st MPJ**
Normal 65-75° dorsiflexion and 40° plantarflexion

**1st Metatarsal-medial cuneiform angle**
Normal 22°

**1st ray ROM**
Normal 5 mm dorsiflexion + 5 mm plantarflexion = 1 cm total ROM

## 5th Ray/Tailor Bunion Evaluation

**Fallat & Buckholz 4th IM angle**
Angle between bisection of 4th metatarsal and proximal-medial cortical border of 5th metatarsal
Normal 6°
Pathologic 8.7°

**Fallat & Buckholz Lateral Deviation angle (lateral bowing)**
Angle of line bisecting head and neck of 5th met and line adjacent to proximal-medial cortex
Normal 2.64°
Pathologic >8°

## Metatarsals/MPJ

**Metatarsal length**
Longest 2 > 3 > 5 > 4 > 1 shortest

**Metatarsal protrusion**
Longest 2 > 3 > 1 > 4 > 5 shortest

**Lesser MPJ dorsiflexion/plantarflexion**
30-40° Dorsiflexion and 50-60° plantarflexion

**Metatarsal declination angle**
Normal 21°

**Metatarsal abductus angle**
Normal 0-15°

**IM angle of 2nd and 5th metatarsals**
Normal 14-18°

## Splayfoot

**IM angle of 1st and 2nd metatarsals**
Pathologic >12°

**IM angle 4th and 5th metatarsals**
Normal 4-5°
Pathologic >9°
(Schoenhause says normal 4th IMA is 8°)

**Splayfoot**
1st IM angle >12° and 4th IM angle >8°
With metatarsus primus adductus, there is a high predilection of splayfoot

## Talus

**Talar neck angle**
Long axis of head and neck with long axis of the body

| | |
|---|---|
| Birth | 130-140° |
| Adult | 150-165° |

**Talar head and neck**
Plantarflexed 25-30°
Medially aligned 15° to body

**Talar torsion angle**
Head is laterally rotated on the body

| | |
|---|---|
| Fetus | 18-20° |
| Childhood | 30° |
| Adult | 40° |

*Note:* this motion brings the supinated foot in utero to a more pronated adult position

**Talar declination angle**
Normal 21°
Pronation – increases
Supination – decreases

**Meary angle – Lateral view**
Intersection of longitudinal axis of talus and 1st metatarsal
Normal 0°
Increases with either pronation or supination
Pronation – moves axis of the talus plantar to 1st metatarsal
Supination – moves axis of the talus dorsal to 1st metatarsal

**Cyma line**
S-shaped line formed by the articulation of T-N and C-C joints
Pronation – moves line anteriorly
Supination – moves line posteriorly

**Talo-navicular joint**
Normal 75° coverage
Pronation – decreases coverage
Supination – increases coverage

**Forefoot abductus**
Normal 8° (0-15°)

## Calcaneus

**Calcaneal inclination angle**
Normal 21°
Pronation – decreases
Supination – increases

**Hibb angle – Lateral view**
Intersection of longitudinal axis of calcaneus and 1st metatarsal

**Fowler & Philip angle**
Angle formed from the intersection of a line along the anterior tubercle and the plantar tuberosity and another line along the posterosuperior prominence at the Achilles tendon insertion
Normal <70°
Haglunds deformity >75°

**Total angle of Ruch**
Fowler & Philip angle + calcaneal inclination angle
Normal 90°
Haglunds deformity >90°

**Calcaneal-cuboid abduction**
Normal 0-5°
Increases with pronation

**Kite angle (Talocalcaneal) – AP view**
Infant 30-50°
Adult 20-40°
Pronation – increases
Supination – decreases

**Talocalcaneal angle – Lateral view**
Normal 25-50° (does not change with age)

# Rearfoot Angles

**Subtalar joint axis direction**
STJ goes through 1st ray in neutral, 2nd ray in supination, and is medial to 1st ray in pronation

**STJ axis of motion**
Lateral, posterior, plantar → medial, anterior, dorsal
48° from frontal plane
42° from transverse plane
16° from sagittal plane

**STJ ROM**
From neutral, 2/3 motion in inversion (20°) and 1/3 in eversion (10°)

**Longitudinal midtarsal joint**
75° from frontal plane
15° from transverse plane
9° from sagittal plane

**Oblique midtarsal joint**
38° from frontal plane
52° from transverse plane
57° from sagittal plane

**Bohler angle**
Angle formed by the intersection of a line from the superior aspect of the anterior process to superior aspect of the posterior facet and another line from the superior aspect of the posterior facet to superior point of the calcaneal process
Normal 25-40°
Decreases with intra-articular calcaneal fracture

**Gissane angle**
Angle formed by the intersection of a line along the posterior facet and another line along the middle and anterior facets
Normal is 125-140°
Increases with intra-articular calcaneal fracture

**Toyger angle**
Line drawn down posterior aspect
Normal should be a straight line (180°)
Decreases with Achilles rupture

# Ankle

**Dorsiflexion/plantarflexion**
Normal 10-20° dorsiflexion and 20-40° plantarflexion

**Axis**
Lateral, posterior, plantar → medial, anterior, dorsal

# Tibia

**Tibial torsion**

| | |
|---|---|
| Birth | 0° |
| 6 years | 13-18° |
| Adult | 18-23° |

**Tibial varum/valgum**
Compare distal 1/3 of tibia to ground

| | |
|---|---|
| Birth | 5-10° varum |
| >2 years | 2-3° valgum |

# Femur

**Angle of inclination**

| | |
|---|---|
| 1 year | 146° |
| 4 years | 137° |
| Adult | 120-136° (avg 127°) |

**Angle of declination (antetorsion angle)**

| | |
|---|---|
| 1 year | 39° |
| 10 years | 24° |
| Adult | 6° |

**Angle of anteversion**

| | |
|---|---|
| Birth | 60° |
| Adult | 10-12° |

# Lower Extremity Joint ROM

**Hip flexion/extension with knee extended**
Normal flexion 90-100°
Normal extension 10-20°

**Hip flexion with knee flexed**
Normal flexion 120-130°

**Rotation of hip**

| | Adults | Children |
|---|---|---|
| Internal rotation | 35-40° | 20-25° |
| External rotation | 35-40° | 45-50° |

**Hip abduction/adduction**
Abduction 24-60° (avg 36°)
Adduction <30°

**Knee flexion/extension**
Flexion 130-150°
Extension 5-10°

**Knee rotation with knee flexed**
Medial rotation 40°
Lateral rotation 40°

**Knee valgum/varus (bow leg, knock knee)**

| | |
|---|---|
| Birth | 15-20° (genu varum) |
| 2-4 yrs | 0° (straight) |
| 4-6 years | 5-15° (genu valgum) |
| 6-12 years | 0° (straight) |
| 12-14 years | 5-10° (genu valgum) |
| > 14 years | 0° (straight) |

## Clinical Tests

**What is the Ortolani test?**
Test for congenital hip dislocation in newborns. With newborn supine and hip and knees flexed, the hips are adducted while pressing downward and abducted while lifting upward. An unstable hip will dislocate when adducted and reduce when abducted.

**Barlow test?**
Test for a hip that is dislocatable but not dislocated in infants. With infant supine and hip and knees flexed, push posteriorly in line with the shaft of femur. An unstable femoral head will dislocate posteriorly from acetabulum.

**Galeazzi (or Allis) sign?**
Sign of unilateral congenital hip dislocation in infants. With infant supine and hip and knees flexed, the knees should be level. If a knee is lower, that hip is dislocated.

**Trendelenberg test?**
Test for weak hip abductors. As patient stands on affected limb, pelvis drops to opposite side.

# Surgery

## Surgical Prophylaxis

**What are indications for the use of antibiotics?**

- Implants (joint or internal fixation)
- Prolonged surgery (>2 h)
- Trauma surgery
- Revisional surgery
- Immunocompromised patient
- Extensive dissection required
- Intra-operative contamination
- Endocarditis (SBE)

**What antibiotics are most commonly used?**
Ancef
Clindamycin if PCN allergy
Vancomycin if concerned about MRSA

## Peri-operative Management

**What pre-op orders are needed for an in-house patient?**

- NPO after midnight, except AM meds with sips of water
- Hold all AM hypoglycemics and cover with SSI (if patient with DM)
- Accu-Check on call to OR (if patient with DM)
- Begin ½NSS @ 60 mL/h at 0600 (D5W½NSS if patient with DM)
- Labs – CBC with diff, PT/PTT/INR, BMP
- Chest X-ray, EKG (if necessary)
- Consult medicine for medical clearance (if not already done)
- Anesthesia to see patient (if necessary)

**What are indications for ordering a chest X-ray?**
>40 years of age, smoker, any history of cardiac or pulmonary disease

**What are indications for ordering an EKG?**
>40 years of age, any history of cardiac disease

**What is the most common time for post-operative myocardial infarction?**
Day 3

**How long should elective surgery be delayed following an MI or CABG?**
6 months

**How to calculate daily fluid input requirements?**
First 10 kg x 100 = 1000 mL/day
Second 10 kg x 50 = 500 mL/day
Remaining kg x 20 = ___ mL/day
(e.g. 70 kg patient requires 1000 + 500 + 1000 = 2500 mL/day)

**How to calculate IV fluid input rate?**
"421 Rule" calculates IV mL/h
First 10 kg x 4 = 40 mL/h
Second10 kg x 20 = 20 mL/h
Remaining kg x 1 = ___ mL/h
(e.g. 70 kg patient requires 40 + 20 + 50 = 110 mL/h)

**What other factors should be considered prior to surgery?**
Is the patient on any insulin, anticoagulants, steroids, or anything else that might put them at risk
*Note:* any non-routine orders should be cleared with patient's primary service

**What is the perioperative management for patients with diabetes?**
- NPO after midnight
- Start D5W½NSS in AM
- Accu-Check
- If insulin-controlled, hold regular insulin, give ½ NPH dose, and cover with SSI
- If oral-controlled, hold oral meds and cover with SSI
- If diet-controlled, cover with SSI

**What should be obtained prior to surgery on a patient with rheumatoid arthritis?**
Cervical spine x-ray

**What are effects of a long-term, high-dose course of steroids?**
Long-term therapy suppresses adrenal function
- Risk of poor or delayed wound healing. Decreased inflammatory process.
- Risk of infection. Low WBC may mask infection.

**What is the perioperative management for patients on long-term, high-dose steroids?**
Peri-op IV steroid supplementation
Hydrocortisone 100 mg IV given the night before surgery, immediately prior to surgery, and then q8h until postoperative stress relieved

**What is the perioperative management for patients at risk for gout?**
Begin colchicine 0.6 mg PO daily 3-5 days pre-op and continue 1 week post-op

**What is the perioperative management for patients with hypertension?**
If the patient has been on long-term diuretics (e.g. HCTZ, Lasix), check for hypokalemia
Avoid fluids high in sodium; may use ½NSS at low rate

**When should aspirin be discontinued prior to surgery?**
7 days due to irreversible binding to platelets

**When should NSAIDs be discontinued prior to surgery?**
3 days due to reversible binding to platelets

**When should heparin be discontinued prior to surgery?**
8 hours (monitor PTT)

**When to Coumadin be discontinued prior to surgery?**
3-4 days (monitor PT/INR)

**What should the INR be for elective surgeries?**
<1.4

**What should be done if the INR is >1.4?**
If necessary, transfuse Fresh Frozen Plasma (FFP)
One unit of FFP will decrease INR by approximately 0.2
Vitamin K can be given but is slow-acting

**When should a patient with an INR >1.4 be allowed to proceed to surgery?**

- If the risk of not doing surgery outweighs the risk of excessive bleeding (i.e. if it is an emergency surgery and you have anesthesia's approval)
- If the patient has PVD and the surgery is a simple debridement or amputation. *Note:* if the patient has PVD, make sure you have Vascular Surgery's approval for surgery. In this case, it is acceptable for the patient to bleed a little extra.

**If a patient with a high INR undergoes surgery, what labs should be carefully monitored?**
Hgb and Hct

**When should a RBC transfusion be given?**
If Hgb <8 or Hct<24, consider transfusing 1-2 units PRBC
One unit of PRBC will increase Hct by approximately 3 percentage points

**What should be done if the patient is thrombocytopenic?**
Order a six pack of platelets, which is a concentration of six pooled platelet units, and consult hematology

## Plastic Surgery

**How are relaxed skin tension lines (RSTL) oriented?**
Perpendicular to the long axis of the leg and foot

**Should a skin incision typically be made parallel or perpendicular to the RSTL?**
Parallel incisions will remain approximated and heal better while perpendicular incisions may gap apart due to increased transverse forces

**What is an anti-tension line?**
S-shaped or zig-zagged incision when exposure needed is not parallel to RSTL

**To close a lesion with minimal tension, what should the ratio of length to width be?**
3:1 length:width

**How much lengthening can be achieved with a 60° Z-plasty?**
75%

**To correct a skin contracture, how should the Z-plasty incisions be oriented?**
The central arm of the "Z" should be parallel to the contracture

**To correct a 5$^{th}$ digit adductovarus rotation, how should the skin incision be oriented?**
Distal medial to proximal lateral

**What is the order of wound graft closure?**
1. Direct closure
2. Graft
3. Local flap
4. Distant flap

**What are the stages of skin graft healing?**
1. Plasmatic
2. Inosculation of blood vessels
3. Re-organization
4. Re-innervation

**What are Blair and Humby knives?**
Knives for harvesting skin grafts

**What device is more commonly used to harvest skin grafts?**
Dermatome

**What is the most common complication of skin grafts?**
Seroma/hematoma

**How do you prevent it?**
Mesh or pie crust graft and apply compressive dressing

**What are advantages of using a split-thickness skin graft?**
Donor site heals spontaneously
May cover large wounds

**What are disadvantages?**
Grafts are fragile
Contraction of graft during healing
May be abnormally pigmented

**What are advantages of using a full-thickness skin graft?**
Minimal contraction of graft
Better appearance

**What are disadvantages?**
More difficult to take
Must close donor site

**What is an advantage of using a muscle flap?**
It brings immediate increased blood supply to donor site

## Fixation Devices

**AO principles of internal fixation (2002)**

- Anatomic articular reduction, adequate shaft reduction
- Stable/biologic fixation
- Preservation of blood supply
- Early ROM

**AO principles (1958)**

- Anatomic reduction
- Rigid internal fixation
- Preservation of blood supply
- Early ROM

**What are the steps to inserting a fully threaded screw?**

1. Overdrill near cortex
2. Underdrill through far cortex
3. Countersink
4. Measure
5. Tap
6. Screw

**How much of a screw should pass the far cortex?**
1 ½ threads

**What is the purpose of tapping?**
Creates a path for the screw threads

**Why do you countersink a screw?**
Prevents stress risers and soft tissue irritation
Provides even compression from screw head (land)

**Describe mini fragment screws**
Screw sizes of 1.5, 2.0, 2.7 – all fully threaded, cortical screws

**What is the screwdriver handle made out of?**
Pressed linen

**What are the differences between cortical and cancellous screws?**
Cortical has smaller pitch
Cortical has smaller rake angle
Cortical has smaller difference between thread diameter and core diameter

**Describe a malleolar screw**
For fixation of medial malleolus, partially threaded, same thread profile and pitch as cortical screw, trephedine self-cutting tip

**What screw has a fluted tip?**
Self-tapping

**What are the screw sizes? What are their underdrill sizes? Overdrill? Countersink**?

**Mini Fragment**

| Sizes | 1.5 | 2.0 | 2.7 | All are fully threaded |
|---|---|---|---|---|
| Overdrill | 1.5 | 2.0 | 2.7 | |
| Underdrill | 1.1 | 1.5 | 2.0 | |
| Countersink | 1.5 | 2.0 | 2.7 | |

**Small Fragment**

| Sizes | 3.5 | 4.0 fully threaded | 4.0 partially threaded |
|---|---|---|---|
| Overdrill | 3.5 | 4.0 | 4.0 |
| Underdrill | 2.5 | 2.5 | 2.5 |
| Countersink | 3.5 | 4.0 | 4.0 |

**Large Fragment**

| Sizes | 4.5 | 4.5 malleolar | 6.5 partially threaded | 6.5 fully threaded |
|---|---|---|---|---|
| Overdrill | 4.5 | 4.5 | 6.5 | 6.5 |
| Underdrill | 3.2 | 3.2 | 3.2 | 3.2 |
| Countersink | 4.5 | 4.5 | 6.5 | 6.5 |

**What sizes are in the Synthes modular hand screw system?**
1.0, 1.3, 1.5, 2.0, 2.4, 2.7

**What are the cannulated screw sizes?**
For Synthes 3.0, 4.0
For Smith & Nephew 4.0, 6.5, 5.5 and 7.0

**What are the steps for inserting a 4.0 cannulated screw?**
1. Insert 1.3 mm guide pin to far cortex
2. Measure
3. Drill near cortex with 4.0 cannulated bit (optional)
4. Drill far cortex with 2.7 cannulated bit (unnecessary for soft bone)
5. Tap (unnecessary with self tapping screws)
6. Countersink
7. Screw

**What is a Herbert screw?**
Headless screw – can be inserted through articular cartilage. Threaded portion proximally and distally and smooth in between. Proximal portion has tighter pitch for compression.

**What is a Reese screw?**
Headless – create compression through arthrodesis. Proximal threads run clockwise, and distal threads run counterclockwise. Smooth in between.

**What are the K-wire sizes and widths in millimeters?**

| Size | 0.028 | 0.035 | 0.045 | 0.062 |
|---|---|---|---|---|
| Width (mm) | 0.6 | 0.9 | 1.2 | 1.6 |

**Why is there a question about K-wires in a screw set section?**
K-wires can be used for the underdrill if the situation arises (e.g. underdrill bit is missing or it fell on the floor)
The 0.062 can be used for the 1.5 underdrill (for the 2.0 screw)
The 0.045 can be used for the 1.1 underdrill (for the 1.5 screw)

**What are the K wire sizes and their appropriate caps?**

| 0.028 | 0.035 | 0.045 | 0.062 |
|---|---|---|---|
| Yellow | Blue | White | Green |

(young boys wear green)

**What are the sizes of Steinman pins?**
Every one from 5/64 to 12/64 except for 11/64

**What are the different types of plate fixation?**
Compression
- Provides axial compression of fracture
- Pre-bend plate
- Eccentric drilling of hole adjacent to fracture; remaining holes drilled centrally
- Place plate on tension side of bone

Neutralization
- Protects against shear, bending, and torsional forces at the fracture site
- Interfragmental compression obtained by lag screws
- All holes drilled centrally

Anti-glide
- Neutralization plate placed on the posterior aspect of the fibula

Buttress
- Maintains alignment of unstable fracture fragments
- No interfragmental compression

**Should a plate be placed on the tension or compression side of a fracture?**
Tension

**Is the tension side of a metatarsal on the dorsal or plantar aspect?**
Plantar

**What is a locking plate?**
Plate in which threaded screws are secured in to threaded plate holes
Does not rely on the bone for stability but rather forms a fixed-angle construct
Good for osteoporotic, comminuted fractures, or revision surgeries

**What is the Hooke law?**
For a material under load, strain is proportional to stress

**What is the Young modulus?**
After a load is removed, the material will spring back to its original shape, the resulting slope represents the stiffness of a material or the Young modulous

## Suture and Absorbable Fixation Devices

**What is a Keith needle?**
Straight needle

**What are some common needle point configurations?**
Taper point – for soft, easily penetrated tissue (subcutaneous tissue, fascia)
Cutting – cutting edge on inner curve (skin)
Reverse cutting – cutting edge on outer curve for tough, difficult to penetrate tissue

**What is orthofix?**
Polyglycolic acid (same as dexon)

**How long for orthofix to lose strength/absorb?**
Loses strength in 6-12 weeks
Absorbed in 1-3 years

**What is orthosorb?**
PDS (PDS=orthosorb)

**How long before PDS loses its strength? When is it absorbed?**
Loses strength in 4-6 weeks
Absorbed in 3-6 months

**What are the two sutures that are the least reactive to tissue?**
Stainless steel (least reactive), Prolene

**What is Vicryl?**
Polyglactin 910 (a copolymer of 90% glycolide and 10% lactide)

**How is Vicryl broken down?**
Hydrolysis

**How long does it take to absorb Vicryl?**
Tensile strength
- 75% @ 2 weeks
- 50% @ 3 weeks
- 25% @ 4 weeks

Absorbed completely in 10 weeks

**Should you use Vicryl with an infection?**
Avoid it if possible, since Vicryl is too reactive

## Arthroscopy

**Who first describe arthroscopy?**
Takagi

**Who were the first podiatrists to describe a podiatric use for arthroscopy?**
Heller & Vogel (1982)

**What are the different scope techniques?**
Scanning – side to side, up and down
Pistoning – in and out
Rotation – 360°

**What are a few indications for an ankle scope?**
Synovitis
Osteochondral lesion/fracture
Soft tissue impingement
Osteophytes
Loose bodies

**What are other uses for arthroscopy?**
Endoscopic plantar fasciotomy (EPF) or endoscopic gastroc recession
Ankle fusion
Arthroscopy of STJ or 1st MPJ

**What is the most common complication following an EPF?**
Lateral column instability → calcaneal-cuboid joint pain

## 1st Ray Surgery

**What is the most common indication for a Lapidus?**
Hypermobile 1st ray

**What is the order of the lateral release for a McBride?**
1. Extensor hood
2. ADH tendon release
3. Fibular sesamoid ligament
4. Lateral collateral ligament
5. FHB
6. Fibular sesamoid excision (if performing)

**What is the difference between a Vogler, Kalish, and Youngswick?**
Vogler – offset V (apex at metaphyseal-diaphyseal joint)
Kalish – long-arm Austin with angles of approximately 55° for screw fixation
Youngswick – Austin with a slice taken dorsally to allow decompression and plantar flexion

**What procedures correct PASA?**
Reverdin
Peabody
Biangular Austin
DRATO
Offset V with rotation

**What procedure corrects DASA?**
Proximal Aikin

**What procedure corrects hallux interphalangeous?**
Distal Aikin

**What are complications associated with a Keller?**
Diminished propulsion of digit, loss of hallux purchase, stress fracture of 2nd metatarsal

**What should be done if the capital fragment falls on the floor?**
1. Rinse with saline
2. Bacitracin soak for 15 minutes
3. Rinse with saline
4. Bacitracin soak for 15 minutes
5. Rinse with saline
6. Document and inform patient

# Post-Op White and Blue Toes

**What are causes of a white toe post-operatively?**
Arterial in nature, usually acute
Signs – pain, pale, parasthesia, pulselessness

**What are treatments for a white toe?**
- D/C ice and elevation
- Loosen bandages
- Place foot in dependent position
- Rotate K-wire
- Apply warm compresses proximally
- Apply nitroglycerine paste proximally
- Local nerve block proximally
- Avoid nicotine
- Consult vascular surgery

**What are causes of a blue toe?**
Poor arterial inflow – toe is cold and doesn't blanch with pressure
Poor venous outflow – toe is warm and will blanch with pressure

**What are treatments for blue toe due to arterial insufficiency?**
- (Treat like white toe)
- D/C ice and elevation
- Loosen bandages
- Place foot in dependent position
- Rotate K-wire
- Apply warm compresses proximally
- Apply nitroglycerine paste proximally
- Local nerve block proximally
- Avoid nicotine and caffeine
- Thermostat controlled heat lamp, not to exceed 90°
- Vasodilators
- Consult vascular surgery

**What are treatments for blue toe due to sluggish venous outflow?**
- D/C ice (but not elevation)
- Loosen bandages
- Avoid dependency
- Don’t attempt to increase vascular perfusion
- Consult vascular surgery

# Rearfoot Surgery

**Describe a Keck & Kelly procedure?**
For Haglund deformity with cavus foot and high calcaneal inclination angle. Remove wedge from posterior-superior aspect of calcaneus. The posterior superior prominence is moved anteriorly.

**What are treatments for equinus?**
Stretching/exercises
Night splints
Gastroc recession
- Strayer
- Vulpius
- Baker
- McGlamary & Fulp

Tendoachilles lengthening
- Open/closed Z
- Hauser
- White
- Hoke
- Sgarlato
- Stewart

**What is the Murphy procedure?**
Achilles advancement for spastic equinus

**Name surgical procedures for pes planus**
Transverse
- Evans
- Kidner
- C-C distraction arthrodesis

Sagittal
- Cotton
- Young
- Lowman
- Hoke
- Miller
- Cobb

Frontal
- Koutsogiannis
- Dwyer
- Chambers
- Gleich
- Baker-Hill
- Lord

**Name surgical procedures for pes cavus**
Tendon
- Jones
- Hibbs
- STATT
- PT

Bone
- Dorsiflexory osteotomy of 1st metatarsal
- Cole
- Japas

**What is an arthroereisis?**
A surgical procedure to limit joint mobility (i.e. MBA implant in sinus tarsi)
Typically want 2-4° of STJ eversion with implant

**What is the Valente procedure?**
STJ block using a polyethylene plug with screw threads. Allows 4-5° of STJ pronation.

**Who first described the triple arthrodesis?**
Ryerson

**What order do you resect and what order do you fixate the joints in a triple arthrodesis?**
Resection
1. Midtarsal joints (T-N, CCJ)
2. Subtalar joint (T-C)

Fixation (opposite order)
1. Subtalar joint
2. Midtarsal joints

**What are some types of fixation for a triple arthrodesis?**
6.5-7.0 mm interfragmental compression screws, staples, plates

**What are FDA-approved total ankle implants?**
Two-component devices
- Agility
- Eclipse
- INBONE
- Salto Talaris

Three-component devices
- STAR
- (Not FDA-approved – Buechal-Pappas, TNK, HINTEGRA)

# Bone Healing

**What are the stages of bone healing?**
Bone heals either primarily or secondarily
Primary healing – no motion and no callus formation
1. Inflammation
2. Induction
3. Remodeling

Secondary healing – micro-motion with callus formation
1. Inflammation
2. Induction
3. Soft callus
4. Hard callus
5. Remodeling

**What are some factors that negatively affect bone healing?**
Smoking, antimetabolite or steroid therapy, anemia, osteoporosis

**Name the types of non-unions**
Hypertrophic
- Elephant foot
- Horse hoof
- Oligotrophic

Atrophic
- Torsion wedge
- Comminuted
- Defect
- Atrophic

**What study can distinguish between a hypertrophic and an atrophic non-union?**
Bone scan – positive for a hypertrophic and negative for an atrophic (avascular) non-union

**What is a pseudoarthrosis?**
Type of non-union in which fibrocartilaginous tissue forms between fracture fragments

**What are indications for bone stimulators?**
Non-union, failed fusion

**What are contraindications for bone stimulators?**
Pseudoarthrosis, gap greater than ½ bone diameter

**What are the stages of avascular necrosis?**
1. Avascular – loss of blood supply, epiphyseal growth ceases
2. Revascularization – infiltration of new blood vessels, new bone deposited on dead bone, flattening or fragmentation of articular surface
3. Repair and remodeling – bone deposition replaces bone resorption
4. Residual deformity – restoration of epiphysis, sclerosis, deformed articular surface

**What is the best study for evaluating avascular necrosis?**
MRI – decreased signal intensity within medullary bone in both T1 and T2 images

# Bone Grafts

**What are the different types of bone grafts?**
Osteogenic – able to synthesize new bone
- Mesenchymal stem cells from autologous bone or bone marrow aspirate

Osteoinductive – contains factors that induce host tissue to form new bone
- Demineralized bone matrix
- Bone morphogenic protein
- Platelet-derived growth factors

Osteoconductive – provides scaffold for host tissue to propagate new bone
- Allografts
- Hydroxyapatite
- Calcium phosphate
- Calcium sulfate

**What type of bone graft is osteogenic, osteoinductive, and osteoconductive?**
Autograft

**What are the stages of bone graft healing?**
1. Vascular ingrowth
2. Osteoblastic proliferation
3. Osteoinduction
4. Osteoconduction
5. Graft remodeling

**What is an early radiographic finding of bone graft healing?**
Initial radiolucency of the graft due to increased osteoclastic activity which is followed by osteoblasts laying down new bone

**What is creeping substitution?**
Process in which the host's cutting cone (osteoclasts followed by osteoblasts) invade bone graft

# Miscellaneous

**What is the ASA classification for general anesthesia?**
Class 1 – healthy
Class 2 – mild systemic disease
Class 3 – severe systemic disease
Class 4 – incapacitating systemic disease that is a threat to life
Class 5 – moribund patient who is not expected to live without surgery
Emergency

**What is the maximum tourniquet time?**
90-120 minutes
After that, allow 5 minutes of perfusion for every half hour over

**What are contraindications to using a tourniquet?**
Infection
Open fracture
Sickle cell disease
Peripheral vascular disease
Recent arterial graft
Previous DVT
Hypercoagulability
Skin grafts application where bleeding must be distinguished

**According to Seddon, what are the different types of nerve damage?**
Neuropraxia – nerve contusion resulting in conduction block that recovers promptly
Axonotmesis – interruption of axons with distal Wallerian degeneration. Supporting connective tissue sheaths remain intact allowing regeneration.
Neurotmesis – complete severance of the nerve that is irreversible

**What is the difference between an incisional and excisional biopsy?**
Incisional – only a portion of the lesion is removed
Excisional – the entire lesion is removed

**What are different biopsy techniques?**
Punch, shave, curettage, surgical excision

**How does a bone stimulator work?**
Piezoelectric principle – side under compression makes a negative charge that leads to bone growth. Therefore, placing a cathode in a non-union site will stimulate growth.

**What is the direction of the cut for reverse Wilson of the 5th metatarsal?**
Distal lateral to proximal medial

**Who was the first to describe an arthrodesis?**
Soule

**What is the order for hammertoe surgery?**
*Note:* Perform a Kelikian push-up test to determine if the next step is required

1. PIPJ
    - Tendon
    - Dorsal capsule
    - Collaterals
    - Plantar capsule
    - Arthroplasty

2. MPJ
    - Hood
    - Tendon
    - Capsule
    - Plantar plate
3. PIPJ
    - Arthrodesis

**Why are joint implants used?**
Maintain space between bony surfaces
Relieve pain

**What is the lag time for presentation of osteomyelitis on an X-ray?**
10-14 days

**How to culture osteomyelitis?**
Take one culture from the infected bone, and take a second culture proximal to the clearance margin to ensure remaining bone is not infected

**What is a Brodie abscess? What is the treatment?**
Subacute osteomyelitic lesion usually found in children. It is a well-circumscribed, lytic lesion with sclerotic borders found in the metaphysis, epiphysis, and rarely diaphysis. Painful with periods of exacerbation and remission.
Tx: curettage and packing with autologous bone

**What is in antibiotic beads?**
PMMA or Poly(methyl methacrylate). Gentamycin or tobramycin are often used since they are heat stable with good diffusion coefficiencies. Vancomycin and cefazolin may also be used.

# Trauma

**What should be done when assessing a patient with trauma?**
Primary survey (ABCDE)

- Airway
- Breathing
- Circulation with hemorrhage control
- Disability – assess neurologic status
- Exposure of patient and environmental control

Secondary survey

- Full history – medical and drug
- Thorough examination
    - Evaluate tenderness and stability as well as neurovascular status of each limb
    - Is there injury to joint above or below?
- X-rays and/or CT of all suspected fractures

**What should always be asked with a break in the skin?**
Tetanus status

**Name the appropriate classification**

| | |
|---|---|
| Distal phalangeal/nail | Rosenthal |
| 1st Metatarsophalangeal | Jahss |
| 5th Metatarsal base | Stewart |
| Lisfranc joint | Quenu & Kuss, Hardcastle |
| Navicular | Watson Jones |
| Posterior tibial tendon | Conti (based on MRI findings) |
| Talar neck | Hawkins |
| Talar body | Sneppen |
| Talar dome | Berndt-Hardy, Fallot & Wy |
| Calcaneus | Rowe, Essex-Lopresti, Sanders |
| Anterior process calcaneal fracture | Degan |
| Ankle sprains | O'Donoghue, Leach, Rasmussen |
| Physeal ankle fracture | Dias & Tachdjian |
| Epiphyseal fracture | Salter-Harris |
| Ankle fracture | Lauge-Hansen |
| Pilon fracture (distal tibia metaphysis) | Ruedi & Allgower, Dias & Tachdjian |
| Achilles rupture | Kuwada |
| Open fracture | Gustillo |
| Non-unions | Weber & Cech |
| Frostbite | Orr & Fainer, Washburn |

**What is a clinical test for a fracture?**
Point tenderness over fracture site

**What are common fracture patterns?**
Transverse, greenstick, torus, oblique (spiral), comminuted

**Which is the most stable pattern?**
Transverse is most stable

**What is the weakest region of the physis?**
Zone of cartilage maturation

**What is the Vassal principle?**
Initial fixation of the primary fracture will assist stabilization of the secondary fractures

**What are possible complications of fractures?**
Delayed union
Non-union
Pseudoarthrodesis
OA
AVN

**What is the most common cause of non-healing for a bone fracture?**
Improper immobilization

**Who was Lisfranc?**
He was a field surgeon in Napoleon's army

**Are dorsal or plantar Lisfranc dislocations more common?**
Dorsal – the plantar ligaments are stronger than dorsal

**What are the Ottowa Ankle Rules?**
A series of ankle X-ray films is required only if there is any pain in the malleolar zone and any of the following findings:

- Bone tenderness at posterior edge or distal 6 cm of lateral malleolus
- Bone tenderness at posterior edge or distal 6 cm of medial malleolus
- Inability to bear weight both immediately and in ED

A series of foot X-ray films is required only if there is any pain in midfoot zone and any of the following findings:

- Bone tenderness at base of 5$^{th}$ metatarsal
- Bone tenderness at navicular
- Inability to bear weight both immediately and in ED

## Talar Fractures

**What is the classification for talar dome lesions?**
Berndt & Hardy

**What stages of Berndt & Hardy are often associated with lateral ankle ligament ruptures?**
II, III, IV

**What are the common locations of talar dome lesions and their mechanisms of injury?**
(DIAL a PIMP)
Dorsiflexion Inversion – Anterior Lateral (unstable, shallow, wafer-shaped lesion)
Plantarflexion Inversion – Medial Posterior (deep, cup-shaped lesion)

**What is Hawkins sign?**
Presence of subchondral talar dome osteopenia seen 6-8 weeks after talar fracture signifying intact vascularity. Absence of the sign implies AVN.

**What is the Sneppen classification?**
Talar body fractures

**What percentage of fractures of the talus involve the calcaneus?**
60%

**Of these fractures, how many involve the joint?**
75%

## Calcaneal Fractures

**What is a Mondor sign?**
Plantar, rearfoot ecchymosis that is pathognomonic for calcaneal fractures

**How is the Bohler angle affected by a calcaneal fracture?**
Decreases with intra-articular calcaneal fracture

**How is the Gissane angle affected by a calcaneal fracture?**
Increases with intra-articular calcaneal fracture

**What fractures are commonly associated with calcaneal fractures?**
Vertebral fractures, especially L1
Femoral neck
Tibial plateau

**What is the mechanism of injury for an anterior process fracture?**
Inversion with plantarflexion

## Ligamentous Ruptures

**What are tests for ankle ligament pathology?**
Anterior drawer test
Calcaneofibular-stress inversion
Abduction stress
Ankle arthrogram
Peroneal tenography

**Describe the anterior drawer test**
5-8 mm drawer → rupture of ATF
10-15 mm drawer → rupture of ATF + CF
>15 mm drawer → rupture of ATF + CF + PTF

**Describe the talar tilt test**
>10° → rupture of CFL

**Describe the stress inversion test**
5° inversion → rupture of ATF
10-30° inversion → rupture of ATF + CF

# Achilles Tendon Ruptures

**What are clinical symptoms of an Achilles tendon rupture?**
Pain with history of "pop"
Weakness or loss of function
Palpable dell in area of ruptured tendon
Inability to perform single leg rise
Increased ankle dorsiflexion

**What is the Thompson test?**
A positive test results when squeezing of the calf muscle does not plantarflex the foot

**What is the Hoffa sign?**
Increased dorsiflexion compared to the contralateral side along with the inability to perform a single leg rise test

**What is a radiographic finding of an Achilles tendon rupture?**
Disruption of Kagers triangle

**Where is the most common location for the Achilles tendon to rupture?**
1.5-4 cm proximal to the calcaneal insertion

# Ankle Fractures

**Name the fractures**

| | |
|---|---|
| Pott | Bimalleolar fracture |
| Cotton | Trimalleolar fracture |
| Tillaux-Chaput | Avulsion fracture of anterior, lateral tibia from AITFL |
| Wagstaff | Avulsion fracture of anterior, medial fibula from AITFL |
| Volkman | Posterior tibial malleolar fracture from PITFL |
| Cedell | Fracture of posterior medial process |
| Shepard | Fracture of posterior lateral process |
| Foster | Entire posterior process |
| Bosworth | Lateral malleolar fracture with ankle displacement |
| Maisonneuve | Proximal fibular fracture |

**What is the most common mechanism of injury (MOI) causing an ankle fracture?**
SER

**What is the MOI causing a transverse lateral malleolar fracture?**
SAD I

**What is the MOI causing a short, oblique medial malleolar fracture?**
SAD II

**What is the MOI causing a short, oblique lateral malleolar fracture (AP view)?**
PAB III

**What is the MOI causing a spiral, lateral malleolar fracture with a posterior spike (AP and Lateral views)?**
SER II

**What is the MOI to the ankle with a high fibular fracture? What is this fracture called?**
PER III
Maisonneuve fracture

**What is a Lauge-Hansen Type V?**
Pronation dorsiflexion

1. Vertical tibial malleolar tip fracture
2. Anterior tibial lip fracture
3. Supramalleolar fibular fracture
4. Transverse posterior tibia fracture level with proximal aspect of anterior tibial fracture

**When should a posterior malleolar fracture be fixated?**
ORIF when fragment is greater than 25% of the posterior malleolus

**What direction should transsyndesmotic screws be inserted?**
Approximately 30° from the sagittal plane from posterior-lateral to anterior-medial

**Should transsyndesmotic screws be inserted using a lag technique?**
No. Fully-threaded cortical screws are placed across both cortices of the fibula and the lateral cortex of the tibia. The goal is stabilization rather than compression.

**What do you test clinically test via Jack Toe Test?**
Foster fracture – a fracture of the entire posterior process

**What is the Thurston-Holland sign?**
Epiphysis is separated from the physis with the fracture extending into the metaphysis resulting in a triangular fracture fragment (AKA Flag sign)

# Bone Tumors

**What are the different patterns of bone destruction?**
Geographic – well-defined, short zone of transition → benign or low-grade malignancy
Moth-eaten – more aggressive, intermediate zone of transition → benign or malignant
Permeative – poorly-defined, wide zone of transition → malignant

**What are the different patterns of periosteal reactions?**
Single layer – benign but sometimes malignant
Onion skin – malignant, multiple layers of periosteum
Sunburst – spiculated rays
Hair on end – parallel rays
Codman triangle – triangular elevation of periosteum

**Name benign bone tumors of the foot**
(FOG MACHINES)
F – fibrous dysplasia
O – osteochondroma
G – giant cell tumor
M – myeloma
A – aneurysmal bone cyst
C – chondroblastoma, chondromyxoid fibroma, clear cell
H – hemangioma
I – infection
N – non-ossifying fibroma
E – eosinophillic granuloma, enchondroma, epidermal inclusion cyst
S – solitary bone cyst

**Name malignant bone tumors of the foot**
Chondrosarcoma
Osteosarcoma
Periosteal sarcoma
Ewings sarcoma
Fibrosarcoma
Multiple myeloma

**What is the most common, benign, primary bone tumor?**
Osteochondroma

**What is the most common, malignant, primary bone tumor?**
Multiple myeloma

**What primary bone tumors are more frequent in females?**
Giant cell tumor
ABC
Parosteal osteosarcoma

**What are the most common cancers that metastasize to foot?**
Breast, prostate, lung, kidney

**What bone tumors do not form matrix?**
Bone cysts
Ewings sarcoma
Giant cell tumor

**What are bone tumors typically located?**
Epiphysis
- Chondroblastoma
- Giant cell tumor (forms in metaphysis)

Metaphysis
- Enchondroma (also diaphyseal)
- Osteochondroma
- Nonossifying fibroma
- Unicameral bone cyst
- Aneurysmal bone cyst
- Giant cell tumor (extends into epiphysis)
- Medullary osteosarcoma
- Parosteal osteosarcoma
- Chondrosarcoma

Diaphysis
- Osteoid osteoma
- Osteoblastoma
- Enchondroma (also metaphyseal)
- Ewings sarcoma (also meta-diaphysis)
- Periosteal osteosarcoma

Centrally located
- Enchondroma
- Unicameral bone cyst

Eccentrically located within medullary canal
- Giant cell tumor
- Chondrosarcoma
- Osteosarcoma

Cortical
- Osteoid osteoma
- Nonossifying fibroma

Periosteal

- Osteochondroma
- Periosteal osteosarcoma

**What are characteristics of an osteoid osteoma?**

- Benign, osteolytic lesion with central nidus (<1 cm) that may have calcifications
- 1st to 2nd decades of life
- Dull pain, worse at night, relieved with ASA

**What are characteristics of an osteoblastoma?**

- "Giant osteoid osteoma"
- Benign tumor that may become malignant
- Osteolytic lesion with well-circumscribed nidus (>1.5 cm) that may have multiple calcifications
- 2nd to 3rd decades of life
- Less symptomatic than osteoid osteoma, pain not relieved by ASA

**What are characteristics of an enchondroma?**

- Benign, well-defined, intramedullary, cartilaginous lesion
- Geographic lesions with punctuate calcified matrix
- 3rd to 4th decades of life
- Painless swelling unless pathologic fracture

**What is Ollier disease?**

- Multiple enchondromatosis
- May become malignant
- 1st decade of life

**What is Maffuccis disease?**

- Multiple enchondromas with soft tissue hemangiomas
- Most become malignant
- 1st decade of life

**What are characteristics of a chondroblastoma?**

- Benign, geographic, osteolytic, lesion with sclerotic margins
- 2nd to 3rd decade of life
- Pain and joint effusion

**What are characteristics of an osteochondroma?**

- Most common benign primary bone tumor
- Cartilage-capped, hyperplastic bone pointing away from the joint
- 2nd to 4th decades of life
- Suspect malignant transformation with growth after skeletal maturity, pain, or cap >2 cm

**What are characteristics of nonossifying fibromas?**

- Benign connective tissue lesion with fibrous replacement of bone
- Expansive, radiolucent, medullary lesions
- 1st to 2nd decades of life
- Lesions typically resolve with age
- Do not biopsy

**What are characteristics of a fibrous dysplasia?**

- Benign, geographic, fibro-osseous lesion with ground glass matrix
- Presents with deformity
- Sometimes painful 2° to fracture

**What are characteristics of a unicameral bone cyst?**

- Benign, geographic, medullary lesion that is fluid-filled
- Commonly found in calcaneus
- Fallen fragment sign – pathologic fracture in which cortex lies within lesion
- 1st to 2nd decades of life
- Asymptomatic until fracture

**What are characteristics of an aneurysmal bone cyst?**

- Benin, expansile, lytic lesion with blood-filled cavities
- May extend into soft tissue
- Fluid-fluid levels seen on MRI
- 1st to 3rd decades of life
- More common in females
- Painful, especially with pathological fractures

**What are characteristics of a giant cell tumor?**

- Benign but locally aggressive, lytic lesion with ground glass, “soap bubble” appearance
- May destroy cortex and have soft tissue mass
- More common in females
- 3rd to 4th decades of life
- Painful

**What are characteristics of a multiple myeloma?**

- Most common primary malignant bone tumor
- Punched out lesions or diffusely osteopenic with hair-on-end radiating spicules
- Affect 45-80 y/o
- Painful with weakness or neurologic symptoms
- Bence-Jones protein found within urine

**What are characteristics of an osteosarcoma?**

- Most common primary malignant bone tumor
- Sunburst periosteal reaction with Codman triangle and cloud-like, dense bone formation
- 2nd to 3rd decades of life
- Dull aching pain
- Medullary
    - Poor prognosis
- Parosteal
    - More common in females
    - Better prognosis than medullary
- Periosteal
    - Slightly better prognosis than medullary

**What is the most common bone tumor associated with Paget disease?**
Osteosarcoma

**What are characteristics of a Ewings sarcoma?**

- Common, malignant, primary bone tumor
- Aggressive, permeative, lytic lesion with hair-on-end, Codman triangle, and onion skin (wings and onion rings)
- May have large soft tissue mass
- Usually under 20 y/o
- Painful with fever, weight loss, and elevated ESR
- Poor prognosis

**What are characteristics of a chondrosarcoma?**

- Common, malignant, moth-eaten, lesion with medullary and soft tissue calcifications
- May arise from malignant transformation of enchondromas or osteochondromas
- 5th to 6th decades of life
- Painful

**What study is most useful in searching for metastatic bone disease?**
Total skeletal bone scan
Malignant lesions will show increased uptake

# Wound Care

**What are the stages of wound healing?**

1. Inflammatory (lag) phase
    - Days 1-4
    - Initial vasoconstriction (minutes) followed by vasodilation (days)
    - Neutrophils and macrophages are recruited
2. Proliferative (repair) phase
    - Days 3-21
    - Collagen synthesis provides tensile strength of wound
    - At 14 days, tensile strength of would equals that of suture
3. Remodeling (maturation) phase
    - Days 21 up to one year

**In what stage of healing do chronic wounds stop progressing?**
Proliferative

**What is Santyl?**
collagenase – an enzymatic debrider that digests collagen in necrotic tissue

**What is Regranex?**
PDGF-1 (platelet derived growth factor)

**Where is Regranex made?**
Puerto Rico (I was really asked this once)

**What is a normal value for serum albumin?**
3.4-5.0 g/dL

**What is a low serum albumin level (<3.5 g/dL) associated with?**
Decreased wound healing
Edema
Impaired cellular immunity
Decreased collagen synthesis
Decreased fibroblast proliferation

**What minimum ABI is necessary for wound healing?**
Non-diabetic patient – 0.35
Diabetic patient – 0.45

**Using transcutaneous oximetry, what minimum pressure is necessary for wound healing?**
Non-diabetic patient – 30 mm Hg
Diabetic patient – 40 mm Hg

**How does negative pressure wound therapy (e.g. Wound VAC) assist wound closure?**
NPWT applies mechanical shear stress to the wound site. This is believed to promote granulation by decreasing bacterial bioburden, reducing edema, and inducing capillary budding.

**How does hyperbaric oxygen therapy assist wound closure?**
HBOT increases the partial pressure of $O_2$ in arterial circulation, which increases diffusion of $O_2$ at the wound site. This is believed to increase growth factors promoting angiogenesis and collagen synthesis.

## Bioengineered Tissue

**What is Integra?**
Bilayer graft composed of bovine tendon collagen with chondroitin-6-sulfate and a silicone layer to control moisture loss

**Oasis?**
Extracellular graft matrix derived from porcine, small intestine submucosa

**Apligraf?**
Bilayer graft derived from neonatal foreskin with dermal and epidermal layers

**GraftJacket?**
Extracellular graft matrix derived from human tissue with intact vascular channels

**TissueMend?**
Acellular collagen matrix derived from fetal bovine dermis

# Classifications

*Note:* Although all of the classifications are important, the ones in bold and capitalized (i.e. LAUGE-HANSEN) are the most commonly used.

# Forefoot

## Hallux Valgus

Stage 1
- Excess pronation causes hypermobility of 1st ray. Tibial sesamoid ligament gets stretched & fibular sesamoid ligament contracts.
- Lateral subluxation of proximal phalanx occurs

Stage 2
- Hallux abductus progresses, touches against 2nd digit
- FHL & FHB gain lateral mechanical advantage
- Crista starts to erode

Stage 3
- Further subluxation at 1st MPJ, formation of IMA
- IMA increases secondary to retrograde forces from abductor hallucis

Stage 4
- Hallux subluxes & dislocates on 1st metatarsal
- Increased crista erosion

## Hallux Limitus

**REGNAULD** (Foot, 1986)

Grade 1 – functional hallux limitus with dorsal spurring
- Intact sesamoids with no associated disease
- Joint enlargement but joint space narrowing and arthrosis
- <40° dorsiflexion and <20° plantarflexion

Grade 2 – broad flat metatarsal head with structural elevatus and significant spurring
- Pain at rest
- Osteochondral defects in metatarsal head and sesamoidal hypertrophy
- Joint space hypertrophy and narrowing
- 75% decrease in total ROM

Grade 3 – ankylosis and articular hypertrophy with extensive peri-articular osteophytes
- Osteochondral defect with joint mice and extensive 1st metatarsal-sesamoid disease
- Severe loss of joint space or collapse of joint → bone on bone
- FDL contracture

**MODIFIED REGNAULD/OLOFF** (ACFAS, 1994)
Stage 1 – functional hallux limitus
- Limited dorsiflexion with weightbearing but normal ROM with non-weightbearing
- No DJD changes on x-ray
- No pain on end ROM

Stage 2 – joint adaptation
- Flattening of metatarsal head with small dorsal exostosis
- Pain on end ROM

Stage 3 – joint deterioration
- Severe flattening of metatarsal head with non-uniform joint space narrowing, osteophytes, and subchondral sclerosis/cysts
- Crepitus on ROM

Stage 4 – ankylosis
- Obliteration of joint space with osteophyte fragmentation
- Minimal to no ROM

**Drago, Oloff, and Jacobs** (J Foot Ankle Surg, 1984)
Grade 1 – pre-hallux limitus
- Pain on end ROM
- X-Rays: plantar subluxation of proximal phalanx, met primus elevatus, minimal DJD
- Joint preservation/reconstruction surgery

Grade 2 – flattening of metatarsal head
- Pain on end ROM, limited ROM
- X-Rays: small dorsal exostosis, osteochondral lesion, flattened met head
- Joint preservation/reconstruction surgery

Grade 3 – severe flattening of the metatarsal head
- Pain on full ROM, crepitus
- X-Rays: large dorsal exostosis, marked flattened met head, osteophytic production, non-uniform joint space narrowing
- Joint preservation/reconstruction surgery

Grade 4 – obliteration on joint space with joint mice
- <10° ROM
- May be asymptomatic if ankylosed
- X-Rays: loss of joint space, loose bodies
- Joint destructive surgery

**Hanft** (J Foot Ankle Surg, 1993)
Grade 1 – metatarsus primus elevatus, mild dorsal exostosis, and sclerosis around MPJ
Grade 2 – Grade 1 with flattening of metatarsal head, joint space narrowing, and dorsal/lateral osteophytes
Grade 3 – Grade 2 with DJD findings (osteophytes, subchondral sclerosis, and cysts)
Grade 4 – Grade 2 with severe flattening and sesamoid hypertrophy
Grade 5 – Grade 3 with DJD findings

**Ktavitz, Laporta, Lauton** (1994)
Stage 1 – normal to mild flattening of the head
Stage 2 – minimal narrowing
Stage 3A – irregular joint space narrowing with dorsal spurring and cysts
Stage 3B – minimal joint space with loose bodies and large dorsal flag
Stage 4 – no joint space with sesamoid fusion and large exostosis formation

## 1st Metatarsal Dislocations

**JAHSS** (condensed)
Type l – dorsal dislocation of proximal phalanx and sesamoids with intact intersesamoid ligament
Type 2 – dorsal dislocation of proximal phalanx and sesamoids
2A – intact sesamoids with ruptured of intersesamoid ligament
2B – transverse fracture of sesamoid with intact intersesamoid ligament

**JAHSS** (Foot Ankle, 1:15, 1980)
* Secondary to extreme dorsiflexion
Type 1 – dorsal dislocation of proximal phalanx and sesamoids with intact intersesamoid ligament
- Tx: requires ORIF

Type 2A – dorsal dislocation of proximal phalanx and sesamoids with ruptured intersesamoid ligament
- Tx: closed reduction and surgical shoe or BK walking cast

Type 2B – dorsal dislocation of proximal phalanx and transverse fracture of sesamoid with intact intersesamoid ligament
- Tx: closed reduction and surgical shoe or BK NWB cast or excision of the fractured sesamoid

## 5th Metatarsal Fractures

**Stewart (**condensed)
Type 1 – extra-articular fracture at metaphyseal-diaphyseal junction (true Jones fracture)
Type 2 – intra-articular avulsion fracture of 5th metatarsal base
Type 3 – extra-articular avulsion fracture of styloid process of 5th metatarsal base
Type 4 – intra-articular comminuted fracture of 5th metatarsal base
Type 5 – extra-articular avulsion of epiphysis in children

**Stewart** (Clin Ortho, 1960) – Stewart described only the first 4 types
Type 1 – transverse fracture at the metaphyseal-diaphyseal junction of 5th metatarsal base approximately 1 cm from the articular cartilage. This is due to rotation of the forefoot with the base of the 5th metatarsal remaining fixed.
- True Jones fracture (Sir Robert Jones 1902-4 fractures his own)
- This type of injury has a high propensity for non-union
- MOI: internal rotation, PF ankle, and adduction of forefoot
- Tx if non-displaced: BK NWB cast for 4-6 weeks
- Tx if displaced: ORIF

Type 2 – intra-articular avulsion fracture of the 5th metatarsal base (styloid process)

- MOI: shear force. Resulting from contraction of the peroneus brevis.
- Tx if reducible: BK NWB cast for 4-6 weeks
- Tx if non-reducible: ORIF

Type 3 – extra-articular avulsion of the 5th metatarsal base

- "Tennis fracture"
- Most common is 5th metatarsal fracture
- MOI: contraction of PB with DF of ankle
- Tx if reducible: BK NWB cast for 4-6 weeks
- Tx if non-reducible: ORIF (possibly tension band wiring)

Type 4 – intra-articular, comminuted fracture of the 5th metatarsal base

- MOI: crush
- Tx: BK NWB cast for 4-6 weeks
- Tx if severely displaced: bone graft and ORIF

Type 5 – extra-articular, avulsion fracture of the epiphysis (in a longitudinal direction)

- Seen in children with open growth plates
- Risk of Iselin AVN
- AKA Salter-Harris type 1
- Tx: BK NWB cast 4-6 weeks

**Lawrence –** Review Article (Foot Ankle, 1993)
Confusion of 3 fracture

- Jones fracture
- Diaphyseal stress fracture
- Tuberosity avulsion fracture

**Shereff** (Foot Ankle, 1991)
Spalteholtz tech. of 5th blood supply/nutrient artery proximal and medial 1/3 shaft
On X-ray, fracture heals medially to laterally
Fixation: tension band wire, low profile plate, screws, cross K-wires, 4.5 malleolar screw
Complications: sural nerve entrap
Apophysis fuses at 9-12 years of age

**Torg** (JBJS, 1984)
Type 1 – acute Jones fracture
Type 2 – delayed union of a Jones fracture or diaphyseal stress fracture
Type 3 – non-union of a Jones fracture or a diaphyseal stress fracture

**Champman**
Type 1A – Jones fracture
Type 1B – displaced Jones fracture with possible comminution
Type 2 – delayed or non-union of a Jones fracture
Type 3A – avulsion fracture of the styloid
Type 3B – intra-articular fracture of the styloid

# Nail Injuries

**ROSENTHAL** (Ortho Clinics NA, 14(4):695, 1983)
Zone 1 – distal to bony phalanx
Zone 2 – distal to lunula
- Tx: V-Y advancement

Zone 3 – proximal to distal end of lunula
- If nail bed is lacerated, it is considered an open fracture
- Tx: amputation

# Metatarsal Head

**Freiberg Infarction**
Type 1 – metatarsal head dies but heals by replacement. Articular surface preserved.
Type 2 – head collapses but articular surface remains. Peripheral osteophytes (dorsal).
Type 3 – head collapses with articular cartilage loosening. Joint is destroyed.
Type 4 – multiple heads involved

# Lisfranc Dislocations

**QUENU & KUSS** (Rev Chir, 39:281-336,720-91,1093-134, 1909)
Convergent homolateral
- All metatarsals subluxed laterally
- All 5 metatarsals displaced laterally in the transverse plane

Isolateral
- 1st metatarsal subluxed medially or metatarsals 2-5 subluxed laterally
- 1 or 2 metatarsals displaced laterally in the transverse plane

Divergent
- 1st metatarsal subluxed medially and metatarsals 2-5 subluxed laterally
- Displacement in both sagittal and transverse planes

**HARDCASTLE** (JBJS, 64B:349, 1982)
Type A – total incongruity
    A1 – homolateral
    A2 – homomedial
Type B – partial incongruity
    Bl – partial medial displacement
        - 1st metatarsal displaced medially and/or in combination with metatarsals 2-4
    B2 – partial lateral displacement
        - Lateral displacement of one or more lesser metatarsals
Type C – divergent
    Cl – partial displacement
        - 1st metatarsal displaced medially with any combination of metatarsals 2-4 displaced laterally
    C2 – total displacement
        - 1st metatarsal displaced medially with metatarsals 2-5 displaced laterally

Treatment Options

- Cast immobilization (sprains 3-5 weeks)
- Closed reduction and percutaneous pinning
- ORIF

Reduction Sequence

1. First realign 2nd metatarsal on middle cuneiform. Once stabilized, lesser metatarsals will follow.
2. Next stabilize 1st metatarsal and then lateral metatarsals

Post-op Care

- BK casting for 6 to 12 weeks
- Initial NWB for 6-8 weeks
- Partial WB approximately 6 weeks
- Begin ambulation in stiff-soled shoe
- PT ASAP
- Accommodative orthotics

Complications

- Majority – post-op DJD
- Serious – circulatory compromise

**Myerson** (Foot Ankle, 6(5):225, 1986)
Type A – total displacement in any plane or direction
Type Bl – medial displacement of 1st metatarsal
Type B2 – lateral displacement affecting 1 or more lesser metatarsals
Type C1 – partial displacement with medial 1st metatarsal and lateral lesser metatarsals
Type C2 – total displacement with a divergent pattern and total incongruity

## Navicular Fractures

**WATSON-JONES** (condensed)
Type 1 – navicular tuberosity fracture
Type 2 – dorsal lip fracture
Type 3 – transverse body fracture
    3A – fracture of body without displacement
    3B – fracture of body with displacement
Type 4 – stress fracture

**WATSON-JONES** (Fracture and Joint Injuries, Watson & Jones, 5th ed, p 1200)
Type 1 – navicular tuberosity fracture

- Usually an avulsion fracture by tibialis posterior tendon
- 24% of navicular fractures
- Nutcracker fracture – displaced fracture with compression fracture of the cuboid between 4th and 5th metatarsal bases and calcaneus
- MOI: forceful eversion w/medial avulsion of the PT off the tuberosity or

- MOI: direct blow to the tuberosity
- Need to D/Dx Os Tibiale Externum vs. true fracture,
- Best viewed on AP and lateral oblique films
- TX: BK cast with partial WB for 4 weeks

Type 2 – dorsal lip fracture

- Most common
- Tx: BK cast with partial WB for 4-6 weeks

Type 3 – transverse navicular body fracture

3A: without displacement

- Tx: BK walking cast for 6-8 weeks

3B: with displacement

- Tx: ORIF and BK NWB cast for 6-8 weeks

Type IV – stress fracture of the navicular

- Tx if non-displaced: BK NWB cast for 4-6 weeks
- Tx if displaced: ORIF followed by BK NWB x 6-8 weeks

## Accessory Navicular – Os Tibiale Externum

**Geist** (1914), first described by Bahin (1605)

Type l – sesamoid in tendon

Type 2 – articulating os center (Sella Clin Ortho, 1986, Foot Ankle, 1987)

2A – synchondrosis acute angle

2B – synchondrosis obtuse angle

Type 3 – fused accessory os center

## Navicular Classifications

**Wilson**

Chip, comminuted, and crush

**Watson Jones**

Tuberosity, dorsal lip, and transverse

**DePalma**

Dorsal lip, avulsion, tuberosity, and fracture dislocation

**Rockwood & Green**

Body fracture with/without dislocation, chip, and tuberosity

**Goldman**

Chip, tuberosity, body, displaced, and osteochondral fracture

# Rearfoot

## Calcaneal Fractures

**ROWE** (condensed)
Type 1
- 1A – fracture of plantar tuberosity
- 1B – fracture of sustentaculum tali
- 1C – fracture of anterior process

Type 2
- 2A – "beak fracture"
- 2B – avulsion fracture of Achilles insertion

Type 3
- 3A – simple oblique fracture of body not involving STJ
- 3B – comminuted oblique fracture of body not involving STJ

Type 4 – intra-articular fracture involving STJ
Type 5 – intra-articular, comminuted, depression fracture with STJ involvement
*Note:* Rowe is primarily used for extra-articular fractures. Intra-articular fractures (Rowe 4 & 5) are usually replaced by Essex & Lopresti.

**ROWE** (JAMA, 184:98-101, 1963)
Type 1
- 1A – fracture of the plantar tuberosity due to inverted or everted foot
  - Tx of non-displaced: CR and BK WB cast for 6 weeks
  - Tx of displaced: ORIF
- 1B – fracture of the sustentaculum tali due to twist on a supinated foot
  - Tx of non-displaced: CR and BK cast for 6 weeks
  - Tx of displaced: ORIF
- 1C – fracture of the anterior tubercle due to plantarflexion on a supinated foot
  - Most common type 1 fracture
  - Most common in females
  - Tx: CR and BK WB cast for 6 weeks. If symptoms persist, excise the fragment

Type 2
- 2A – "beak fracture" without Achilles insertion involvement
  - Tx: NWB BK cast for 6 weeks in plantarflexion
- 2B – avulsion fracture of the Achilles tendon
  - Tx: ORIF or attempt percutaneous pinning

Type 3
- 3A – simple oblique fracture of body not involving STJ
- 3B – comminuted oblique fracture of body not involving STJ
  - Most common extra-articular
  - Tx of non-displaced: NWB AK cast with knee flexed
  - Tx of displaced: ORIF

Type 4 – intra-articular fracture involving STJ
Type 5 – intra-articular, comminuted, depression fracture with STJ involvement

**ESSEX-LOPRESTI** (condensed)
Type 1 – tongue fracture (vertical fracture line) without STJ involvement
Type 2 – joint depression fracture (horizontal fracture line) with STJ involvement

**ESSEX-LOPRESTI** (Br J Surg, 39:395-419, 1952)
Type 1 – tongue type fracture with a primary fracture line running superior to inferior with a secondary fracture line exiting the posterior aspect of the calcaneus without STJ involvement
1A – tuberosity fracture
1B – calcaneal-cuboid joint involvement
Type 2 – joint depression fracture with a primary fracture line running superior to inferior with a secondary fracture line involving STJ
2A – non-displaced secondary fracture line exits posteriorly
2B – displaced secondary fracture line exits dorsally
2C – gross comminution
** 75% of all calcaneal fractures are intra-articular

**Treatment of Intra-articular Fractures**
Essex-Lopresti Technique
Percutaneous pinning technique placing a Steinmann pin into the tuberosity. The tongue fragment is reduced, and a pin is placed into the anterior calcaneus or cuboid. No cast required, and motion is performed immediately. The pin is removed in 8-10 weeks and WB is begun. Indicated for Sanders 2C (87% success rate).

Closed reduction
Used if <2 mm displacement

ORIF
Incisional Approaches
- Medial Approach: Burdeaux
- Combined Approach: Stephenson
- Extended Lateral Approach: Benirschke

Procedure
- Goal is to restore the STJ and C-C articulation
- Perform surgery within 6-8 hours of the injury or wait until the swelling is reduced
- Reduction is performed by placing a Steinmann pin through the tuberosity fragment to restore the STJ posterior facet. Once aligned, the tuberosity fragment is fixated to the constant fragment (sustentaculum fragment). Various plates can be used as a buttress.
- Before arthrodesis is performed, CR or ORIF should be attempted

**DEGAN** (J Bone Joint Surg, 64:519, 1982)
Type 1 – non-displaced fracture of the anterior process
Type 2 – extra-articular, displaced fracture of the anterior process
Type 3 – intra-articular, displaced fracture of the anterior process involving C-C joint

**SANDERS** (Clinics Ortho, 290:87-95, 1993)

- Used for CT evaluation from coronal and axial views
- Classified by number of pieces
- Lines A and B divide the inferior portion of the posterior talar facet into 3 equal portions. Line C separates the medial and posterior facets.

A – lateral
B – midline
C – medial (at sustentaculum tali)
1 – any number of fracture lines

- All non-displaced, extra-articular fractures

2 – one fracture line

- Two-part fracture of posterior facet
- Use one letter (2A, 2B, or 2C)

3 – two fracture lines

- Three-part, intra-articular fracture of posterior facet with depressed central fragment
- Use two letters (3AB, 3AC, or 3BC)

4 – three fracture lines

- Four-part, intra-articular fracture of posterior facet and sustentaculum fragment with high degree of comminution

## Anterior Calcaneal Process Fractures

**Hannover** (Clinics Ortho, 290:76-86, 1993)
CT scan evaluation based on fragments involved and number of joint fractures
1 – sustentaculum
2 – tuberosity
3 – STJ
4 – anterior process
5 – anterior STJ
* Most common is the 5 fragment/2 joint fracture

## Talar Neck Fractures

**HAWKINS** (condensed)
Type 1 – vertical fracture of talar neck that is nondisplaced
Type 2 – vertical fracture of talar neck with STJ dislocation/subluxation
Type 3 – vertical fracture of talar neck with STJ and ankle dislocation/subluxation
Type 4 – vertical fracture of talar neck with STJ, ankle, and T-N dislocation/subluxation

**HAWKINS** (J Bone Joint Surg, 60A:143-156, 1978)
MOI: hyperdorsiflexion of the foot on leg
Type 1 – vertical fracture of talar neck without displacement

- Disruption of 1 blood vessel with 12% risk of AVN
- Tx: BK cast immobilization for 8-12 weeks, NWB for 6-8 wks
- Must have trabeculation across fracture site prior to weightbearing

Type 2 – vertical fracture of talar neck with STJ displacement (ankle joint remains aligned)

- Disruption of 2-3 blood vessels with 42% risk of AVN

- Tx: attempt closed reduction by pushing backward on plantarflexed foot while pulling forward on the distal tibia. If successful, percutaneous pinning is performed. Cast in equinus for 4 wks with subsequent casts bringing the foot out of equinus. Requires 3 months of NWB casting.
- Tx: after one unsuccessful attempt at closed reduction, ORIF is indicated. Avoid multiple attempts at closed reduction. Longitudinal anteromedial incision along the neck of the talus, just medial to the TA. 6.5 mm cannulated cancellous screws. Use titanium screws to facilitate the later use of MRI to monitor the progress of osteonecrosis.

Type 3 – vertical fracture of talar neck with STJ and ankle displacement

- Disruption of 3 blood vessels with 91% risk of AVN
- 25% are open fractures
- Tx: during ORIF, it is important not to dissect off deep fibers of deltoid ligament which may remain attached to the talar body (osteotomize the medial malleolus rather than reflect the deltoid)

Type 4 – vertical fracture talar neck with STJ, ankle joint and talonavicular joint displacement

- Disruption of 3 blood vessels with 91% risk of AVN
- Tx: ORIF

10% incidence of calcaneal fractures associated with talar neck fractures
19-28% incidence of medial malleolar fractures associated with talar neck fractures

X-rays to provide best view of talar neck

- Ankle in maximum equinus
- Foot on cassette pronated 15°
- X-ray tube directed 75° from horizontal

Sclerotic (apparent increase in density) appearance due to surrounding bones becoming osteoporotic due from disuse and acute hyperemia

Osteonecrosis is the most common complication associated with this injury

Rates of osteonecrosis

- Type 1 (0-13%)
- Type 2 (20-50%)
- Types 3, 4 (83-100%)

MRI can define the presence and extent of osteonecrosis in the talar body as early as 3 weeks

Hawkin sign – presence of subchondral talar dome osteopenia seen 6-8 weeks after talar fracture signifying intact vascularity. Absence of the sign implies AVN.

Up to 36 months are required for complete creeping substitution of the body after union has occurred. Protect the patient from WB until complete revascularization occurs. A patellar tendon brace may partially relieve the load on the talar dome once WB is initiated.

Blair fusion – if the talar dome collapses, excise the avascular talar body and place a sliding corticocancellous graft from the anterior distal tibia into the residual, viable talar head and neck

Subchondral fenestration to increase vascularity and fibrocartilage production

## Talar Body Fractures

**SNEPPEN** (condensed)
Type 1 – compressive fracture of the talar dome usually involving medial or lateral aspect
Type 2 – shearing fracture of the talar body
    2A – coronal shearing force
    2B – sagittal shearing force
    2C – horizontal shearing force
Type 3 – fracture of the posterior tubercle
Type 4 – fracture of the lateral process
Type 5 – crush fracture

**SNEPPEN** (Acta Ortho Scand, 45:307, 1974)
Type 1 – transchondral or compression fracture of the talar dome (including osteochondritis of the talus)
Type 2 – coronal, sagittal, or horizontal shearing fracture involving the entire body
    2A – coronal shearing force
    2B – sagittal shearing force
    2C – horizontal shearing force
- MOA: unknown but thought to be forced dorsiflexion with the foot locked, combined with axial compression
- Fractures displaced >2-3 mm at trochlear surface require ORIF
- 75% incidence of OA of STJ

Type 3 – fracture of the posterior tubercle of the talus
- Shepherd fracture – posterior lateral tubercle fracture
- Sometimes confused with os trigonum. Bone scan can differentiate.
- MOA: hyperplantarflexion or avulsion of posterior talofibular ligament
- Tx: short leg NWB cast with foot in mild equinus. If pain persists, excise fragment.

Type 4 – fracture of the lateral process of the talus
- "Snowborder's ankle"
- MOA: dorsiflexion with inversion
- Tx: 6 weeks of NWB cast immobilization in slight equinus. Large fragments can be internally fixated.

Type 5 – crush fracture of the talar body
- Poor prognosis
- Primary arthrodesis after 2-3 weeks due to risk of soft tissue envelope if performed immediately

23% of open talar fractures go on to osteomyelitis and may result in future talectomy

**Boyd & Knight** (South Med J, 35:160, 1942)
Type 1 – coronal or sagittal shear fracture
    1A – non-displaced
    1B – fracture with displacement of talo-crural joint
    1C – Type 1B with displacement of the STJ
    1D – fracture with total displacement of the talar body
Type 2 – horizontal shear fracture
    2A – non-displaced
    2B – displaced

## Talar Dome Fractures

**BERNDT & HARDY** (condensed)
Stage 1 – nondisplaced compression of talar dome
Stage 2 – partially detached osteochondral lesion
Stage 3 – completely detached, nondisplaced osteochondral lesion
Stage 4 – completely detached, displaced osteochondral lesion

**BERNT & HARDY** (J Bone Joint Surg, 41A:988-1020, 1959)
Mechanism: – DIAL A PIMP
Stage 1 – nondisplaced, subchondral compression of the talar dome
- Tx: conservative, off-loading patellar tendon brace

Stage 2 – partially detached, nondisplaced osteochondral fracture
- Tx: conservative, off-loading patellar tendon brace

Stage 3 – completely detached, nondisplaced osteochondral fracture
- Tx medial lesion: conservative, off-loading patellar tendon brace
- Tx lateral lesion: surgical excision of the fragment, saucerization of crater, and fenestration to increase vascularity and fibrocartilage production

Stage 4 – completely detached, displaced osteochondral fracture
- Tx: surgical excision of the fragment, saucerization of crater, and fenestration to increase vascularity and fibrocartilage production

Mechanism of Injury: DIAL a PIMP
DIAL – Dorsiflexion and Inversion → Anterior-Lateral lesion
- Wafer-shaped lesion, associated with trauma

PIMP – Plantarflexion and Inversion → Posterior-Medial lesion
- Small, deep, round cup-shaped fragment, 80% not associated with trauma

Stages 2-4 require lateral ankle ligament disruption to occur

Treatments
- Tx of Stages 1, 2, and medial 3: NWB Short leg cast for 6-12 wks
- Tx of lateral stage 3 and 4: surgical excision of the fragment, saucerize the crater, and

# Lateral Talar Process Fractures

**Hawkins** (J Bone Joint Surg, 47A:1170, 1965)
Type 1 – simple fracture of lateral process that extends from talofibular articular surface down to posterior talocalcaneal articular surface of the STJ
Type 2 – comminuted fracture of lateral process that involves both fibular and posterior calcaneal articular surfaces of the talus and the entire lateral process
Type 3 – chip fracture of anterior and inferior portions of posterior talar articular process

# Posterior Lateral Talar Process Fractures

**Dobas & Watson** (Arch Pod Med Foot Surg, 3:17, 1976)
Stage 1 – normal posterior lateral process; no clinical significance
Stage 2 – enlarged posterior lateral process
Stage 3 – non-fused os trigonum
Stage 4 – synchondrosis of the os trigonum to the talus

**McGougall** (J Bone Joint Surg, 37B:257-265, 1955)
Stage 1 – line of cleavage occurs at impingement point
Stage 2 – posterior lateral process begins to separate from the main body of the talus
Stage 3 – complete separation of the posterior lateral process from the talar body

# STJ Dislocations

**Buckingham**
Type 1 – medial STJ dislocation (FF moves medially and talar head moves laterally)
Type 2 – lateral STJ dislocation
Type 3 – anterior and posterior STJ dislocation

# Tarsal Coalitions

**DOWNEY** (JAPMA, 81:187-197, 1991)
Juvenile (Osseous Immature)
Type 1 – extra-articular coalition
- A – no secondary arthritis
  - Tx: Badgley procedure
- B – secondary arthritis
  - Tx: resection or triple

Type 2 – intra-articular
- A – no secondary arthritis
  - Tx: resection, isolated arthrodesis, or triple
- B – secondary arthritis
  - Tx: triple

Adult (Osseous Mature)
Type 1 – extra-articular
- A – no secondary arthritis
  - Tx: resection or triple

B – secondary arthritis
- Tx: triple

Type 2 – intra-articular
A – no secondary arthritis
- Tx: isolated or triple

B – secondary arthritis
- Tx: triple

## Chopart Fractures

**Main & Jowett** (JBJS, 57B:89, 1975)
Classification based on direction of deforming force and resulting displacement
Medial force
Type A – flake fracture of dorsal talus or navicular and of the lateral calcaneus or cuboid
Type B – medial displacement of forefoot with medial disassociation of T-N and C-C joints
Type C – forefoot rotates medially around interosseous talocalcaneal ligament, with T-N disassociation and intact C-C joint
Longitudinal force
Type A – maximally plantarflexed ankle giving a characteristic pattern of through and through navicular compression fracture
Al – force through the 1st ray crushes medial 3rd with tuberosity displaced medially
A2 – force through the 2nd ray crushes middle 3rd with middle 3rd and tuberosity displaced medially
A3 – force through the 3rd ray crushes lateral 3rd with medial 2/3rd and tuberosity displaced medially
Type B – submaximally plantarflexed ankle resulting in dorsal displacement of the superior navicular and crush of the inferior portion
Lateral forces
Type A – forefoot forced into valgus with resulting fracture of the navicular tuberosity or dorsal talus and a compression fracture of the C-C joint (Nutcracker Fracture)
Type B – T-N joint displaces laterally with comminution of the C-C joint
Plantar forces
Type A – avulsion fracture of the dorsal navicular to talus and the anterior process
Type B – impaction fracture of the inferior C-C joint

## Ankle Fractures

**LAUGE-HANSEN**
1st word – position of the foot with respect to the leg
2nd word – motion that causes fracture pattern (how talus moves with respect to tibia/fibula)
* indicates hallmark sign

Supination-Adduction (SAD) – No tib-fib diastasis
Stage l – rupture of lateral collaterals or * transverse fracture of lateral malleous below level of ankle joint
Stage 2 – * vertical fracture of medial malleolus

Pronation-Abduction (PAB)
Stage 1 – rupture or deltoid ligament or transverse avulsion fracture of medial malleolus
Stage 2 – rupture of anterior and/or posterior distal tib-fib ligaments
Stage 3 – * short fibular fracture (oblique on AP, trans, on lateral) at level of ankle joint

Supination-Eversion (SER) – most common
Stage 1 – disruption of anterior tib-fib ligament with either a tibial avulsion (Tillaux-Chaput) or a fibular avulsion (Wagstaffe)
Stage 2 – * spiral oblique fracture of the fibula at level of ankle joint
Stage 3 – rupture of posterior tib-fib ligament or tibial avulsion (Volkmann)
Stage 4 – ruptured of deltoid or transverse fracture of medial malleolus

Pronation-External Rotation (PER)
Stage 1 – rupture of deltoid ligament or transverse avulsion of med malleolus
Stage 2 – disruption of anterior tib-fib ligament with rupture of interosseous ligament and Tillaux-Chaput or Wagstaffe avulsions
Stage 3 – * high fibular fracture above level of ankle joint (Maisonneuve fracture)
Stage 4 – Posterior tib-fib ligament or Volkmann fracture

Pronation-Dorsiflexion (Arch Surg, 67:813-820, 1953)
Describes pilon fracture
Stage 1 – rupture of deltoid ligament or fracture of medial malleolus (oblique or transverse)
Stage 2 – fracture of anterior lip of tibial plafond
Stage 3 – fracture of fibula above the level of the syndesmosis
Stage 4 – transverse fracture of the distal tibia at the same level as the proximal margin of the large tibial fracture

**DANIS WEBER** (condensed)
Describes location of fibular fracture
Type A – transverse avulsion fracture below the level of the ankle joint (corresponds with Lauge-Hansen SAD)
Type B – spiral or oblique fracture at the level of the ankle joint (corresponds with Lauge-Hansen SER and PAB)
Type C – fracture above the level of the ankle joint (Maisonneuve fracture) (corresponds with Lauge-Hansen PER)

**DANIS-WEBER** (Ortho Clinics of NA, 661, 1980)
Type A – transverse avulsion fracture of fibula below the level of ankle mortise
- MOI: SAD
- Tx: K-wire w/ tension band for fibular fracture and 2 interfrag screws for the med malleolus

Type B – fracture at the level of ankle mortise
- MOI: PAB or SER
- Tx: interfrag screws and/or plate, repair ATFL

Type C – fracture above the level of ankle mortise

- MOI: PER
- Tx: interfrag screws and plate, repair ATFL and interosseous membrane

# Pilon Fractures

**Lauge-Hansen**
Pronation-Dorsiflexion (Arch Surg 67:813-820, 1953)
Stage 1 – deltoid ligament rupture or medial malleolar fracture (oblique or transverse)
Stage 2 – fracture of the anterior lip of the tibial plafond
Stage 3 – fibular fracture above the level of the syndesmosis
Stage 4 – transverse fracture of distal tibia at level of proximal margin of the large tibial fracture

**RUEDI & ALLGOWER** condensed
Pilon fractures – distal tibial metaphyseal fracture
Type 1 – non-displaced tibial fragments
Type 2 – intra-articular tibial fracture without comminution
Type 3 – comminution and disruption of tibial articular surface

**Ruedi & Allgower** (Clin Ortho, 138:105-110, 1979)
Type 1 – mild displacement, no comminution, without major disruption of ankle joint
Type 2 – moderate displacement, no comminution, with significant dislocation of ankle joint
Type 3 – "explosion fracture", severe comminution, with displacement of distal tibial metaphysis

Femoral distractor – brings tibia out to length before fixation
If Type 3 fracture, fix tibia first
40-80% failure of ankle fusion

**Maale and Seligson** (Orthopedics, 3:517-521, 1980)
Modification of Ruedi & Allgower
Type 1 – distal tibial compression fracture
Type 2 – external rotatory fracture with a large posterior fragment
Type 3 – spiral fracture extending from the articular surface into the metaphysis

**Ovadia and Beals** (J Bone Joint Surg, 68A:543-551, 1986)
Modification of Ruedi & Allgower Type II
Type 1 – non-displaced articular fracture resulting from rotational forces
Type 2 – minimally displaced fracture resulting from articular forces
Type 3 – displaced articular fracture with several large fragments due to compressive forces
Type 4 – displaced articular fracture with multiple fragments including a large metaphyseal fragment resulting from compressive forces
Type 5 – severe comminution due to compressive forces

**AO System (Ankle Fractures)**
Type A – extra-articular
Type B – partially articular
Type C – completely articular
All 3 can involve:

- No comminution or impaction in the articular or metaphyseal surface
- Impaction involving the supra-articular metaphysis
- Comminution and impaction involving the articular surface with metaphyseal impaction

**Destot System**
Subgroup 1 – posterior marginal tibial fracture
Subgroup 2 – anterior marginal tibial fracture
Subgroup 3 – explosive tibial fracture
Subgroup 4 – supra-articular tibial fracture with extension into the ankle joint

**Kellam and Waddell** (J Trauma, 19:593-601, 1979)
Type A – rotational pattern consisting of two or more large tibial articular fragments, minimal or no anterior cortical comminution, and a transverse or short oblique fibular fracture at the level of the tibial plafond
Type B – compressive fracture pattern with multiple tibial fragments and marked anterior tibial cortical comminution

**Mast** (Clinics of Ortho, 230:68-82, 1988)
Type 1 – malleolar fracture with significant axial load at the time of the injury producing a large posterior fragment
Type 2 – spiral extension fracture
Type 3 – centrally compressive injury divided into A, B and C

## Medial Malleolar Fractures

**Muller**
Type A – avulsion of the tip of the medial malleolus, horizontal orientation
Type B – avulsion fracture at the level of the ankle joint, horizontal orientation
Type C – oblique fracture
Type D – vertical fracture

## Fibular Avulsion Fractures

**Pankovich: Wagstaffe-LeFort Fracture** (Clinics Ortho Rel Res, 143:138, 1979)
Type 1 – avulsion fracture maintaining attachment to both the anterior talofibular and anterior-inferior tib-fib ligaments
Type 2 – avulsion fracture associated with an oblique fracture of the fibula originating distal to the anterior-inferior tib-fib ligament. Spiral fracture of the fibula with a proximal fibular spike and a transverse fracture associated with the avulsion fragment.
Type 3 – avulsion fracture of the anterior tibial tubercle followed by a Type 2

# Lateral Ankle Trauma

**Leach**
1st Degree – rupture of the ATF
2nd Degree – rupture of the ATF and CF
3rd Degree – rupture of the ATF, CF, and PTF

**O'Donoghue** (condensed)
Grade 1 – partial ATF tear
Grade 2 – complete ATF tear
Grade 3 – complete ATF and CFL tear

**O'Donoghue** (Northwest Med, 1277, 1958)
Grade 1 – partial ATF tear with mild tenderness and swelling
- No loss of function or instability. Pt can walk, play.

Grade 2 – complete ATF tear with moderate pain, swelling, ecchymosis
- Some loss of function and moderate instability. Pt limps after injury.

Grade 3 – complete ATF and CFL tear of with severe pain, swelling, and ecchymosis
- Unable to bear weight and severe instability. Pt cannot walk after injury.

**Dias** (J Trauma, 19:266-269, 1979)
Grade 1 – partial rupture of the CFL
Grade 2 – rupture of the ATF
Grade 3 – complete rupture of the ATF, CF, and/or PTF
Grade 4 – rupture of all lateral collateral ligaments and partial failure of the deltoid ligament

# Posterior Tibial Malleolar Fracture

**Volkmans**
Type A – large intra-articular fracture (>25% of surface area) with displacement
Type B – small intra-articular fracture (<25% of surface area) with impaction
Type C – small fracture with minimal impaction and articular damage
Type D – avulsion of posterior-inferior tib-fib ligament without articular involvement

# Physeal Injuries

**Salter-Harris Classification of Fractures**
Site – epiphysis, metaphysis, diaphysis
Extent – complete vs. incomplete
Configuration – transverse, oblique, spiral, comminuted
Position – rotated, angulated, distracted, impacted, overriding, lateral shift
Environment – open, closed

**SALTER-HARRIS**
(SMACK – Same, Metaphysis, Articulation, Continuous, Krush)
(SALTR – Same, Above, Lower, Through, Really bad)
1 – fracture through physis
2 – fracture through physis into metaphysis
3 – intra-articular fracture through physis into epiphysis
4 – intra-articular fracture through epiphysis, physis, and metaphysis
5 – crush injury

**SALTER-HARRIS** (Skeletal Rad, 6:237-253, 1981)
Type 1 – complete transverse separation of the epiphysis from the metaphysis through the physis
- Epiphysis separates from the metaphysis without any bone fragments
- Germ cells remain with epiphysis
- Common in infants
- Shearing force seen in pathologic fractures
- Growth is not disturbed unless there is associated avascular necrosis or premature closure of the physis
- Tx: closed reduction if within 7 days of injury, followed by 3-4 weeks of casting

Type 2 – fracture through the physis extending into the metaphysis
- Thurston-Holland sign
- Tx: closed reduction if within 7 days of injury, followed by 3-4 weeks of casting

Type 3 – intra-articular fracture extending from the physis through the epiphysis
- Tillaux fragment

Type 4 – continuous, intra-articular fracture extending from the epiphysis into the physis and metaphysis
Type 5 – comminuted fracture from impaction of the epiphysis into the physis and metaphysis
- Tx of Types 3-5: attempt closed reduction, but usually requires anatomic reduction of the physis. Fixation should be kept within metaphysis.

**Rang**
Type 6 – perichondral injury produced by shearing force resulting in a cup-shaped fragment of epiphyseal, physeal, and metaphyseal bone with possible degloving
- Tear of the "ring of Lacroix"

**Ogden**
Type 7 – intra-epiphyseal fracture not involving the physis
Type 8 – transverse fracture of the metaphysis only
Type 9 – diaphyseal growth injury resulting in periosteal elevation and possible degloving of the periosteum

**Poland**
Type 1 – separation of the epiphysis from the metaphysis
Type 2 – partial separation of the epiphysis from the metaphysis with fracture of the diaphysis
- Thurston-Holland sign

Type 3 – partial separation of epiphysis from the metaphysis with fracture of the epiphysis
Type 4 – complete separation of the epiphysis from metaphysis with fracture of the epiphysis

**Peterson** (J Ped Ortho, 14:439, 1994)
Type 1 – transverse fracture of the metaphysis with extension to the physis by longitudinal compression (15.5%)
Type 2 – separation of part of the physis with a part of the metaphysis attached (53.6%)
- Thurston-Holland sign
- Salter-Harris Type 2

Type 3 – separation of the epiphysis from the diaphysis through the physis (13.2%)
- Salter-Harris Type 1

Type 4 – separation of a portion of the physis with extension of a fracture into the joint (10.9%)
- Salter-Harris Type 3

Type 5 – fracture involving the metaphysis, physis, and epiphysis (6.5%)
- Salter-Harris Type 4

Type 6 – fracture involving a missing portion of the physis.
- Often caused by open fractures, lawn mowers, farm machinery, or other power equipment

**Weber**
Type A – extra-articular
Al – separation of the epiphysis and metaphysis
A2 – fragments in the epiphysis or metaphysis
Type B – intra-articular
Bl – fracture within the physis extending into the epiphysis
B2 – fracture through the epiphysis, physis, and metaphysis

# MRI Rupture

**CONTI**
Stage 1 – 1-2 fine, longitudinal tears
Stage 2 – intramural degeneration, variable diameter
Stage 3 – diffuse swelling

# Achilles Tendon Ruptures

**KUWADA**
Type 1 – partial tear <50%
- Tx: cast with foot plantarflexed

Type 2 – complete tear with <3 cm defect after debridement
- Tx: end-to-end attachment

Type 3 – complete tear with 3-6 cm defect after debridement
- Tx: end-to-end attachment and tendon flap

Type 4 – complete tear with >6 cm defect after debridement
- Tx: end-to-end attachment, recession, or graft

# Radio-opaque Lesions of Achilles Tendon

**Morris & Giacopelli** (J Foot Surg, 1990)
Type 1 – opacities at the Achilles insertion with calcifications within tendon and partially attached to the calcaneus
Type 2 – opacities l-3 cm proximal to insertion with lesions separate from calcaneus
Type 3A – opacities > 3 cm proximal to insertion with partial tendon calcification
Type 3B – opacities > 3 cm proximal to insertion with total tendon involvement

# Peroneal Tendon Subluxations

**Eckert & Davis** (J Bone Joint Surg, 58A:670, 1976)
Grade 1 – retinaculum and periosteum ruptures from the cartilaginous lip and lateral malleolus
Grade 2 – distal edge of fibrous lip elevated with retinaculum
Grade 3 – thin fragment of bone with fibrous lip avulsed from deep surface of peroneal retinaculum and deep fascia

# Posterior Tendon Ruptures

**MUELLER**
1 – direct injury
2 – pathologic rupture (RA)
3 – idiopathic
4 – functional abnormality

# Posterior Tibial Tendon Dysfunction

**Johnson & Strom**
Stage 1 – normal tendon length with mild degeneration
- Medial foot and ankle pain

Stage 2 – supple flatfoot with attenuation or PT rupture
- "Too many toes" sign
- Abducted forefoot, increased talar-1$^{st}$ metatarsal angle, and uncovering of talar head

Stage 3 – rigid flatfoot with complete PT rupture
- Fixed calcaneal valgus with decreased STJ ROM

Stage 4 – rigid flatfoot
- Valgus tilt of talus/ankle mortise leading to lateral tibial/talar degeneration

**Wilson** (J Bone Joint Surg, 54B:677, 1972)
Inversion Injury
Stage 1 – lateral dislocation of 4 lesser metatarsals with divergent diastasis
Stage 2 – Stage 1 with dorsolateral dislocation of 1$^{st}$ metatarsal and other metatarsals

Eversion Injury
Stage 1 – medial dislocation of 1$^{st}$ metatarsal
Stage 2 – dorsolateral dislocation of lesser 4 metatarsals with divergent diastasis

# Other Classifications

## Open Fractures

**GUSTILLO & ANDERSON** (condensed)
Type 1 – wound <l cm without extensive soft tissue damage
Type 2 – wound >l cm without extensive soft tissue damage
Type 3 – extensive skin, soft tissue, muscle, and neurovascular damage
3A – adequate tissue coverage, high energy trauma
3B – periosteal stripping, massive comminution
3C – arterial injury

**GUSTILLO & ANDERSON** (J Bone Joint Surg, 58A:453, 1976)
Type 1 – open fracture with wound <1 cm without extensive soft tissue damage
- Simple, transverse or short oblique fracture with little comminution
- No crush involved

Type 2 – open fracture with a laceration >1 cm without extensive soft tissue damage
- Slight or moderate crushing injury with moderate comminution
- Moderate contamination
- Minimal foreign material

Type 3 – open fracture with extensive soft tissue damage >5 cm
- Severe comminution associated with high velocity injury
- High degree of contamination
- Significant foreign material
- Gunshot wounds, farm injuries, arterial injuries, motor vehicle accidents

3A – adequate soft tissue coverage
3B – extensive soft tissue loss/damage with periosteal stripping and bone exposure requiring local or free flap
3C – any open fracture associated with arterial injury requiring repair. Amputation rate of 25-90%.

## Non-Union of Fractures

**WEBER & CECH**
Hypertrophic – hypervascular (90%)
- Elephant foot
- Horse hoof
- Oligotrophic

Atrophic – avascular (10%)
- Torsion wedge
- Comminuted
- Defect
- Atrophic

# Ulcerations

**WAGNER** (Foot Ankle, 2:64-122, 1981)
Grade 0 – no open lesions but bony prominence and/or structural deformity present
Grade 1 – superficial ulcer without penetration to the deep layers
Grade 2 – deep ulcer penetrating to tendon, joint capsule, or bone
Grade 3 – Grade 2 depth with the presence of infection
Grade 4 – gangrene of the forefoot
Grade 5 – gangrene of the entire foot

**Wound, Ostomy and Continence Nurses Society** (formerly I.A.E.T., Standards of Care, 1987)
Stage 1 – nonblanchable erythema of intact skin
Stage 2 – partial thickness loss of skin involving epidermis, dermis, or both.

- Ulcer is superficial and presents clinically as a blister or shallow crater with erythema and induration

Stage 3 – full-thickness tissue loss involving damage to or necrosis of subcutaneous tissue that many extend down to, but not through underlying fascia

- Ulcer presents clinically as deep crater often with undermining, erythema, and drainage

Stage 4 – full-thickness tissue loss with extensive destruction, tissue necrosis, or damage to muscle, bone or supporting structures (e.g. tendon, joint capsule)

- Undermining and sinus tracts often associated

**University of Texas at San Antonio – UTSA** (J Foot Ankle Surg, 35:528-531, 1996)
Grade 0 – completely epithelialized pre- or post-ulcerative lesion
Grade 1 – superficial wound not involving tendon, capsule, or bone
Grade 2 – wound penetrating to tendon or capsule
Grade 3 – wound penetrating to bone or joint
Within each grade, there are 4 subtypes:
A – non-ischemic, clean wound
B – infected wound
C – ischemic wound
D – infected and ischemic wound

# Diabetic Foot Ulcers

**Meade & Mueller** (Med Times, 96:154-169, 1968)
Type 1 – diffuse, inflammatory infection of soft-tissue
Type 2 – deep plantar space infection
Type 3 – mal perforans neuropathic foot ulcers (subclassed by Wagner and USATHC)

# Charcot

**Sanders & Freykberg**
1 – IPJ, phalanx, MPJ, and metatarsals
2 – Lisfranc
3 – C-N, T-N, and C-C
4 – ankle
5 – calcaneus

# Osteomyelitis

**Waldvogel**

Hematogenous – spread via blood starting inside the bone and working out towards the cortex

- Seen most commonly in metaphyseal region of children with open growth plates

Direct extension – secondary to trauma or surgery first affecting periosteum, then cortex, and then marrow

- Proteolytic enzymes destroy Sharpey fibers

Contiguous – spread of infected soft tissue to underlying bone

Vascular insufficiency – PVD

**Cierny & Mader**

Anatomic Type

Medullary
Superficial
Localized
Diffuse

Physiologic Type

A-Host – good immune system and delivery

- Normal immune response
- Normal metabolic reserve
- Good vascular supply

B-Host – compromised locally or systemically

- Metabolic compromise
- Nutritional compromise
- Immunologic compromise
- Impaired vascularity
- Systemic illness

C-Host – no treatment because treatment is worse than disease

- Minimal disability
- High morbidity
- Poor prognosis for cure

**Buckholz** (J Foot Surg, 26(1):17, 1987)

Type 1 – wound induced osteomyelitis

1A – open fracture with complete incontinuity
1B – penetrating wound of injury
1C – post-op infections

Type 2 – mechanogenic osteomyelitis

2A – implants and internal fixation
2B – contact instability as bone-to-bone appositional movement

Type 3 – physeal osteomyelitis
Type 4 – ischemic limb disease
Type 5 – combination osteomyelitis, Types 1-4 as acute bone infections
Type 6 – osteomyelitis with septic arthritis
Type 7 – chronic osteomyelitis

# Medicare PVD Classification

Class A
- A1 – nontraumatic amputation of foot or integral portion thereof

Class B
- B1 – absent posterior tibial pulse
- B2 – advanced trophic changes such as (3 required)
  - 2a – hair growth diminished or absent
  - 2b – nail changes (thickened)
  - 2c – pigmentary changes
  - 2d – skin texture (thin, shiny)
  - 2e – skin color (rubor, redness)
- B3 – absent dorsalis pedis pulse

Class C
- C1 – claudication
- C2 – temperature changes (cold feet)
- C3 – edema
- C4 – parathesias
- C5 – burning

# Soft Tissue Injuries

**Tscheme & Gotzen**

Grade 0 – little or no soft tissue injury
Grade 1 – significant abrasion or contusion
Grade 2 – deep, contaminated abrasion with local contusion to skin or muscle
Grade 3 – extensive contusion or crushing of skin or destruction of muscle

# Malignant Melanoma

**Clark** (Cancer Res, 29:705-727, 1969)
Based on histological level of invasion
Level 1 – located within epidermis or epidermal-dermal junction
Level 2 – located within papillary dermis
Level 3 – located within papillary-reticular junction
Level 4 – located down into reticular dermis
Level 5 – located within subcutaneous tissue

**Breslow** (Ann Surg, 172:902-908, 1970)
Based on thickness
Level 1 – <0.75 mm (99% cure)
Level 2 – 0.76-1.5 mm
Level 3 – 1.51-4.0 mm
Level 4 – >4.0 mm

# Polydactyly

**Blauth & Olason**

Radiographic and morphological presentation of the deformity
Describes position of duplication in both the longitudinal and transverse planes
Longitudinal Type – describes degree of duplication of the ray from distal to proximal with a division into 5 types:

- Distal phalanx
- Middle phalanx
- Proximal phalanx
- Metatarsal
- Tarsal

Transverse Type – indicates which rays are involved in the duplication

- Classification in Roman numerals starting with the 1st ray and ending with the 5th ray

**Temtamy & McKusick**

Preaxial – located on the medial side of a line that bisects the 2nd digit (15%)
Postaxial – located on the lateral side (80%)
Type A – fully developed
Type B – vestigial duplication involving soft tissue

**Venn & Watson**

Based on degree of differentiation

- Wide metatarsal head
- T-metatarsal
- Y-metatarsal
- Complete duplication

# Syndactyly

**Davis & German**

Type 1 – Incomplete webbing between two digits
Type 2 – Complete webbing to ends of digits
Type 3 – Simple with no phalangeal involvement
Type 4 – Complex with abnormal phalangeal bones

# Special Studies

## Bone Scan

**What are the phases of bone scan? When is each phase done?**
Phase 1 – Immediate, early, blood flow, or angiogram (it goes by all these names)
- 2-3 seconds

Phase 2 – Blood pool
- 2-3 minutes

Phase 3 – Delayed
- 2-3 hours

Phase 4 – Fourth phase
- 24 hours

**What do each of the phases of the bone scan test for?**
Immediate – Blood flow
Pool – Soft tissue
Delayed – Bone activity
Fourth phase – Bone uptake for patient with PVD

**What normally lights up on a bone scan?**
Epiphysis of a growing child
Fracture
Tips of scapula
Bladder
Sternum
Intercostals (ribs)

**What is the half-life of Technetium-99?**
6 hours

**What does it mean if the bone scan lights up in Phases 1-2 but not in 3?**
Cellulitis most likely

**Name a way to test between Charcot disease and osteomyelitis**
Ceretec scan or Indium-111

**What does Indium-111 tag?**
WBC's (as does the Ceretec scan)

**What does Indium-111 test for?**
Highly sensitive and specific for acute soft tissue and osseous infections

**What does Gallium-67 test for?**
Acute inflammation and infection

**How long does it take for a Gallium-67 test to work?**
2-3 days
*Note:* it's expensive

**Why would you use a Technetium-99 scan with a Gallium-67 scan?**

| | Acute Osteo | Chronic Osteo | Septic Arthritis |
|---|---|---|---|
| **Tech-99** | | | |
| *Phase 1* | + | +/- | +++ |
| *Phase 2* | ++ | + | +++ |
| *Phase 3* | +++ | +++ | +/- |
| **Gallium-67** | Positive focal uptake | Negative | Positive focal uptake |
| **Indium-111** | Positive | Negative | Positive |

| | Fracture | Acute Cellulitis | Charcot |
|---|---|---|---|
| **Tech-99** | | | |
| *Phase 1* | +++ | +++ | +/- |
| *Phase 2* | +++ | ++ | +/- |
| *Phase 3* | +++ | + | +++ |
| *Phase 4* | | | ++/+++ |
| **Gallium-67** | Negative | Positive diffuse uptake | Negative |
| **Indium-111** | Negative | Positive | Negative |

# MRI

**What causes increased signal intensity on a T1 image?**
Fat

**What causes increased signal intensity on a T2 image?**
Fluid, Infection, Inflammation, Tumor (F.I.I.T.)

**For MRI, what are the main indications for STIR imaging?**
It is useful for evaluation of edema in high lipid regions, such as bone marrow.
It is also useful for evaluating cartilage.

**What is fat saturation used for?**
Evaluation of fat…c'mon, that's obvious

**What is Gradient Echo also known as?**
Steady State Magnetization

**What is Gradient Echo used for?**
Joint imaging

**What are 2 uses for Gadolinium?**
Intravenously
- It will be distributed to places with increased vascularity, such as neoplasms and inflammation
- Cellulitis and walls of abscesses will enhance, but the pus will not.

Intra-articular
- Tests cartilage integrity

**What will a stress fracture show up as on MRI?**
T1
- Linear zone of decreased signal intensity surrounded by a less defined area of signal intensity

T2
- Linear zone of decreased signal intensity surrounded by an increased signal intensity due to edema

STIR
- Increased signal intensity because fatty bone marrow is suppressed

**How will osteomyelitis show up on MRI?**
T1
- Break in cortex, decreased signal in the bone marrow

T2
- Break in cortex, increased signal in the bone marrow

**How will AVN show up on MRI?**
T1 and T2
- Decreased signal intensities

STIR and Long T2
- Double rim sign: Inner margin will show an increased signal intensity (this represents granulation tissue). Outer margin will show decreased signal intensity (this shows mineralization).

**What does MRA stand for?**
Magnetic Resonance Angiography

**What is MRA used for in the LE?**
PVD, DVT, neoplasm and anatomic studies
Most commonly ordered by a vascular surgeon for further description of occlusions/stenosis

# CT

**What are the 3 planes of a CT Scan?**
Coronal
Axial
Sagittal

**Which of these planes is computer reconstructed?**
Sagittal

**What does the coronal plane of a CT scan represent?**
Frontal plane
(Memorization tip! 1st vowel in coronal and frontal is "O")

**What does the axial plane of a CT scan represent?**
Transverse plane
(Memorization tip! 1st vowel in transverse and axial is "A")

# Miscellaneous

**What must you D/C before an A-gram?**
Glucophage because patient may develop metabolic acidosis

**What are some tests for sickle cell anemia?**
Microscope and observe
Hemoglobin electrophoresis

**How many phases in a Ceretec scan?**
One!

**What does HMPAO stand for?**
Hexylmethypropyleneamineoxime (a.k.a. Ceretec scan)

**What does MDP stand for?**
Methyldiphosphate

# Name That Surgery!

*Note:* This section has a variety (but incomplete list) of surgeries with some indications and brief descriptions to help you sift through the vast amounts of procedures that are named after their creators. If you're going to interview or rotate with a program that has an attending in which a procedure is named after, please know more than what is listed here! Asterisks are next to the most common procedures you should know.

## 1st Ray & Tailor Bunion Procedures

*** Akin**

Indications: Large DASA → Proximal Akin
Long proximal phalanx → Central Akin
High hallux abductus angle >15° → Distal Akin

Procedure: Medially based wedge osteotomy of the proximal phalanx

*** Austin (a.k.a. Distal Chevron Osteotomy)**

*Note:* If you don't know this one, stop reading this book and find a paper bag to cover your head in shame.

Indications: HAV (IMA 12°-14°)

Procedure: V-shaped osteotomy with the apex in the center of the metatarsal head and the arms forming a 60° angle

*** Cheilectomy**

Indications: Hallux limitus

Procedure: Removal of the dorsal bone spur and dorsal ⅓ of the 1st metatarsal head
OPTIONAL – Removal of bony prominences from proximal phalanx base

*** Closing Base Wedge Osteotomy (CBWO, a.k.a. Louisan-Balaceau)**

Indication: HAV (high IMA)

Procedure: Closing wedge osteotomy straight across the base of 1st metatarsal (difficult to fixate)

*** Crescentic (a.k.a. Weinstock or Arcuate)**

Indication: HAV (IMA >13°)

Procedure: Crescentic osteotomy, (with crescentic blade) concavity directed proximally

**DRATO**

Indications: Large 1st IMA + Abnormal PASA + Valgus rotation of 1st metatarsal

Procedure: Derotational osteotomy of the 1st metatarsal head (vertical cut through metatarsal head, cartilage is rotated for realignment, very unstable)

**Hohmann**
*Note:* Reverse Hohmann used for Tailor's bunion
Indications: HAV
Procedure: Through and through transverse osteotomy at the metatarsal neck (unstable osteotomy)

*** Juvara**
Indications: HAV (IMA >15°)
Procedure: Oblique CBWO (apex prox-med, wedge laterally with the base ending in mid ⅓ of the metatarsal, direction allows for better fixation)

*** Kalish**
Indications: HAV (IMA ≤15°)
Procedure: Similar to Austin but with a long dorsal arm for screw fixation (angle reduced to 55° between arms)

*** Keller**
*Note:* Used in patients >50-55 years old
Indications: HAV (IMA 16° or less) + Hallux limitus/rigidus
Procedure: Resection of the proximal ¼ to ⅓ base proximal phalanx (⅓ more commonly, cut perpendicular to long axis of bone), and cheilectomy with capsular tissue sewn into 1st MPJ space

**Kessel-Bonney**
Indication: Hallux limitus
Procedure: Removal of a pie-shaped dorsiflexory wedge of bone from proximal phalanx

**Lambrinudi**
Indication: Hallux limitus
Procedure: Plantarflexory wedge osteotomy of 1st metatarsal base

*** Lapidus**
Indication: HAV + 1st ray hypermobility
Procedure: Fusion of 1st metatarsal base to medial cuneiform (with the resections of bone angled to correct the deformity)

**Logroscino**
Indications: HAV (IMA ≥15° in rectus foot, 13° with adductus) + Abnormal PASA
Procedure:
1. CBWO (or Crescentic) → to correct HAV
2. Reverdin (or Peabody) → to correct cartilage orientation

**Loison**
Indications: HAV
Procedure: Transverse CBWO

**Ludloff**
*Note:* Opposite orientation to Mau
Indication: HAV
Procedure: Oblique bone cut diagonally (dorsal-prox to plantar-dist) through the 1st metatarsal. Transpositional osteotomy.

**Mau**
*Note:* Opposite orientation to Ludloff
Indication: HAV
Procedure: Oblique bone cut diagonally (dorsal-dist to plantar-prox) through the 1st metatarsal. Rotational osteotomy.

*** McBride**
Indication: Mild HAV (does not truly correct the HAV deformity)
Procedure: Silver plus soft tissue, capsular releases/tightening

*** McKeever (a.k.a. 1st MPJ Arthrodesis/Fusion)**
Indications: HAV with dislocation
Hallux limitus/rigidus
Polio, CP, previous joint surgery
Procedure:
1. Removal of cartilage on 1st metatarsal head and base of proximal phalanx
2. Remodel the opposing sides to be a matching cone-in-cup shape

Hallux Position: Abducted 5°-10° (or parallel to lesser digits)
DF 5°-10° off WB surface

**Mitchell**
Indication: HAV
Procedure: Distal metaphyseal osteotomy with rectangular block of bone removed and preservation of lateral cortical "spur" (width of spur varied depending on amount of correction needed) that hangs over shaft when transposed.

*** Opening Base Wedge Osteotomy (OBWO, a.k.a. Trethowan**)
Indication: HAV
Procedure: Opening base wedge osteotomy (osteotomy across base of 1st metatarsal, then insert a pie-shaped piece of bone graft into the side of the 1st metatarsal cut)

**Peabody**
Indication: Abnormal PASA
Procedure: Reverdin done in the 1st metatarsal neck

*** Reverdin**
Indications: Mild HAV + Abnormal PASA
Procedure: Medially based wedge (proximal cut perpendicular to long axis 1st metatarsal and distal cut parallel to articular cartilage surface) resection in 1st metatarsal head

*** Reverdin-Green**
Indications: Mild HAV + Abnormal PASA
Procedure: Reverdin osteotomy but in an L-shape (or trapezoidal) to preserve sesamoid articulation

*** Reverdin-Laird**
Indications: Moderate HAV + Abnormal PASA
Procedure: Reverdin-Green with lateral shift of capital fragment to correct IMA

**Reverdin-Green-Laird-Todd**
Indication: Hallux limitus + HAV
Allows for correction in 3 planes
Procedure: Triangle-shaped wedge removed from both the top and side of the distal 1st metatarsal

*** Scarf**
Indication: HAV (IMA 12°-18°)
Procedure: Z-type osteotomy through the shaft of the 1st metatarsal

**Silver**
Indications: Medial 1st MPJ pain
Mild HAV (but does not correct the true HAV deformity)
Procedure: Isolated resection of medial eminence of 1st metatarsal head

**Stamm**
Indication: HAV
Procedure: OBWO in medial cuneiform (wedge of graft inserted into medial cuneiform)

**Valenti**
Indication: Hallux limitus
Procedure: Removal of angled (usually 45°) dorsal wedges from the 1st metatarsal and proximal phalanx to increase ROM

*** Vogler (a.k.a. Offset-V)**
Indication: HAV
Procedure: V-osteotomy made in the neck of the 1st metatarsal (similar to Kalish but more proximal)

**Watermann**
Indication: Hallux limitus
Procedure: Removal of closing wedge of bone from 1st metatarsal head to DF capital fragment

**Watermann-Green**
Indications: Hallux limitus
Procedure: Watermann osteotomy but with a plantar shelf to preserve sesamoid articulation

**Wilson**
*Note:* Reverse Wilson can be done for Tailor's bunion
Indication: HAV (IMA 12°-14°)
HAV + Long 1st metatarsal
Procedure: Oblique (dist-med to prox-lat) through and through osteotomy at the 1st metatarsal neck, capital fragment slides laterally on shaft (unstable and slow healing)

*** Youngswick**
Indications: HAV + DF 1st metatarsal
HAV + Hallux limitus
Procedure: Austin but with an extra slice taken out on the dorsal arm to allow the head to drop plantarly and decompress the 1st MPJ

**Gerbert**
Indication: Tailor's bunion
Procedure: Wedge osteotomy (transverse or oblique) at 5th metatarsal base. K-wire or screw fixation.

**Mercado**
Indication: Tailor's bunion
Procedure: Oblique wedge osteotomy at 5th metatarsal neck

**Reverse Austin** (or Reverse Chevron)
Indication: Tailor's bunion
Procedure: Transverse plane V-osteotomy in distal 5th metatarsal with medial transposition and impacted on shaft for fixation (or pin fixation)

**Reverse Hohmann**
Indication: Tailor's bunion
Procedure: Transverse osteotomy in distal metaphysis of 5th metatarsal with medial transposition of capital fragment. Fixation not usually used.

**Reverse Wilson**
Indication: Tailor's bunion
Procedure: Osteotomy from dist-lat to prox-med to shorten the 5th metatarsal and medial transposition of metatarsal head. Fixation not usually used.

**Yancey**
Indication: Tailor's bunion
Procedure: Oblique or transverse (most stable) wedge osteotomy at 5th metatarsal prox mid-diaphyseal area. Fixation used.

# Metatarsus Adductus Procedures

**Bankart**
Indications: Met adductus + Age 8 years or older
Congenital absence of medial cuneiform
Procedure: Excise cuboid (to balance out lack of medial cuneiform)

**Brown**
Indications: Met adductus + Ages 2-6 years old
Procedure:
1. Transfer TP into navicular
2. Medial capsulotomy of nav-cun joint

**Chondrotomy by Johnson**
Indications: Met adductus + Ages 6-8 years old
Procedure:
1. Resect 2.5 mm lateral based wedges (apex medial) of cartilage in metatarsals 2-5, enlarge bases medially
2. Lateral base wedge osteotomy distal to epiphysis of 1st metatarsal
3. Lengthen ABductor hallucis

**Fowler**
See Clubfoot Procedure section

*** Berman & Gartland**
*Note:* Most popular osseous procedure for met adductus
Indications: Met adductus + Age 6 years or older
Procedure:
1. Panmetatarsal base wedges dome-shaped or crescentic osteotomies
    a. Optional – rearfoot procedures to correct combined deformities
2. Manipulate foot into corrected position, use pin fixation in all metatarsals and cast for 6 weeks

**Ghali**
Indications: Met adductus + Ages 2-6 years old
Procedure:
1. Heyman, Herndon & Strong procedure
2. PLUS ant-medial release of naviculocuneiform joint

*** Heyman, Herndon & Strong (a.k.a. Tarsometatarsal soft tissue release)**
Indications: Met adductus + Ages 2-6 years old
Procedure:
1. 3 dorsal incisions (originally one dorsal transverse incision)
2. Capsulotomies and ligament releases of all tarsometatarsal joints (metatarsals 1-5)
    a. Keep plantar lateral ligaments and joint capsules intact (modification from original to prevent dorsal subluxation)

b. Optional – syndesmotomy of naviculocuneiform joint and release of TA tendon, also could use K-wires to maintain corrected positions

3. Manipulate metatarsals and foot into rectus position and cast for 3 months

**Lange**
Indications: Met adductus + Ages 2-6 years old
Procedure: Capsulotomy of 1st metatarsal-cuneiform, followed by serial casting

**Lepird**
Indications: Met adductus + Age 8 years or older
Procedure:
1. 3 dorsal incisions
2. Transverse plane osteotomies in bases of metatarsals 2-4 from dorsal-dist to plantar-prox, parallel to WB surface of foot, fixated with compression screws
3. Oblique base wedge osteotomies of 1st and 5th metatarsals, fixed with compression screws

**Lichtblau**
*Note:* Same name as procedure for clubfoot
Indications: Met adductus + Ages 2-6 years old
To release abductor hallucis
Procedure: Sectioning of abductor hallucis through a small medial incision

**McCormick & Blount**
Indications: Met adductus + Age 8 years or older
Procedure:
1. Arthrodesis of 1st metatarsal-cuneiform joint
2. Osteotomy of bases metatarsals 2-4

**Peabody & Muro**
Indications: Met adductus + Age 8 years old or older
Procedure:
1. Excise bases of metatarsals 2-4
2. Osteotomy of 5th metatarsal
3. Mobilize and reduce subluxation of 1st metatarsal -cuneiform joint
4. Correction of any abnormal insertion of TA tendon
5. Optional – Hoke triple arthrodesis to realign rearfoot when necessary

**Steytler & Van der Walt**
Indications: Met adductus + Age 8 or older
Procedure: Oblique V-osteotomy (apex of "V" toward rearfoot) of all metatarsal bases
Modified from original to include fixation

**Thompson**
Indications: Met adductus + Ages 2-6 years old + hallux varus (a.k.a. hallux abductus, severe contraction of abd hallucis)
To release abductor hallucis
Procedure: Resect abductor hallucis

## Achilles Tendon Procedures

*** Baker**
Indication: Achilles tendon lengthening
Procedure: Tongue-in-groove cut in aponeurosis with the tongue distal, facing upward
Suture aponeurosis bands to one another in retracted position

**Bauman**
Indication: Gastroc equinus
Procedure: Isolated gastroc recession in the deep interval between soleus and gastroc muscles

**Hoke**
Indication: Achilles tendon lengthening
Procedure:
1. Incision 5 cm in length over medial aspect of tendon
2. Triple hemisection of Achilles tendon
    a. Cut Achilles in half in 3 sections: posteriorly in proximal and distal aspects of incision and anteriorly in central portion of incision
    b. Modification – cuts med/lat instead of ant/post, can be percutaneous
3. Forcibly DF the foot to allow for sliding into lengthened position

**Lindholm**
Indication: Achilles tendon ruptures
Procedure: Two flaps taken proximally from Achilles and reflected distally to fill defect

**Lynn**
Indication: Achilles tendon ruptures
Procedure: End-to-end reapproximation of ruptured Achilles (may reinforce with plantaris)

**Fulp & McGlamry Modification** (of Baker's technique)
Indication: Achilles tendon lengthening
Correction of non-spastic gastroc equinus
Procedure: Tongue-in-groove cuts in aponeurosis with the tongue distal, facing downward (inverted version of Baker's technique)

**Silfverskiöld**
*Note:* Makes a 3 joint muscle into a 2 joint muscle
Indication: Achilles tendon lengthening
Procedure:
1. Release the gastroc heads at their attachments to the femoral condyles (above knee joint)
2. Reinsertion into the posterior proximal tibia area (below knee joint)

*** Sliding "Z" Lengthening**
Indication: Achilles tendon lengthening
Procedure: Cuts most commonly done in frontal plane but can be in sagittal plane
Usually percutaneous, recommended open in McGlamry
DF the foot after cutting to separate and lengthen ends of the tendon
If open procedure, suture ends of "Z" together in lengthened position

**Strayer**
Indication: Gastroc equinus
Procedure:
1. Distal recession with the complete transverse cutting of gastroc aponeurosis
2. Proximal retracted portion of gastroc is sutured into the deeper soleus

*** Vulpius & Stoffel**
*Note:* Originally a transverse cut in aponeurosis
Indications: Gastroc equinus
Procedure: Distal resection of gastroc aponeurosis using an inverted "V"
But DON'T suture to soleus

**White**
Indication: Achilles tendon lengthening
Procedure:
1. Section anterior ⅔ of distal Achilles and medial ⅔ of Achilles (5-7.5 cm proximal to this point)
2. This lengthens the gastroc in relation to its twisting before its insertion

## Pes Planus and PTTD Procedures

**Baker & Hill**
Indications: Pes planus (to restore alignment of STJ and reduce heel valgus and excess pronation)
Cerebral palsy
Procedure: Horizontal osteotomy inferior to posterior facet of STJ (in calcaneus, medial cortex intact as hinge) and a wedge-shaped graft inserted

**Chambers**
Indication: Flexible pes planus (more often in children, <8 years old)
Rarely performed anymore
Procedure:
1. TAL
2. Bone graft under sinus tarsi (similar to location of arthroereisis to block translocation of talus on the calcaneus)

**Chiappara**
Indication: Pes planus
Procedure:
1. Silver (opening wedge calc osteotomy from lateral side) with TP advancement
2. TA tenodesis to TP

**Cobb**
*Note:* Good procedure because FDL preserved
Indications: PTTD
Pes valgus
Procedure:
1. Hemi-section of TA (more medial portion released, other half left intact at insertion near ankle level)
2. Lay released portion of TA along TP tendon and suture together

*** Cotton**
Indications: Pes planus
PTTD
Medial column repair (to get structural PF of medial column)
Procedure:
1. Medial (and sometimes intermediate cuneiforms) osteotomy dorsal to plantar (maintaining plantar cortex intact)
2. Triangular shaped bone graft (base measuring 4-7mm) inserted in osteotomy. No fixation necessary.

*** Dwyer**
Indication: Pes planus
To produce calcaneal varus
Procedure: Closing wedge osteotomy from medial side (difficult due to possible nerve entrapment)

*** Evans Calcaneal Osteotomy**
*Note:* Same name as procedures indicated for clubfoot and lateral ankle instability
Indications: Pes valgus foot deformity
To lengthen calcaneus
Procedure:
1. Incision over C-C joint, reflect EDB
2. Osteotomy of calcaneus parallel and 1-1.5 cm (dist ⅓) prox to C-C joint
3. Wedge of graft inserted into osteotomy (lateral side of graft up to 1 cm in kids and max 7 mm in adults)

**Gleich**
Indication: Pes valgus foot deformity (especially frontal plane dominant)
Procedure: Oblique calc osteotomy (posterior calc osteotomy) displaced anteriorly (to "restore the normal angle of the long axis of the calc to the floor")

*** Hoke Arthrodesis**
*Note:* Not to be confused with the Hoke Achilles procedure
Indication: Pes planus
Medial column repair
Usually done in conjunction with ankle equinus correction and calcaneal osteotomies or arthroeresis
Procedure:
1. TAL
2. Fusion of navicular to medial and intermediate cuneiforms

*** Kidner**
Indications: Pes planus
Kidner foot type (accessory navicular and/or enlarged navicular)
Medial column repair
Procedure:
1. Detach TP from navicular medially
2. Resect accessory navicular and/or bump from navicular
3. Reattach TP to navicular more plantarly (tendon bone anchors commonly used)

*** Koutsogiannis** (nickname "Kouts")
*Note:* Sometimes combined with Evans osteotomy for PTTD
Indication: Pes valgus foot deformity
Restores heel valgus, less so in restoring medial longitudinal arch. Also shifts the functional insertion of the Achilles medially.
Procedure:
1. Medial displacement of an oblique osteotomy of calcaneus from lateral incision
    a. Posterior portion of calcaneus "slides" medially ⅓ to ½ the width of calcaneus until it sits just below sustentaculum tali
2. K-wire, Steinmann pins, or lag screw fixation

**Lord**
Indication: Pes planus
Procedure: A Gleich (oblique calcaneal osteotomy) displaced anteriorly, medially, and inferiorly

**Lowman**
Indications: Pes planus
Medial column repair
Procedure:
1. TAL
2. Talo-navicular wedge arthrodesis
3. Reroute TA under navicular and suture into spring ligament
4. Tenodesis of medial arch by taking slip of TA and reflect downward (leave its insertion to the calcaneus intact) along medial arch

**Miller**

Indications: Pes planus (more often appropriate in adults than children)
Medial column repair

Procedure:

1. TAL
2. Medial column fusion (navicular to medial cuneiform to 1st metatarsal)
3. Resect hypertrophy of navicular (use as bone graft for fusion sites)
4. Advance medial soft tissues

**Peroneus Brevis Tendon Transfer (PBTT)**

Indication: Type 1 vertical talus
Severe pes planovalgus

Procedure: Detach PB and reroute dorsally to talar neck
ALT – Detach PB and transfer to lateral cuneiform or 3rd metatarsal

**Selakovich**

Indication: Flexible pes planus + Ages 5-9 years old
Congenital vertical talus (flexible/supple deformity) + Ages 5-9 years old

Procedure:

1. Osteotomy and grafting of sustentaculum tali
    a. Osteotomy performed midway between interosseous talocalcaneal ligament and post margin of sustentaculum tali
    b. Wedge bone graft inserted to redirect the middle and anterior facets
2. Tightening of medial structures (tightening redundant spring ligament and repositioning of the TP)
3. Reroute half or all of TA into navicular

**Silver or Opening Wedge Dwyer**

Indication: Pes planus

Procedures:

1. Opening wedge calcaneal osteotomy from lateral incision
    a. Oblique osteotomy from just post to post facet inferiorly to just prox to C-C joint
    b. The more proximal and anterior the osteotomy, the greater correction
2. Graft insertion into osteotomy
    a. Average wedge size ¼ inch, no fixation needed

*** STJ Arthroereisis**

Indication: Flexible pes valgus + patient not yet at skeletal maturity (or if arthrodesis not appropriate in older patient)

Procedure:

1. Incision 2-4 cm long parallel to relaxed skin tension lines over sinus tarsi. Incise deep fascia to expose lateral talar process, post facet and sinus tarsi floor.
2. Further steps of dissection depend on the specific device you are using
    a. MBA (Maxwell-Brancheau Arthroereisis) implant, STA-peg device

**Young Tenosuspension**
*Note:* Often done in conjunction with other procedures
Indications: Pes planus + Age 10 years or older
Patients with navicular-cuneiform fault but no DJD yet
Helps to PF 1st ray (takes away TA antagonist action against PL)
Procedures:
1. TAL
2. Reroute TA through keyhole in navicular (do not detach TA from insertion)
    a. Alternate – detach TA from insertion and reattach after passing through a trephine hole in navicular
3. TP reattachment beneath navicular (creates a powerful plantar navicular-cuneiform ligament)

# Lateral Ankle Instability Procedures

*** Brostrom-Gould (or just Brostrom)**
*Note:* Common procedure used, see Special Surgery Section for details
Indication: Lateral ankle instability
For primary repair
Procedure:
1. Incise lateral ankle capsule 2-3 cm distal to lateral malleolus
2. Evert foot and tighten capsule including ATFL and CFL in pants over vest fashion with non-absorbable suture
3. Mobilize extensor retinaculum, pull it over capsule and suture down

*** Christman & Snook**
*Note:* Could use PL instead of PB for this procedure
Indication: Lateral ankle instability
To reinforce ATFL and CFL
Procedure:
1. Detach half of PB from its insertion
2. Reroute it through a drill hole in the talar neck and distal lateral malleolus (through widest part, anterior to posterior). Suture graft tendon to periosteal flap at level of CFL.
3. Distal half of PB then sutured to proximal half

**Elmslie**
Indication: Lateral ankle instability
To reinforce ATFL and CFL
Procedure: Tensor fascia lata routed through calcaneus, then lateral malleolus, then talus, back through lateral malleolus and back through calcaneus

**Evans**
*Note:* Same name as osteotomies indicated for pes planus and clubfoot. Similar to Nilsonne but with an osseous tunnel instead of subperiosteal tunnel.
Indication: Lateral ankle instability
Reinforces ATFL only (this does not reconstruct ATFL or CFL anatomically)

Procedure:

1. PB is detached proximally
2. Reroute it through fibular drill hole (anterior-most and distal-most → post-prox location). PB secured posteriorly at prox aspect of superior peroneal retinaculum.
3. Prox PB is attached to PL

**Hambly**

Indication: Lateral ankle instability
Reinforces ATFL and CFL

Procedure:

1. Split PL
2. Reroute into talus (or attached through it), through a lateral malleolus drill hole (anterior to posterior), through calcaneus and attached to the other half of the PL

**Kelikian**

Indication: Lateral ankle instability
Reinforces ATFL and CFL

Procedure:

1. Isolate the plantaris tendon
2. Reroute it from the calcaneus into lateral malleolus through a drill hole (posterior to anterior), back through the calcaneus then sutured on itself

**Lee**

Indication: Lateral ankle instability
Reinforces ATFL only

Procedure:

1. PB detached proximally
2. Reroute it through lateral malleolus drill hole (post → ant) and sutured upon itself (peroneal anastomosis)
3. Periosteal flap from dist fibula reinforces new ligament
4. Prox PB attached to PL

**Nilsonne**

Indication: Lateral ankle instability
Reinforces ATFL only

Procedure:

1. PB detached proximally at musculotendon junction
2. Reroute it through subperiosteal groove through fibula (post-superior → ant-inferior), CFL primarily repaired if necessary
3. PB secured in subperiosteal tunnel (this approximates ATFL course)
4. Prox PB attached to PL

**Seeburger**

Indication: Lateral ankle instability
Reinforces ATFL and CFL

Procedure:

1. Use a hemi-section of PL
2. Reroute it from talus into lateral malleolus and into calcaneus

**Watson-Jones**

Indication: Lateral ankle instability
Reinforces ATFL only

Procedure:

1. PB detached proximally
2. Reroute it through lateral malleolus (drill hole posterior to anterior ~2 cm from distal tip of fibula) into talar neck (vertical drill hole dorsal to plantar), then back through lateral malleolus (along ATFL course) and sutured on itself posterior to fibula
3. Proximal PB attached to PL

**Whinfield**

Indication: Lateral ankle instability
Reinforces ATFL and CFL

Procedure:

1. PB detached proximally while maintaining distal attachment
2. The detached portion is rerouted through a lateral malleolus drill hole (anterior to posterior) and inserted into calcaneus

## Clubfoot Procedures

**Baja Project**

Indication: Clubfoot

Procedure:

1. Cuboid decancellation procedure
2. Laterally based triangular wedge of bone removed from cuboid and lateral cuneiform

*** Dwyer**

*Note:* Indicated also for pes planus but wedge done laterally instead of medially (calcaneus goes into varus)

Indication: Clubfoot
Cavus foot deformity

Procedure: Opening wedge medial calcaneal osteotomy
Calcaneus goes into a more valgus position

*** Evans**

*Note:* Same name as procedures indicated for pes planus and lateral ankle instability

Indication: Clubfoot

Procedure: Shorten lateral column by calcaneal-cuboid fusion

**Fowler**
*Note:* Often done in conjunction with other procedures, especially if more rigid deformity
Indications: Residual clubfoot deformity
Cavovarus deformity
Met adductus + Age 8 years or older
Procedure:
Bone graft inserted into medial cuneiform with opening wedge osteotomy to lengthen medial column
Modification – closing wedge osteotomy of cuboid and lateral cuneiform, then use this bone as the graft for the opening medial cuneiform osteotomy. Good with ages 3-10 years old, residual adduction, or varus deformity in forefoot/midfoot.

**Lichtblau**
*Note:* Same name as a procedure for met adductus
Indication: Clubfoot
Procedure: Closing base wedge osteotomy of anterior calcaneus (base of wedge lateral, shortens lateral column)

**Lund**
Indication: Clubfoot (neglected or arthrogryphotic neuromuscular type) + Ages 2-5 years old (ideally, occasionally in adults)
Procedure:
Talectomy (foot posteriorly displaced allowing for correction in sagittal and frontal planes)
Optional – portions of navicular and fibula may need to be resected. Also may use midfoot wedges adjunctively. Often multistaged.
Fixation with Steinmann pin from calc to tibia for pseudojoint space. Long leg casting for 1 month to BK cast for 4 months.

## Miscellaneous Procedures

**Hibbs**
Indication: To decrease MPJ buckling and increase DF
Procedure:
1. EDL is detached from insertion and reattached to lateral cuneiform or 3rd metatarsal
2. Distal stubs of EDL are attached to EDB at metatarsal head area

*** Hoffman**
*Note:* Often done with Keller arthroplasty
Indications: MPJ subluxation secondary to rheumatoid arthritis and fat pad atrophy
Procedure: Resection of metatarsal heads 2-5

**Hoffman-Clayton**
Indications: MPJ subluxation secondary to rheumatoid arthritis and fat pad atrophy
Procedure: Resection of metatarsal heads 2-5 and bases of proximal phalanxes

*** Jones**

Indications: Cock-up hallux
Weak TA (procedure enhances DF)

Procedure:

1. EHL is detached and inserted into 1st metatarsal head via a med → lat drill hole
2. IPJ fusion
3. Stump of EHL is attached to EHB

**Murphy**

Indication: Spastic equinus
Procedure: Anterior transfer of TA into calcaneus
Modification – route under FHL

**OATS (Osteoarticular Transfer System)**

Indication: Posterior medial talar dome osteochondral lesion

Procedure:

1. Take a plug of bone with articular cartilage from the knee
2. Through a trans-tibial approach, insert it into the talus (matching the contours of cartilage on graft to dome of talus)

**Peroneus Longus Tendon Transfer (PLTT)**

Indication: Drop foot
Anterior muscle weakness
Flexible cavus deformity

Procedure:

1. Cut PL near PB insertion site, suture distal PL to PB
2. Reroute it dorsally to 3rd cuneiform

**Silver & Simon**

Indication: Spastic equinus

Procedure:

1. Proximal release of gastroc without reinsertion of heads
2. Neurectomy of tibial branches to medial head of gastroc

*** Split Tibialis Anterior Tendon Transfer (STATT)**

*Note:* Same as TATT but only half the tendon is used. See Special Surgery Section for details.

Indications: To increase true ankle DF and decrease long extensor swing phase
To decrease adductovarus forefoot

Procedure:

1. Detach half of TA from its insertion
2. Reroute and insert it into peroneus tertius (or cuboid, if peroneus tertius isn't present)

**Stoffel**

Indication: Correction of spastic muscular forms of ankle equinus
Procedure: Selective denervation of tibial nerve

**Tachdjian-Grice**
*Note:* Grice procedure = STJ arthrodesis
Indications: Congenital convex pes planovalgus (vertical talus!) + Ages 4-6 years old
Procedure:
1. First stage: TAL with posterior ankle and STJ capsular release
2. Second stage: (3 weeks later) STJ extraarticular arthrodesis

**Tibialis Anterior Tendon Transfer (TATT)**
*Note:* The STATT is slightly preferred due to fewer complications. See Special Surgery Section for details.
Indications: To decrease forefoot supinatory twist
To increase true ankle DF
Procedure:
1. TA is detached from its insertion
2. Reroute and insert it into lateral cuneiform or 3rd metatarsal (or inserted into peroneus tertius if present)

**Tibialis Posterior Tendon Transfer (TPTT)**
*Note:* See Special Surgery Section for details.
Indications: Drop foot
To eliminate flexor substitution
Procedure:
1. TP is detached at its insertion site on the navicular
2. It is then rerouted through the interosseous membrane of the tibia and fibula, brought anteriorly and then inserted into the lateral cuneiform

# Special Surgical Section

This section is based on my notes on how to do a select few rearfoot and ankle cases. Basically, the outlines are a combination of McGlamry's, Coughlin's, and Kitoaka that I used in my third year to prepare for the cases. Obviously, my notes are only one of many ways to do the cases.

I have included my notes here as a quick outline reference. As always, it is up to the reader to go to the original sources to learn the material.

--Brett

We also used McGlamry and Coughlin & Mann to prepare for cases. We have included a few additional notes that we found helpful.

--Hubert & Sandi

# Achilles Tendon Rupture

- Frequently in "Weekend Warriors" men 30-50 yrs old
- Location of tear usually occurs in the "watershed area" (2-6 cm proximal to the Achilles insertion) though avulsions and myotendinous junction ruptures are also possible
- **Clinical Exam**
  - Patient can PF because of posterior tibialis but can't do a one-legged heel raise
  - Positive Thompson test (squeezing the calf reveals an absence of ankle plantarflexion)
  - Palpable gap, although this may be less obvious with edema after 24 hours
- **Surgery vs Conservative Tx**
  - Younger people tend to do better and recover faster with surgery over conservative methods
  - Older, non-active people tend to do better with conservative methods
- **Conservative Treatment**
  - PF cast for 2 weeks NWB
  - Increase DF (but still PF) for 2 more weeks. Continue NWB.
  - At 4 weeks, if can cast in neutral, pt can WB
  - At 8 weeks, D/C cast and use CAM boot for 4 more weeks. A 2-2.5 cm heel lift can be put in shoes. Begin passive ROM.
  - At 12 weeks, start active exercises in regular shoe (with ¼" to ½" heel lift)
- **Pre-op Tx**
  - Jones compression dressing with mild PF of foot

- **<u>Procedure</u>**
  - **Patient set-up**
    - Prone
    - General or spinal
    - Thigh tourniquet

  1. <u>Incision</u>: medial aspect of the Achilles tendon from just above the myotendinous junction to insertion on calcaneus. Incision is down to paratenon.
     a. Use very careful dissection as this area is very avascular
     b. *Watch out for*:
        i. Plantaris medially
        ii. Sural nerve perforates the Achilles tendon centrally at the myotendinous junction and then courses laterally
        iii. Lesser saphenous vein may also run with the sural nerve
  2. **Incise the paratenon**. The paratenon should be opened as part of the full thickness flap. Get good exposure to the tendon.
- For **<u>End-to-end or mid-tendon ruptures</u>**
  3. **Irrigate, debride** the mop-top ends of tendon
  4. **Reapproximate** using Bunnel, Kessler or Krackow type of suture using 3-0 or 2-0 Ethibond or other non-absorbable polyester suture
  5. **Reinforce** site with 1-0 or 2-0 Vicryl in a circumferential stitch. Irrigate again.
  6. **Close** paratenon with 3-0 Vicryl, subcutaneous, then skin

- For **<u>Myotendinous junction ruptures</u>** (Reverse Lindholm's technique)
    3. Rather than inverted strips of tendon being raised from prox → dist (as in Lindholm's technique), go dist → prox
    4. **Weave inverted tendon** into place
    5. **Suture** with Bunnel, Kessler or Krackow technique, similar to end-to-end repair
    6. **Reinforce** with Vicryl circumferential suture, close subcutaneous and skin
- For **<u>Avulsion ruptures</u>**
    3. Extend incision distally past insertion of Achilles onto calcaneus
    4. **Debride calcaneus of fibrous tissue**, debride down to cancellous bone
    5. Make **2 drill holes** longitudinally to each other and put **non-absorbable suture** in tendon (i.e. half a Kessler) bring suture through drill holes and tie over itself or (more commonly now) use suture bone anchors
    6. **Close**

- **<u>Post-op</u>**
    - Jones compression dressing for 7-10 days
    - NWB BK cast for 2-3 weeks
        - Cast in 20° PF for avulsion and mid-tendon ruptures
        - Cast in neutral for myotendinous ruptures
    - After the PF cast, cast in neutral position (have the patient rest foot on a footrest for 15-20 min to gently allow the foot to go to neutral or close). WB BK cast for 2-4 weeks or CAM boot (removable walking cast) here instead. Pt may also start passive ROM.
    - After casts, return to regular shoes with a 1" heel lift
    - Aggressive walking may begin around 10 weeks post-op
    - Return to sports at 14-16 weeks post-op
    - *Note:* Pt may not be able to get full DF of foot for 3-6 months

# Delayed Repair of Achilles Tendon

- **Clinical Presentation**
  - At time of rupture, pt feels as if *struck in the back of the calf*
  - Pt complains of weakness in PF
  - If pt has progressive degenerative changes to Achilles tendon, insidious onset
  - Often rupture is not palpable
  - Tendon tends to be thicker as it progressively gets longer
- **Areas of Ruptures**
  - At tendon 2-6 cm from insertion
  - At myotendinous junction
  - Calcaneal avulsion
- **Conservative Treatment**
  - Heel lifts, lace up shoes, MAFO, braces
  - BUT…these won't restore normal push-off
- **Indications for Surgery**
  - Restore normal push-off power
  - Take X-rays and MRI
    - If >3 cm defect and >3 months → end-to-end suture (as in Acute Achilles repair)

- **Procedure**
  - **Patient set-up**
    - Prone
    - General or spinal
    - Thigh tourniquet
  - For **mid-tendon tear**
    1. Posterior medial incision over Achilles from just above myotendinous junction to past calcaneal insertion. Make full thickness incision to paratenon.
    2. Incise paratenon, reflect with full thickness flap
    3. Irrigate, clean up mop-handle like edges
  - If **>3 cm tear**
    4. Kessel, Bunnel or Krackow type suture with 3-0 Ethibond
    5. Reinforce ends circumferentially with 2-0 or 3-0 Vicryl
  - If **gap is approx 3 cm** → inverted V-Y advancement is done
    4. Inverted V-Y – leaving underlying muscle attached to the paratenon
    5. Advance the distal flap distally
    6. Close the defect via Kessel, Bunnel, or Krackow with 3-0 Ethibond
    7. Reinforce ends circumferentially with 2-0 or 3-0 Vicryl
  - If **gap is much greater than 3 cm** → V-Y advancement, close end-to-end, **reinforce with FHL**
    - Inverted V-Y will have to be done at an acute angle and will make the tendon very thin…which is why you have to reinforce with FHL
    - **FHL Transfer**
      1. Incision is on medial border of midfoot, from the navicular to head of 1st metatarsal, just above the level of the abductor muscle (approximately where plantar skin meets regular skin)

2. Dissect down to the layer of the abductor hallucis fascia. Reflect the muscle downward. Retract with Weitlaner.
3. FHB is reflected plantarly
4. Identify the FHL (medial) and FDL
    a. These are usually covered by a fatty layer
    b. Flex the IPJ of the hallux, and the FHL can be identified
5. Section the FHL as distally as possible, generally at midshaft of 1st metatarsal
6. Tag prox part of FHL. Suture distal FHL to FDL with the toes in neutral position.

- **Posterior Medial Incision**
    1. Posterior medial <u>incision</u> over Achilles from just above myotendinous junction to past calcaneal insertion. Make full thickness incision to paratenon.
    2. Incise paratenon, reflect with full thickness flap
    3. **Irrigate**, clean up mop-handle like edges
    4. Incise the fascia overlying the FHL. By pulling on the suture from the FHL, you can identify the muscle.
    5. Retract the tendon through post-medial incision
    6. Make transverse drill hole into posterior calcaneus just distal to insertion of calcaneus halfway from medial → lateral
    7. 2nd drill hole goes from prox → dist to intercept the holes in calcaneus. A large towel clip is used to connect the 2 holes.
    8. A **suture passer** is inserted in the dist-medial hole upward. The FHL is attached to it and the FHL tendon is passed from prox → dist-medial.
    9. The **FHL** is then **woven into the Achilles** tendon from dist → prox and repeated to use the full length of FHL tendon.
    10. The tendon is secured with Ethibond
    11. Repair paratenon, then **close** in layers

- **<u>Post-op</u>**
    - Jones compression dressing and plaster splints with foot in 15° PF until first post-op visit (7-10 days)
    - BK cast with foot in 15° PF for 4 weeks
    - Cast foot in neutral with BK walking cast or removable cast boot for 4 weeks
        - Put foot on footrest with hip flexed. Allow foot to passively go to neutral.
    - At 8 weeks post-op, begin strength training and ROM exercises
    - Patient remains in removable cast boot until the 10° of DF and 4/5 PF strength is achieved
    - Half-inch heel lift is added to their shoe. Home exercises are performed at this period.
    - Athletic activity restricted for 6 months

# Excision of Calcification of Achilles Tendon

- **Procedure**
  - General or spinal
  - Prone is ideal
  - Thigh tourniquet
- Have Mitek anchor or other kind of anchor in room
  1. Incision: from the superior-medial of the Achilles tendon (can go 1 cm medial to tendon and 3-4 cm proximal to spur or tuberosity)→lateral (2-3 cm distal to spur or tuberosity), with the horizontal part over the spur
     a. Note: can go the other direction which may keep away from sural nerve
  2. Dissect in layers, tag paratenon
  3. **Incise Achilles** tendon longitudinally (Lateral ½ = Medial ½). Keep distal attachments of Achilles, if possible.
     a. If total resection of Achilles tendon must be performed, remove all bony prominences and treat it like a ruptured Achilles tendon
        i. Can drill holes and use non-absorbable suture (ie fiberwire) or Mitek bone-tendon anchor
  4. **Reflect Achilles** tendon side to side, remove any intra-tendon calcification
  5. Deepen incision—remove retrocalcaneal bursa
  6. **Release** any paratenons fibrosing or scaring
     a. Expose any posterior calcaneal exostosis
     b. Can resect calcaneal exostosis with an osteotome
  7. **Repair Achilles** tendon with 2-0 Vicryl in running suture
  8. Close

- **Post-op**
  - 3-6 weeks NWB in cast (if necessary)
  - 3-6 weeks in a WB boot

# Murphy Procedure – Achilles Tendon Advancement

- **Indication**
  - Spastic equinus
  - Plantarflexory force of gastroc-soleus complex at ankle joint is weakened with minimal decrease of toe-off force

- **Procedure**
  1. Incision 5 cm slightly medial to midline of Achilles tendon
  2. Dissect down to deep fascia and paratenon. Incise and tag the paratenon. Do not dissect in layers because this will lead to soft tissue necrosis.
  3. Detach TAL from its insertion to the calcaneus
     a. If child, *careful* not to disturb the calcaneal apophysitis
  4. Reroute the TAL under the FHL (if desired)
  5. Divide the fat over the calcaneus, then resect a 0.5 cm wedge of bone from calcaneus just posterior to posterior facet
  6. From that wedge, make 2 drill holes, one exiting medially, one exiting laterally
  7. Use a Bunnell technique to the distal end of the TAL with either an absorbable (1-0 Vicryl) or non-absorbable (1-0 Ethibond) suture
  8. Bring one of the loose end strands through the medial drill hole, and bring the other strand laterally
  9. With the foot in neutral, guide the tendon into the wedge and tie the sutures over the dorsal surface of the calcaneus, anterior to Achilles tendon
  10. Close, cast in AK cast with knee slightly flexed, foot in neutral

# Ankle Arthrodesis

- **Ideal position**
  - Ankle neutral (no DF or PF)
  - 5° valgus
  - External rotation equal to opposite limb

- **Procedure**
  - Patient set-up
    - Prone with sandbags
    - Thigh tourniquet
    - General or spinal

- **Lateral approach**
  1. Incision is curved starting approx 10 cm proximal to fibula to base of 4th metatarsal
     a. *Avoid* sural and intermediate dorsal cutaneous nerves
  2. Create skin flaps
  3. **Strip periosteum from fibula** (reflect anteriorly and posteriorly)
  4. Incision is carried down to expose posterior facet of STJ and sinus tarsi
  5. Use a periosteal elevator to **strip the tibia, ankle joint and prox talar neck** (med → lat)
     a. *Do NOT* dissect talar neck except for prox portion. You don't want to strip off the blood supply to the talus!
  6. **Osteotomize the fibula** approx 2 cm prox from ankle joint
     a. Bevel the cut proximal-lateral to distal-medial so you don't leave a sharp edge
     b. Remove distal portion of the fibula
     c. Reflect peroneal tendons posteriorly
  7. Make incision through deep fascia at post tibia. With a periosteal elevator, **strip the soft tissues off the tibia**.
     a. This is visualized after fibula is removed
  8. The **initial cut in the tibia** is with the short wide blade, then complete with the long wide blade
     a. **Cut is perpendicular to long axis** of bone
     b. Remove as little bone as possible
     c. Stop cut where the tibia curves for the medial malleolus

- **Medial approach**
  1. Incision is 4 cm over the anteromedial aspect of the medial malleolus and directed slightly inferior so that the medial tip of the medial malleolus can be exposed
  2. **Strip soft tissue anteriorly**
     a. Do as little damage to deltoid ligament as possible
  3. With a size 10 osteotome, cut along the medial malleolus to **finish the initial tibial cut** while freeing up the initial portion

- **Lateral incision**
  1. With a broad osteotome, **wedge out the tibial cut** using gentle levering
  2. **In the talus**, cut 3-4 mm from the superior surface
  3. **Check alignment** and remove more bone if needed

- **Fixation**
  1. **Temporary fix** with 0.062 K-wire
     a. Check position relative to patella
     b. Place two 3.2 drill bits, one in sinus tarsi and one just above lateral process
     c. Check position
  2. Insert two 6.5 mm screws from lat-distal → med-prox
     a. *Note:* There are multiple specialty plates available specifically for this procedure that may change the way you do your fixation
  3. Be sure to **engage medial cortex of tibia**
  4. If soft bone, use a washer
     a. Check rigidity of arthrodesis site
     b. Optional – Can put 3rd screw through medial incision
     c. Optional – Fixation of fibula with 4.0/4.5 mm cancellous screw
  5. **Closure**
     a. Use a **drain**
     b. Deep closure, etc.
     c. Administer marcaine block
     d. Compression dressing and splint

- **Post-op**
  1. Leave post-op dressing in place for 10-12 days, change and remove stitches
  2. Put patient in BK cast, NWB
  3. Do not use removable cast because they don't provide enough support
  4. At 6 weeks, X-ray. If healing begins to appear, use BK WB cast.
  5. At 12 weeks, if satisfactory healing, can WB
  6. **Avg fusion time: 14 weeks**
  7. **Avg shortening: 9 mm**

# Tibial-Calcaneal Arthrodesis

- **Procedure**
  - Patient set-up
    - Supine with bump under ipsilateral hip
    - Thigh tourniquet
    - General or spinal

- **Lateral Approach** (similar to lateral approach in Tibiotalar arthrodesis)
  1. Incision 10 cm proximal to tip of lateral malleous across the tip of the lateral malleolus and toward the 4th metatarsal base
     a. *Watch out* for sural nerve and superficial peroneal nerve
  2. **Strip the periosteum** from the anteroposterior aspect of the fibula, the lateral aspect of the talus, and the calcaneus
  3. The **distal portion of the fibula is removed** approx 1.5 cm above the level of the distal tibia
  4. Dissect over the anterior portion of the tibia to the medial malleolus
  5. An incision is made over the posterior aspect of the tibia, and the periosteal elevator is passed along the back of the tibia to the level of the calcaneus
     a. The **entire lateral aspect of the ankle joint and talus is now exposed**
  6. Using a saw, **cut the talar neck**, from lat → med just distal to the dorsal articular cartilage of the talus
  7. **Remove the talus body**
     a. The calcaneal articular surface can now be visualized
  8. **Remove the articular cartilage of the tibia** perpendicular to the long axis of the tibia
     a. Starting approximately 2 mm above the cartilage, remove as little bone as possible
  9. With the foot in plantargrade position, **remove the dorsal aspect of the calcaneus**. This creates a flat surface for the arthrodesis.
     a. This includes the posterior and middle facets but *leaves the sinus tarsi intact*
     b. *Do not violate* the C-C joint or the anterior process of the calcaneus

- **Medial approach**
  1. Incision over the anteromedial aspect of the joint and carry it out distally past the tip of the medial malleolus for about 2cm to the TN joint
  2. **Strip the periosteum** from the medial malleolus (the portion uncut from the osteotomy)
  3. **Remove this portion of the medial malleolus**, usually by osteotome
     a. *Be careful* of the neurovascular bundle at the posterior medial portion of tibia

- **Remember your alignment (**5° of dorsiflexion and 5° of valgus)
  1. If necessary, remove bone from tibia or calcaneus to achieve it
  2. The fusion site should be posterior enough for normal posterior curvature of the heel
  3. Make **cut in anterior aspect of the tibia** parallel to the cut made in the talar neck
  4. **Drill surfaces** of arthrodesis sites

- **Internal Fixation**
  1. Use 0.062 K-wires for **temporary fixation**
     a. **Check alignment**
  2. Insert 7.0 or 7.3 cannulated **screws** from posterior calcaneus to anterior portion of tibia
     a. If possible, insert two screws
     b. The screws are more plantar than in a subtalar arthrodesis, even if this means you are on a WB surface
     c. Can throw a third screw from tibia to calcaneus post → ant or apply a blade plate
  3. Fixate the talus to tibia with two 4.0 screws
  4. *Note:* There are multiple specialty plates available specifically for this procedure that may change the way you do your fixation
  5. Check alignment with C-arm
  6. **Close**

# Subtalar Arthrodesis

- **Procedure**
  - Patient set-up
    - Prone
    - Thigh tourniquet

  1. Lateral incision over sinus tarsi from tip of lateral malleolus to 4th metatarsal base
  2. **Free the EDB** from its attachment to calcaneus
  3. Incise the fatty plug longitudinally
  4. Retract the peroneals plantarly
  5. With lamina spreader, **spread the sinus tarsi**.
  6. **Remove articular cartilage** with rasp, curette, osteotome or rongeur
     a. Preserve the shape and contour of the bones
     b. *Be careful* not to violate the tibio-talar joint
  7. Make a stab incision. **Put guide wire in calcaneus**.
  8. Put **heel in 5˚-10˚ of valgus**
     a. After the heel is in good position, advance wire into talus
     b. X-ray and advance 7.0 mm cancellous **screw** with 16 mm thread length
  9. **Test strength of fusion**
  10. Optional – 2nd screw through same incision.
  11. If not stable, remove hardware and insert a screw through talar neck into calcaneus.
  12. If bone graft is needed, you can take part of the anterior process of calcaneus. Or use Grafton.

- **Post-op**
  - First 48˚ Jones compression dressing with splint
  - Then BK cast NWB for 6 weeks (remove stitches at 3 weeks)
  - BK WB cast for 4-5 weeks until radiographic evidence of healing
  - Eventually rehab with or without PT

# Talo-Navicular Fusion

- Good results in low activity patients
- High demand patients should probably add a C-C fusion (double arthrodesis)
- **Indications**
  - Primary arthrosis secondary to trauma or rheumatoid arthritis (main indication)
  - If instability secondary to PT dysfunction or collapse of TNJ from rupture of spring ligament, isolated T-N fusion is indicated (but Coughlin usually does triple)

- **Procedure**
  - Ideal position of foot
    - 5° valgus
    - TNJ in neutral
    - Forefoot 0-5° varus
  - **Patient set-up**
    - General or spinal
    - Thigh tourniquet
    - Patient supine

1. Incision just distal to medial malleolus to 1 cm beyond the navicular-cuneiform joint, curved slightly dorsal (especially if large dorsal osteophyte is present)
2. Strip joint capsule with periosteal elevator or sharp osteotome
3. Remove osteophytes with rongeur or osteotome
4. Identify articular surfaces, remove with curette or osteotome
   a. Can use towel clip in medial navicular for exposure
   b. Visualization can be improved with lamina spreader if bone is hard
   c. Difficult to see laterally, but this must be exposed and debrided
5. Joint surfaces are heavily feathered and foot is manipulated into anatomic alignment
6. Stabilize calcaneus and place STJ in 5° valgus
   a. Manipulate midtarsal joint into a few degrees abduction
   b. Forefoot into a plantigrade position that is perpendicular to long axis of tibia
   c. Forefoot should not have a residual of more than 7-10° varus or valgus
7. **Internal fixation—**can use two 4.0 or 4.5 mm canulated cancellous screws. For large person, can use 7.0 mm screw. If bone is soft, can use multiple staples.
8. Hold foot in corrected alignment, drive guide pin into navicular starting at navicular-cuneiform joint and drill obliquely across navicular into head and neck of talus
9. Check alignment of foot, C-arm
10. Add second guide wire, C-arm
11. Overdrill navicular, insert 40 to 50 mm long threaded cancellous screw. Screw threads must pass the intended fusion site. If soft bone, use washer. C-arm
12. Check stability of foot
13. If bone is soft or the fusion is not stable, use staples. This is also useful if there is a fracture of the navicular.
14. Close
15. Marcaine at the end

- **<u>Post-op</u>**
  - Compressive dressing with two splints
  - NWB for at least 6 weeks
  - Add cast on 1st visit
  - After sutures are removed, place patient in short leg removable cast
  - After 6 weeks, and x-rays look good, patient can ambulate with short leg cast
  - 3 months after surgery, if x-rays ok, patient can d/c the short leg cast

- **Complications**
  - Non-union—Rate is higher than in CCJ or STJ probably because of inadequate exposure to joint. Also because navicular is avascular.
  - Flatfoot—Results from placing the STJ in too much valgus and forefoot in too much abduction
    - Correct with a triple arthrodesis

- **Items needed for surgery**
  - Periosteal elevator, osteotome, curettes
  - Possible saggital saw
  - Wire driver
  - Towel clips
  - Lamina spreader
  - 4.0, 4.5 or 7.0 canulated cancellous screw (probably 40-50 mm)
  - Possible washers
  - Possible staples
  - 3-0, 4-0 Vicryl, 5-0 Monocryl or 4-0 prolene
  - Splints for stirrup/posterior split

# Triple Arthrodesis

- **Procedure**
  - Patient set-up
    - Prone
    - Thigh tourniquet
    - General or spinal
  1. **See Subtalar Arthrodesis** for subtalar steps
  2. **Lateral incision**
     a. Incise over sinus tarsi from lateral malleolus to base of 4th metatarsal
        i. *Avoid* superficial peroneal nerve and peroneal tendons
     b. **Reflect EDB** off calcaneus
     c. Longitudinally incise sinus tarsi fat plug
     d. **Find bifurcate ligament** → this will show you the entry point to debride the talonavicular (TNJ)
     e. Spread with lamina spreader
     f. Mobilizing the soft tissues is necessary for reducing the pes planovalgus articulation
  3. **Calcaneal-Cuboid joint (C-C joint)**
     a. From the above incision, reflect down to the C-C joint
     b. Distract with a Hohmann spreader
     c. Reflect the soft tissues
  4. **Talonavicular joint**
     a. Find the bifurcate ligament and resect it
     b. Resect the soft tissues of the TN joint
  5. After all the soft tissues are released, the deformity can be corrected → **minimally resect the articular cartilage of the joints**
     a. Resect TN joint, then C-C joint, then the talocalcaneal joint
  6. **Dorsomedial incision**
     a. Incision is centered over TNJ and extends proximally up talar neck
     b. Resect the soft tissues and then the cartilage
  7. **Fixation: Order TC → TN → CC**
     a. From talar neck aimed post-lat, a 6.5 mm partially threaded cancellous screw
        i. *Avoid* placing the screw too far posteriorly into the talar neck because it will cause ankle impingement
        ii. Could also go from calcaneus into talus.
     b. A 4.5 mm cortical screw is placed from the navicular to talus
        i. Screw should measure less than 40 mm
     c. C-C joint is fixated with a 4.5 mm cortical screw placed from calcaneus to cuboid
        i. Screw should measure less than 40 mm

# Calcaneal Slide Osteotomy

- Can slide medially for flatfoot, or laterally for ankle instability

- **Procedure**
  - **Patient set-up**
    - General or spinal
    - Supine
    - Thigh tourniquet
    - Bump hip

  1. Incision is1 cm posterior to fibula and 2 cm proximal to superior aspect of calcaneous (behind peroneal tendons and anterior to Achilles tendon). Stay posterior to peroneal tendons. Ends at junction of plantar and lateral skin at level of peroneal sulcus.
  2. **Sharp dissection** down to bone, careful of peroneal tendons and sural nerve.
  3. **Bone cut**: perpendicular to calcaneous. From the midpoint of tuberosity to 1 cm past the plantar weight bearing portion of the calcaneous. ***Careful about cutting too far medial because your nerves and arteries are over there.
     a. Score your cut first
     b. Get a wider, longer blade than usual.
     c. May have to finish with osteotome.
  4. **Displace tuberosity:**
     a. If laterally so that midaxis of tibia is slightly medial to the midpoint of the calcaneus. The lateral wall of calc should be just lateral to the lateral malleolus.
     b. If medially, displace approx 1 cm.
     c. Can displace with an osteotome or lamina spreader without teeth.
  5. If needed, can use a Dwyer wedge for added valgus. A Dwyer wedge is generally 1 cm laterally.
  6. **Fixation:** angled plate, one (or two) 6.0 or 7.0 partially threaded cannulated screws, or two 4.0 partially threaded screws.
     a. For the screws: insert just off the heel pad posteriorly (about 1.5 cm above plantar surface). If sliding medially, insert screw just laterally. If sliding laterally, insert just medially.
     b. C-Arm for position.
  7. **Marcaine** post-op block
  8. **Close**.

- **Post-op**
  - Posterior splint in OR, compression dressing
  - Cast application after 1st visit for 5 weeks.
  - Removable cast: ROM exercises until osteotomy site is healed.

# Evans Calcaneal Osteotomy

- Mark out tendons and CC joint before surgery

- **Procedure**
  - **Patient set-up**
    - General or spinal
    - Supine
    - Thigh tourniquet

  1. Get bone graft in saline and starting to reconstitute.
  2. Incision is oblique over distal half of calcaneous (cut will be 1-1.5 cm from CCJ)
  3. **Dissect** to bone. Careful of Intermediate Dorsal Cutaneous Nerve (Dorsal) Sural N and Peroneal Tendons (Plantar)
  4. Expose to **osteotomy site** 1-1.5 cm from CCJ
  5. Free up **EDB**
  6. Pass a probe thru the **anterior and middle facets**.
  7. Make **cut** with sagital saw parallel to CCJ, aimed slightly distal to emerge in between the anterior and middle facets. Don't go too far medially or you may damage vital soft tissues medially. Can use osteotome to finish the medial cut
  8. L**amina spreader** is put in place of the osteotomy site.
  9. The osteotomy site is **opened** by loading the fifth met and putting foot in adduction. Load until the hind foot valgus is corrected as well as the forefoot varus.
  10. Insert bone graft. **Bone graft** is probably going to be twice as wide on the outside as the medial side. Most likely the graft will be about 1cm in width at the widest side (maximum). Don't forget to keep the cortical sides with the other cortical sides.
  11. Can **fixate** with staple, or screw. Screw is placed distal dorsal to proximal plantar.
      a. Very often no fixation is used.

- **Post-op**
  - NWB BK cast. For adults 6-8 weeks, for adolescents 5-6 weeks.

# Peroneal Brevis Tendon Repair and Reconstruction

- Non-operative management—BK cast in neutral to slight inversion for 6 weeks.
  - Associated with 30-40% rate of redislocation.

- **Procedure**
  - Pt supine
  - Sandbag under hip or lateral decubitous.
  - General or spinal
  - Thigh tourniquet
  1. Incision-curvilinear, approx 5-7 cm behind the fibula, inline with the peroneal tendons. Half of incision above malleolus, half below.
  2. Full thickness flaps, identify superior peroneal retinaculum
  3. Inspect peroneal tendons for subluxations, partial or complete tears and tenosynovitis
  4. Retract PL anteriorly to visualize PB and often reveals a central split and subluxation over posterior ridge of fibula
     a. If PB tear is found and degenerative tissue is <50% of tendon→debride degenerative tissue. Then tubularize the remaining tissue using a running, absorbable suture.
     b. If peroneus tertius or low-lying muscle belly is present→excise it.
     c. If lateral ligament instability→use Brostrom or Chrisman-Snook
     d. If PB tear is >50% then resect the whole tendon (not sure about this personally) and attach to PL.
  5. Inspect floor of peroneal groove. If too shallow make larger groove (pg 303)
  6. Use rongeur to prepare fresh-bleeding fibular bed, then reattach the superior peroneal retinaculum through drill holes in lateral ridge. Go from deep thru holes to dorsal. Suture the rest of superior peroneal retinaculum with pants over vest style.

- **Post-op**
  - NWB splint for 1 week
  - BK walking cast for 4-6 weeks

# Posterior Tibial Tendon Repair-Substitution

- **Stages**
  - I: Normal length with tendonitis or peritendonitis
    - Surgical options: Debridement or repair
  - II: PT is elongated, but RF is still flexible
    - Surgical options: FDL transfer
  - III: PT is elongated, RF rigid
    - Surgical options: Triple arthrodesis
- Tendon is usually worse than you thought
- Always try **conservative** first-rest, arch supports, PT, oral anti-inflamatories, immobilization with cast or brace
- Steroid injections are contraindicated.

- **Procedure**
  - Almost always done with an osseous procedure
  1. Incision is 10 cm proximal to tip of tibial malleolus and 1 cm posterior down behind the medial malleolus to the navicular tuberosity's plantar portion. (Follows the TP tendon)
  2. At the upper end of the incision, the deep fascia is incised and the **TP is exposed**.
     a. The TP lies very close to the posterior margin. Trace the tendon distally to its insertion while leaving a 2 cm pulley just posterior to medial malleolus at the level of the tibial plafond.
  3. Determine the length of the TP tendon.
     a. **If TP is normal length**, it's stage I→then do tendon debridement, tenosynovectomy and sheath resections are done and close wound
     b. **If tendon is elongated**, it's stage II and FDL transfer is needed.
  4. For debridement of tendon:
     a. If **fraying**—smooth edges leaving major portion of tendon intact
     b. If **bulbous enlargement** just tip of medial malleolus-an ellipse is removed from bulb and tendon is sutured burying the knot
     c. If **longitudinal split** exists-clear inner side of tendon of scars and approximate scars
  2. **Tenosynovectomy**—the outer portion of the tendon sheath distal to the pulley is removed to prevent a possible reformation of stenotic tendon sheath
  3. **Inspect tendon for area of tear**. Proximal to the region involved, the tendon will be dull and white if the tear is old. Sometimes there is a transverse tear.
  4. **Transfer of the FDL**: Detach FDL distal to the crossover area of FDL and FHL. Cut the FDL under direct vision.
     a. *Optional*: Suturing of distal end of FDL to FHL
  5. **Tag FDL** with strong, non-absorbable suture in zigzag suture
  6. Identify **tuberosity of navicular** and expose the inferior and superior surfaces of the tuberosity
  7. With 0.25 or 0.375 inch drill bit, a **drill hole** is done from superior to inferior. The drill hole should come out inferior to the main surface of the PT
  8. Leave FDL in its own sheath. **Bring FDL into navicular drill hole** from inferior to superior. Pull through as tightly as possible with foot PF and supinated.

9. **Suture the FDL** with its non-absorbable suture into the capsule dorsally. Reinforce the tendon by suturing the inferior portion of FDL (under navicular) into the TP tendon.
10. **Assess the proximal TP muscle**. Often the muscle will become fibrotic and stiff after a TP dysfunction. Test the muscle by pulling on the proximal portion of the tendon.
    a. If there is some elasticity (the muscle still has some function)—then do a side-to-side suturing of FDL to TP with non-absorbable sutures, buried knot.
    b. If the muscle is stiff—don't suture the two muscles together.
11. *Optional:* Advancement of the spring ligament and the TN capsule
12. **Alternative method: TP tendon repair with side-to-side suturing.**
    a. Limitations-cannot restore significant flatfoot deformity to normal alignment, but it should relieve pain and improve function
    b. Identify and resect the diseased section of the **TP tendon**. Suture tendon ends together with non-absorbable suture
    c. Then do a **side-to-side repair** with the FDL with non-absorbable suture.

- **<u>Post-op</u>**
  - Without FDL transfer
    - Jones compression cast with foot in PF and inversion for 1-2 days
    - BK WB cast for 3 weeks
    - Post op shoe and gradually move into shoe. May take months
  - With FDL transfer
    - Jones compression cast with foot in PF and inversion for 1-2 days
    - NWB BK with foot in adduction and inversion for 3 wks.
    - Remove sutures, NWB BK with foot in neutral for 3 more weeks
    - Progress to WB as tolerated, PT

# Tibialis Posterior Tendon Transfer (TPTT)

- **Procedure**
  - Patient set-up
    - Prone
    - Thigh tourniquet
    - General or spinal
  - Four incisions
    - One at TP insertion site on navicular
    - One at middle distal 1/3 of leg, medial to tibial crest
    - One at middle distal 1/3 of leg, 1 cm lateral to tibial crest
    - One at lateral cuneiform-3rd metatarsal insertion site

1. First incision – at TP insertion on navicular
   a. **Release the TP** from its insertion on navicular
2. Second incision – at middle distal 1/3 of leg medial to tibial crest
   a. **Pull TP up through** this incision
3. Third incision – at middle distal 1/3 of leg 1 cm lateral to tibial crest
   a. **Separate TA** from tibia
   b. Expose interosseous membrane and **make a window** in it
   c. Compress the posterior muscle mass. This will **expose TP**
4. Gently **pull TP** from medial incision **through window** in interosseous membrane with blunt curved Kelly forceps and moist sponges
   a. *Be careful* of NV bundle which lies under TP
   b. Often there are muscle fibers attached distally from the window → gently pull them free
5. Fourth incision – over lateral cuneiform or 3rd metatarsal
   a. Insert tendon passer, Bozeman forceps or uterine packing forceps into insertion site incision and retrograde up extensor sheath. **Grab TP and retrograde**.
   b. **Fixate TP** to lateral cuneiform with foot in neutral position

# Split Tibialis Anterior Tendon Transfer (STATT)/ Tibialis Anterior Tendon Transfer (TATT)

**STATT**

- **Procedure**
  - Patient set-up
    - Prone
    - Thigh tourniquet
    - General or spinal
  1. Three incisions
     a. One over TA insertion of medial cuneiform-1st metatarsal
     b. One over anterior surface of leg just proximal to transverse cruciate ligament
     c. One over peroneus tertius insertion
        i. If the peroneus tertius is not present, the tendon can be inserted to cuboid or sutured to the PB
  2. **Split the tendon** with umbilical tape with a tendon passer in leg incision through to TA insertion
  3. **Cut the lateral ½ of the TA** tendon and **retrograde** that through to the proximal window
  4. **Insert** to peroneus tertius tendon

**TATT**

- **Procedure**
  - Patient set-up same
  - *Note:* Usually with TATT, the 3rd incision is over the lateral cuneif-3rd metatarsal and the TA is transferred to this bone. However, it is possible to transfer the TA all the way to the peroneus tertius sheath.
  1. Three incisions
     a. One over TA insertion of medial cuneiform-1st metatarsal
     b. One over anterior surface of leg just proximal to transverse cruciate ligament.
     c. One over *lateral cuneiform*
  2. **Tendon is separated** from its insertion
  3. Tendon is **drawn up through insertion** onto leg incision
  4. With a tendon passer, bring tendon up **through peroneus tertius sheath** (same as the EDL tendon sheath)
     a. Be sure to be *under extensor retinaculum*
  5. **Insert TA into lateral cuneiform** via hole and button

**Note:** These sections on Ankle Fractures are based on my notes from my personal experiences, the texts I have previously referenced and from my lectures from the AO course in Davos, Switzerland. The first thing they stated at the AO Course in Fracture Management was that they used the Weber Classification and not the Lauge-Hansen system because the Lauge-Hansen was too complicated. Therefore, the surgical choices are broken down by the Weber Classification. However, you still want to learn the Lauge-Hansen system because that is what you will most likely be quizzed/tested.

-Brett

# Weber A Surgical Procedures

- **Screw Placement**
  - Patient set-up
    - Supine with bump under hip
    - Thigh tourniquet
    - General or spinal
  1. Small incision at tip of lateral malleolus
     a. **Expose tip** of malleolus by splitting calcaneofibular ligament longitudinally
     b. *Avoid* tilting lateral malleolus toward the talus
  2. **Insertion point** for medullary fixation is at lateral surface of malleolar tip
     a. 4.0 cancellous screw (or malleolar screw) is inserted across fracture into the proximal medial cortex of fibula above the fracture site
     b. Insertion of a long screw (4.0 mm) across the fracture line into the medullary canal of the proximal fragment
  3. **Avoid rotation** or displacement **of distal fragment** as screw is inserted
     a. K-wire can be added as temporary fixation
     b. *Note:* Since the medullary device (screw) is straight, the lateral malleolus may be inadvertently tilted toward the talus – this will result in narrowing of ankle mortise and reduced motion
  4. **Close**

- **Tension Band Wiring**
  - Patient set-up
    - Supine with bump under hip
    - Thigh tourniquet
    - General or spinal
  1. Skin incision vertical and parallel to long axis of tibia directly over lateral malleolus
     a. *Note:* A straight incision is often used because it can be extended. Try to avoid J-shaped incision because they cannot be extended.
  2. **Dissect sharply down to bone**
     a. If undermining is necessary, do it just over periosteum

3. With a periosteal elevator or #15 blade, **elevate the periosteum** 2-3 mm proximal and distal to the fracture line
    a. Remember, *be good to the soft tissues*
4. **Curette and irrigate fracture** fragments to remove all hematoma
5. Inspect joint
6. **Reduce fracture with towel clip** on fracture fragment and guide it with periosteal elevator
7. **Insert two 0.045 or 0.062 K-wires.** Insert from dist → prox from tip of lateral malleolus across the fracture line, up the diaphysis of the fibula.
    a. Insert at <u>right angles to the fracture</u> (this is pretty vertical)
    b. *Be careful* not to violate the joint
8. **20-gauge wire** is then passed through a transverse drill hole above fracture site and placed in a **figure-8 fashion** around bent tips of protruding K-wires. The fragment should be well-aligned and held securely in place with the wires.
    a. Twist the 20-gauge wire and trim the excess wire off and make sure the twisted tips lie flat against the bone
    b. *Note:* Instead of a transverse drill hole above the fracture site, a screw may be placed at the same level above the fracture line with a washer and tightened down after the figure-8 of wire is wrapped around it.
9. **Close**

# Weber B Surgical Choices

- **Fixation Options**
  - 2 lag screws
  - Posterior anti-glide plate
  - Lateral plate with lag screw
- **Weber B Ankle Fracture Characteristics**
  - Fracture at the joint line
  - Corresponds with PAB or SER
- **Lateral Malleolus Anatomy**
  - PB and PL posterior to fibula
  - Superficial Peroneal Nerve anterior/medial to fibula
  - Sural Nerve and Short Saphenous Vein is posterior and plantar to fibula
  - FHL is posterior and mainly muscular at this level
  - Proximally incision is between peroneus tertius (anteriorly) and PL and PB (posteriorly)
  - *Generally safe with an incision centered over fibular fracture site*

- **Fixation With 2 Lag Screws**
  - **Indications to use 2 Lag Screws**
    - If fibular fracture is spiral (2x diameter of bone) + not comminuted + not osteoporotic → then sufficient fixation can be achieved with only 2 lag screws
  - **Advantages**
    - Allows for a smaller incision
    - Hardware is not prominent and usually does not have to be removed
    - Will not interfere with syndesmotic screws (if they are needed)

  - **Procedure**
    1. Incision is made slightly anterior to midline of fibula
       a. Incision is down to bone without too much layered dissection
    2. Irrigate and **clean up** wound edges
    3. **Restore fibular length**
       a. Hold with reduction clamps
       b. Check with C-arm
    4. **Insert two 3.5 screws** (or 2.7 if small pt) from ant → post using AO lag techniques
       a. C-arm to confirm position
    5. **Close**

- **Lateral Plate and Anterior-to-Post Lag Screw**
  - *Most common surgical approach for Weber B fibular fracture*
  - Ideally, **you want to cross 5 cortices of fixation proximally and distally**. If using a buttress plate, only unicortical screws are used and most likely only 3 cortices will be fixated distally.

- **Procedure**
  - Patient set-up
    - Supine with lateral bean bag/bump
    - Thigh tourniquet
    - General or spinal

1. Incision directly over fibular fracture site. May make incision slightly anterior to midline. (If posterior malleolus fracture is present, then make it posterior.)
   a. *Do not* do too much dissection. Make incision down to periosteum preserving soft tissues. Any undermining should be done at the periosteum level.
2. **Elevate periosteum** 2-3 mm from the fracture line. The full anterior and posterior portions of the fracture line must be exposed.
3. **Curette and irrigate** fracture fragments and hematoma
4. **Explore talus** for any osteochondral defects
5. **Reposition fracture** (increase deformity, distract, reposition) using towel clip and periosteal elevator to assist
6. **Hold fracture in anatomical position** with bone clamps
7. **Reassess anatomical position**
   a. Can use bone clamps, lobster claw, or K-wire across fracture to stabilize it
   b. *Note:* Keep in mind the next step with the lag screw, your clamp will most likely be in the way, so position it thoughtfully!
   c. Can *use posterior spike of fracture as guide for adequate reduction*
   d. C-arm for verification of position
8. **Insert lag screw** (3.5 mm cortical) **ant → post, as perpendicular as possible across the main fracture line**
   a. Screws must engage posterior cortex, but should not extend so far as to disrupt the peroneal tendon sheath
9. Apply **⅓ semi-tubular plate** laterally
   a. **Bend plate** to appropriately contour of fibula
   b. **Plate size is based on the number of screws around fracture site and position on fibula**
      i. **3 proximally (3.5mm cortical** screws)
      ii. **2-3 distally 4.0 cancellous** screws
      iii. Run distal screws short so to avoid violating fibular-talar joint
10. C-arm to check position
11. **Close**

- **Posterior Antiglide Plate**
  - **Advantages**
    - Achieves strong fixation even in osteoporotic bone
    - Hardware generally does not cause symptoms or wound necrosis (or at least less than a straight lateral plate would)
    - Does not interfere with syndesmotic screw insertion
    - Distal screws obtain better purchase, because they engage a thicker part of distal fibula

- Engage 2 cortices without risk of joint penetration (essentially no risk of intra-articular screw insertion because of plate placement)
- Biomechanically, this construct is stronger than lateral plate fixation, especially in osteoporotic bone (i.e. good in elderly!)
- Loss of fixation is rare due to the stability of the construct
- Posterior plate provides better fixation with posterior comminution
- Posterior incision allows access to the posterior malleolus, when direct fixation is required

- **Disadvantages**
  - Technically more challenging
  - May irritate peroneal tendons in minority of patients, but this often spontaneously resolves in 4-8 weeks
  - Peroneal tendon subluxation
    - Should not be a problem is the tendon sheath is left intact

- **<u>Procedure</u>**
  - Patient set-up
    - Supine with lateral bean bag/bump
    - Thigh tourniquet
    - General or spinal

1. <u>Incision</u> is made along the most posterior border of the fibula at fracture level
   a. The plate often lies slightly posterolaterally (rather than directly post), thus the incision will be away from the plate
   b. Incision is carried down to peroneals, but *does not violate the peroneal sheath*
   c. Incision proceeds over the lateral edge of peroneals which are usually retracted posteriorly
2. Some of proximal retinaculum may need to be released to **expose distal fibula**
   a. Clear periosteum off fibula
3. **Fracture reduction** – Ideally, anatomic reduction should be achieved prior to plate application
   a. Reduction can be held with a single K-wire or lag screw
   b. **Apply lag screw** from ant → post so not interfere with plate application
4. Plate application **– ⅓ tubular plate** is applied to posterior surface of the fibula
   a. 4-hole plate – Classically
   b. 6-hole plate – More recently
   c. Because posterior surface of fibula is straight, contouring of the plate is usually not necessary
   d. Due to the *lateral bow of fibula*, the plate sits best posterolaterally
5. **Proximal screw insertion**
   a. **1st 3.5 mm cortical screw is placed proximally**, through the plate, 2 mm above posterior fracture line
   b. Plate helps prevent proximal gliding of the distal fragment
   c. <u>If anatomic reduction is achieved</u>, the proximal screw can be tightened down

d. If anatomic reduction has not been achieved, then do not fully tighten the screw yet
    i. Apply bone clamps to both fracture fragments and distract out to length
    ii. Apply slight internal rotation to distal fragment
    iii. Proximal screw is now tightened, and fragment should be properly aligned

6. **Remaining proximal 3.5 mm cortical screws** are inserted
7. **Lag screw insertion**
    a. Lag screw is then inserted post → ant through the first plate hole which is distal to the posterior fracture line
        i. Because the posterior cortex is thin, **lag screw must be inserted through plate** (which serves as solid posterior cortex)
    b. The screw must be *angled slightly proximally* in order to be perpendicular to the fracture site
        i. Remember to remove initial lag screw (inserted ant → post) if used
    c. *Note:* Lag screws improve fracture reduction but do not significantly improve anti-glide strength
    d. Okay to leave *screw slightly long* because screw is directed away from the peroneal tendons
    e. If possible, a **2nd lag** screw can be inserted using the same technique
8. **Optional – Insert distal screws:** Technically the more distal screws are not necessary, but 4.0 mm cancellous screws may be inserted. Because there is no risk of joint penetration, longer screws can be used to get a better hold on bone.
9. **Close**

# Medial Malleolar Fractures

- **Fixation Options**
  - 2 Lag Screws
  - Medial Plate
  - Tension Band Wiring
- **Patient set-up for all types**
  - Supine
  - General or spinal
  - Thigh tourniquet

- **Two Lag Screw Procedures**
  - **Two methods**
    - **Two Screw Fixation** either open or percutaneous (a.k.a. two stab incision)
    - **Lag Screws:** True lag screws are used to counteract and neutralize a tension failure on the medial side
    - *Brett Chicko Note:* I prefer to do an open procedure over a stab incision because with a fracture of the medial malleolus, there usually is some soft tissue in-between the fracture fragments

- **Two Stab Incision Procedure (Percutaneous)**
  - *Most common procedure for medial malleolus fracture*
    1. Two stab incisions **at tip of medial malleolus**
    2. Blunt dissect (with hemostat)
    3. **K-wire** from distal tip across fracture line at right angles into proximal section
       a. Aim somewhat vertically to avoid the ankle joint
       b. C-Arm to check position
    4. **Insert two 4.0 mm cancellous partially-threaded cannulated screws**
       a. C-Arm to check position
    5. **Close**

- **Open Procedures (Screw/Plate or Tension Band)**
  - Indications
    - For plate insertion
    - For two screw insertion with better visualization
    - Comminuted fractures
    - Difficulty in reduction with percutaneous method

  - **For Screw Fixation or Plate Insertion**
    1. Incision – vertical and parallel to with long axis of tibia directly over medial malleolus
       a. A straight incision is often used because it can be extended. Try to avoid J-shaped incision because they cannot be extended.
    2. **Dissection sharply down to bone.** If undermining is necessary, do it just over the periosteum.

3. With a periosteal elevator or #15 blade, elevate the periosteum 2-3 mm from the fracture lines
    a. Remember to be good to the soft tissues!
4. **Curette and irrigate** fracture fragments to remove all hematoma
5. **Inspect joint**
6. **Reduce fracture** with towel clip and guide it with periosteal elevator
7. **Stabilize with 2 K-wires**
    a. Insert from distal → proximal from tip of malleolus across the fracture
    b. Insert at right angles to the fracture (this is pretty vertical) with care not to violate the joint
8. **Insert two 4.0 mm cancellous bone screws**
    a. Cannulated screws may be used
    b. If not cannulated, remove K-wire and insert screw in K-wire hole
9. If using a **plate**, insert with 3.5 mm cancellous screws. Run the proximal screws short so they don't violate the ankle joint.
    a. Other options: ⅓ semi-tubular, DCP, T, Clover Leaf
    b. *Note:* For a "push off" (shear) fracture, the purpose of the plate is to provide an anti-glide or a buttressing effect
10. **Close**

- **Tension Band Wiring**
    - This can be used for the very small medial malleolar fragments or comminuted
    - Studies differ onto effectiveness of tension band
    - Tension bands are rarely used now for medial malleolus
    - If you always place two screws, you are going to comminute a few medial malleoli and you'll to be very unhappy. Then you will need this tension band technique for salvage.
    - Also, pts hate these wires. Anytime you do a tension band wire and leave a wire long (in an area where there is movement) patients will hate you a lot.

1. Incision – vertical and parallel to with long axis of tibia directly over medial malleolus
    a. A straight incision is often used because it can be extended. Try to avoid J-shaped incision because they cannot be extended.
2. **Dissect sharply down to bone.** If undermining is necessary, do it just over the periosteum.
3. With a periosteal elevator or 15 blade, **elevate the periosteum** 2-3 mm from the fracture lines
    a. Remember to be good to the soft tissues!
4. **Curette and irrigate** fracture fragments to remove all hematoma
5. **Inspect joint**
6. **Reduce fracture** with towel clip on fracture fragment and guide it in with periosteal elevator
7. **Two parallel K-wires** (0.045 inch or 0.062) are inserted at distal end of fibula and engage the proximal medial cortex above fracture site

8. **20-gauge wire** is then passed through transverse drill hole (or a cortical screw may be placed instead at this level, which you would wrap the wire around and tighten the screw down after the wrapping) above fracture site and placed in a figure-8 fashion around bent tips of protruding K-wires
    a. Twist end of wire and trim. Make sure to bend it so it sits close to bone.
9. **Let the first year close**

# Posterior Malleolar Fracture

- **When to do an ORIF?**
  - When > 25% of posterior articular surface is involved as seen on lateral view
  - Fracture is displaced >2 mm
  - There is posterior subluxation of talus
  - If fracture prevents reduction of tibia

- **Procedure**
  - **Patient set-up**
    - Use a posterior lateral approach (similar to the one used for a fibular antiglide plate)
    - Lateral or prone
    - General or spinal
    - Thigh tourniquet

  1. Incision is at posterior border of fibula, if fibula needs to be reduced, do that first
     a. Hold with temporary fixation
     b. *Brett Chicko Note:* According to Coughlin – Do the definitive fixation of fibula after the post malleolus because of lack of exposure after fibula is fixated. However, I have seen the fibula fixated first and then the post malleolus was addressed.
  2. **Bluntly dissect between the PB/PL and the FHL** (muscular at this level) to the posterior surface of the tibia. Must get exposure of entire fracture fragment.
  3. **Reduce fracture**
     a. The fracture reduction is determined by palpation and visualization of extra-articular fracture line and C-arm. Cannot directly visualize the intra-articular joint because talus is in the way.
     b. *Note:* Reduction of fibular fracture most likely will reduce the posterior malleolus because of firm attachment of post tibiofibular ligament. Ligamentotaxis!
     c. If difficulty reducing fracture, DF foot may give slack to ligaments and posterior capsule
  4. **Hold reduction** with large reduction clamp
  5. **Insert 2 K-wires** to the fragment in place (for 4.0 mm partially threaded cancellous lag cannulated screws)
  6. **Insert screws post → ant**
     a. Insert at right angles to the fracture
  7. Alternate fixation: Stab incision anteriorly, insert 4.0mm cortical screw ant → post
     a. Check C-arm for position
  8. **Let the 1st year close**

- **Post-op**
  - NWB until union is solid. This may take up until 3-4 months.

# Syndesmotic Repair

- After every ankle fracture repair, evaluate the syndesmosis with intra-op stress exam
- Syndesmotic separations are unstable and should be stabilized
- Remember the AO principle of stable fixation if non-articular
- **Indications for Syndesmotic Fixation**
  - Irreparable medial joint injury w/ disruption of syndesmosis
  - High fibular (Weber C) fracture >15 cm above the joint line
  - Medial ligament injury, syndesmotic disruption, talar shift w/o fracture of fibula
  - Widening of the tibiofibular "clear space" as a result of disruption of the syndesmosis. The clear space is normally < 5 mm wide.
- **Injury Patterns**
  - Isolated
  - Syndesmotic injury with fibular fracture
  - Syndesmotic injury with medial injury
- **Choices of Syndesmotic Screws**
  - 4.5 mm screw (most common) x2 or 3.5 mm screws in smaller patients
  - Bioabsorbable fixation (polylevolactic acid)
  - Fiberwire (Tightrope or others like this…technique as per manufacture's guidelines)
- **Proper level for a Syndesmotic Screw**
  - Screws should be <u>parallel to joint line</u>
  - <u>1 cm prox to syndesmosis or 4 cm prox to ankle joint</u>
  - **If too low**, can pass through distal tib-fib articulation causing pain
  - **If too high**, may cause tip of fibula to go outward

- **<u>Procedure</u>**
  - **Patient set-up**
    - Prone with hip bump
    - General or spinal
    - Thigh tourniquet

  1. **Stabilize the fibular fracture** before the syndesmosis
     a. Use a plate on the fibula
     b. Fibula should be reduced posteriorly into the tibial sulcus
     c. The syndesmosis should be reduced before the screw(s) are inserted
  2. **Dorsiflex foot 5°**
  3. **Stab** incision on fibula
     a. **Use C-arm to find correct level**: 1cm proximal to syndesmosis and/or 4 cm prox to ankle joint
  4. **Insertion of screw** (4.5 mm cortical fully-threaded)
     a. Because fibula is posterior to tibia, **aim screw through posterior-lateral fibula to anterior-medial tibia at an angle of 25-30° anteriorly**
     b. Perpendicular to long axis of bones, parallel to the ankle joint
     c. Engage 3 cortices or 4 (depending on doctor preference)
     d. Do not lag! Do not over-tighten!

- **Post-op**
  - Screws generally will not loosen or break if the ankle does not dorsiflex past neutral
  - Patients are allowed to WB after 6 weeks in a short leg cast or walking boot
  - Routine removal of screw 8-12 weeks after surgery

# ORIF Calcaneus

- **Indications**
  - Injuries that would do poorly without surgery, such as severely displaced intraarticular, widening of heel, horizontally oriented talus, severe soft tissue injury, and high-energy mechanism
- **Contraindications**
  - Severely comminuted
  - Impaired vascularity
  - Infection
  - Severe neuropathy
- **Essex-Lopresti Classification**
  - Primary fracture line runs from ant-lat → post-med through the STJ (mostly through the posterior facet). As the primary fracture line progresses, this will lead to lateral wall blowout and decrease in calcaneal height.
  - Both Essex-Lopresti types start with the primary fracture line
  - **Type 1** – vertical force will lead to *tongue type*
  - **Type 2** – more horizontal force will lead to *joint depression*

- **Procedure**
  - Patient set-up
    - Lateral decubitus position
    - General or spinal
    - Thigh tourniquet
  - **General order of reduction**
    - Anterior process
    - Medial wall
    - Posterior facet
    - Lateral wall

1. Incision is curved behind the lateral malleolus. The proximal portion is halfway between the anterior portion of the Achilles and the peroneal tendons. The line progresses distally, around the lateral malleolus, and then runs parallel to the bottom of the foot, ending up roughly at the C-C joint.
   a. *Watch out* for sural nerve and peroneal tendons
2. Sharply dissect down to bone, create a flap with the CFL and the peroneals and flap that anterior-superiorly
3. Insert two 0.062 K-wires into the talus and bend K-wires upward to hold this flap up
4. **Expose STJ**, remove hematoma and small fracture fragments via irrigation and rongeur
5. Identify the fracture lines in the anterior calcaneus that extend medially
   a. Determine if the fracture line progresses to the C-C joint
6. The anterior process is typically elevated. Therefore, the **anterior process needs to be retracted plantarly**. Use a retractor or lamina spreader between the talus and the anterior process. Fix with K-wire.
7. **Identify the fracture** line progressing from ant-lat → post-med (the primary fracture lines), separating the posterior facets from the anterior and middle facets

8. The posterior facet is usually PF. With the use of a periosteal elevator, lift up the posterior facet. Hold with K-wire directed from the anterior process laterally to the posterior facet medially.
    a. The lateral part of the posterior facet is retracted laterally or removed. This allows visualization of the medial posterior facet
9. A 4.0 **Shantz pin** is inserted into the tuberosity fragment from post → ant (from the back of the heel into the posterior tuberosity). This is used as a lever to reduce the fragment plantarly, medially, and into slight valgus.
10. When the **medial wall of the tuberosity lines up with the medial wall of the facet fragment**, it is held with two 0.062 K-wires. The K-wires are inserted from the posterior aspect of the tuberosity and directed to the sustentaculum tali (*be careful* not to damage articular cartilage). Use C-arm for this.
11. After the anterior process and the medial wall are reduced, the posterior facet is reduced. **Match the lateral fragment to the medial fragment**. Insert 0.062 K-wires into the anterior and posterior margins.
12. Get intra-op X-rays. If alignment is good, insert a 2.7 mm cortical **lag screw** below the subchondral surface.
    *a.* **Reconstruct the lateral wall** if necessary. Bend and insert plate.
    b. *Best bone* for a plate is subchondral bone deep to the C-C joint, the subchondral bone near Achilles tendon insertion, and the dense bone of the sustentaculum tali
    c. May need to fill in deficit with bone chips, Grafton or other bone substitute
13. Insert **drain and close**

- **<u>Post-op</u>**
    - Course depends on the amount of damage
    - If minimal displacement, 6-8 weeks ROM exercises and NWB
    - If severe displacement, >12 weeks ROM exercises and NWB

- **Complications**
    - Relatively common
    - Infection
    - Delayed wound healing
    - Sural nerve
    - Tibial nerve problems (more likely from injury rather than surgery)

# ORIF Talar Neck Fractures

- ORIF should be done even if Hawkins type II was close reduced because this type of fracture will inevitably develop an equinus contracture that happens with prolonged casting in PF

- **Talar neck fracture WITHOUT dislocation**
  - **Procedure**
    - Patient set-up
      - Supine with bump under ipsilateral hip
      - Have C-arm ready

    1. Anterior-medial incision – made from anterior aspect of the medial malleolus to the dorsal aspect of the navicular tuberosity
       a. Dissect carefully down, go dorsal to TP tendon. Don't disrupt deltoid ligament because this might disrupt some of the vasculature to the talus.
    2. Remove hematoma. Don't dissect the soft tissues off the talus dorsally and plantarly because this might disrupt the blood supply to the talar neck.
    3. Anterior-lateral incision – starting from anterior margin of lateral malleolus to the base of the 3rd or 4th metatarsals
       a. This allows confirmation of the reduction of the talar neck
       b. It also permits removal of foreign bodies
    4. Incise inferior retinaculum
    5. Retract EDL and peroneus tertius. Retract EDB dorsally.
    6. **Remove all fragments**. Probe STJ blindly for fragments.
    7. **Reduce the fracture**
       a. *Careful* not to have comminution or reduce into varus position.
    8. Insert two 2.5mm titanium screws (can be used with MRI). **Do not lag**! A lag screw might send talus into varus.

- **Talar neck fracture is displaced** (as in Hawkin's Type III – STJ and Ankle joint)
  - **Procedure**

    1. Anterior-medial incision – extend the incision over the medial malleolus and the distal aspect of the tibia
    2. Go into the space between tibia and Achilles. The body of the talus will be visualized.
    3. A femoral distractor may be needed. **Put pins in the tibia and calcaneus**.
    4. Manually place the body of the talus back into mortise
       a. **If the talus will not return to the mortise**, a medial malleolar osteotomy will have to be done
          i. For **medial malleolar osteotomy**
             1. Identify the ankle joint for tibia
             2. Make 2 retrograde 2.5 mm drill holes in the medial malleolus across the osteotomy site
             3. Release the anterior portion of the capsule off the deltoid ligament as well as a portion of the TP sheath. Protect the TP tendon.
             4. Incise the periosteum about 5-10 mm superior to the ankle joint

5. With oscillating saw, cut the transverse portion, then the 2 vertical portions
6. Reflect the medial malleolus distally. Don't damage the deltoid ligament.
7. Manually place the talus back into its place

5. Anterior-lateral incision – as above
    a. Fix medial malleolus with two 4.0 mm cancellous titanium screws

- **Post-op**
    - Post-splint or boot
    - Do not do ROM exercises until wound healing is done
    - NWB for 8-12 weeks until trabeculae cross the fracture

- **Complications**
    - AVN
    - Arthrofibrosis
    - Malunion, nonunion
    - Skin necrosis

# Tibial Periarticular Fx Reduction & Fixation

- **Indications**
  - Pilon or Tibial Plafond fractures
  - Articular displacement of >2mm or unacceptable axial alignment
  - Open fractures
  - Neurovascular injury due to fracture
- **Pre-op planning**
  - Check NV, compartment syndrome, soft tissue injury
  - Radiographs: AP, Lat, MO
  - Whole tibial shaft
  - Foot radiographs
  - CT can be useful

- **Procedure**
  - **Staged surgery**—First part immediate once the patient has stabilized (usually 12-18 hours) with ORIF of fibula and external fixator for tibia. Kitaoka recommends EBI or Orthofix
  - **1st Stage**
    1. Fibular incision-slightly posterior-laterally to increase the width of the skin bridge with the later anterior incisions.
    2. **Do not do calcaneal skeletal traction-** (even with a Bohler-Braun frame) this pulls patient out of bed and displaces foot posteriorly
    3. Fix Fibula fracture
    4. Apply Ex-Fix onto tibia
    5. When the soft tissue edema has subsided (usually 10-21 days), ORIF can be performed
  - **2nd Stage**
    - **Patient set-up**
      - Pt supine
      - General or spinal
      - Thigh tourniquet
    - Take frame off tibia but don't remove the pins. Have circulator sterilize the frame. This may be used later in the case for distraction.
    - **Anterior-medial incision**
      1. Locate the fracture fragment. If the fragment is **anterior-medial**: incision begins just lateral to the medial crest of tibial shaft. Extend the incision distally across the ankle joint, staying just medial to tibialis anterior
      2. Identify the anterior tibia tendon sheath. Once identified, create a full thickness flap by incision the tendon sheath and the extensor retinaculum. Bring this incision down to bone/joint down to the periosteum. Do not strip the periosteum or remove any fat unnecessarily
      3. Identify fracture ends, debride and irrigate. Remove all clots
      4. Reduce the fracture. This incision works well with a medial pilon plate

- **Anterior Midline Incision**
    - Use this incision when the fracture is a pure anterior crush injury. This injury gives good exposure and will allow for easy placement of low profile anterior tibial plate
    1. Incision is made between the TA and the EDL
        a. Identify the superficial peroneal nerve, the artery and the deep peroneal nerve. Retract all of this laterally
- **Anterior-Lateral Incision**
    - Use this with large lateral fragments, such as the Tillaux-Chaput avulsions. Careful with this incision because it may jeopardize the skin from the fibular incision.
    - This is why you usually use a posterior lateral incision for the fibula.
    1. Incision starts proximal to the ankle joint and slightly medial to Chaput's tubercle and extends distally in a strait line toward the base of the 3rd and 4th mets.
        a. Superficial peroneal nerve is protected
    2. Incise through the superior and inferior extensor retinaculum
    3. Mobilize the peroneus tertius and EDL, the deep peroneal nerve and the anterior tibial/DP artery
    4. Distally the EDB is seen and can be retracted laterally or detached
    5. Protect the lateral branch of deep peroneal nerve and the lateral tarsal artery

- **Fixation**
    - Fix the jigsaw puzzle, then use reduction clamps followed by 1.6 mm k-wire
    - Canulated screws are rarely used
    - If a piece is small, a bioabsorbable pin can be used
    - Once the screws are in place, a cancellous graft can be used
    - Apply plate. Options are:
        - Medial pilon plates for rotational and varus valgus injuries
        - Anterior pilon plate for anterior crush plates. Note Dr Lutz states to always use an anterior plate.
        - Supplemental washer plates may be needed. Ex: spider washer plate
- **Closure**
    - Small drain, close etc.

- **<u>Post-op</u>**
    - Jones compression dressing and splint
    - At 1 week change to compression stocking and removable boot and start ROM.
    - Pt is to wear the boot at all times, even sleeping or the patient may develop equinus deformity
    - Start formal PT about 4-6 weeks, only after the wounds have healed
    - WB at 3 months if radiographic evidence of healing
    - Outcome is based on the fracture at presentation

- **Technical Pearls**
  - Joint surface should be reconstituted first because anatomical malalignment is not acceptable. The ankle will accept some axial malalignment, but not articular.
  - Shaft reconstruction is performed second
  - Reconstruct the joint with isolated lag screws followed by neutralization plate of the metaphyseal-diaphyseal component
  - Joint surface needs to be anatomic reconstructed. If there are centrally depressed pieces, the perimeter fragments need to be retracted and the central ones need to be elevated
- **Technical Pitfalls**
  - Doing definitive surgery too soon because fracture patterns are not clear with all of the soft tissue swelling
  - Unstable EX-FIX
  - Failure to stabilize the fibula
- **Complications**
  - Infection
  - Wound complications
  - Malunions
  - Post-traumatic complications at 1-2 years

# Ankle Arthroscopy

- **Portals**
  - *Most commonly used* – Ant-med, ant-lat, and post-lat
  - **Anterior-medial port**
    - Medial to TA
    - Lateral to saphenous vein and nerve
  - **Anterior-lateral port**
    - Lateral to Peroneus Tertius
    - Medial to intermediate dorsal cutaneous nerve
  - **Posterior-lateral port**
    - Lateral to Achilles tendon, 1-2 cm distal to anterior ports
  - **Anterior-central port**
    - Just lateral to FHL
    - Medial to DP and deep peroneal nerve, medial dorsal cutaneous nerve crosses over FDL at this level and may be lateral
    - Due to all of the potential complications, this port is usually contraindicated
  - **Posterior-medial port**
    - Medial to Achilles tendon
    - Also in this area: FHL, FDL, posterior tibial nerve and artery, calcaneal artery
    - Due to all of the potential complications, this port is usually contraindicated
  - **Posterior-central port**
    - A.k.a. "trans-Achilles" because it is through the Achilles
    - This is usually contraindicated…

- **Procedure**
- **Insertion of scope**
  1. Mark anatomic landmarks (medial and lateral malleolus, superficial peroneal nerve, TA and peroneus tertius, if this is not present use EDL)
  2. Use 2.7 or 4.5 scope
- For **Anterior-medial and Anterior-lateral ports**
  3. **Find the ankle joint**, insert 18-gauge needle into joint. Fill the joint with 20 cc of NSS or Lactated Ringers
  4. Incise the skin only, use blunt dissection down to the capsule
  5. **Insert cannula and blunt obturator. Insert scope.**
  6. With direct vision of scope, insert 18-gauge needle into lateral port, find the needle with the scope ("**Triangulate**" your position!). *Be careful* of the superficial peroneal nerve.
  7. Incise the skin over the 2nd port hole, blunt dissect and use obturator to complete the port
- For **Posterior-lateral port**
  8. Go lateral to Achilles tendon approx 1-2 cm distal to anterior port levels (this will be just distal to posterior syndesmotic ligament)
  9. Cannula is used for dedicated inflow

- **Joint examination**
  10. Look for anterior joint synovitis and shave with 2.9 or 3.5 shaver
  11. Always remember to do a **good irrigation**, often times this may be all that is needed
- **Anterior ankle exostosis approach**
  12. **Reflect the capsule** by putting the shaver against the osteophyte and lifting the capsule off of it
  13. Use a **4 mm burr** from the ant-lat port while viewing from ant-med port. You may also use a rongeur or osteotome.
  14. **Switch portals** and do lateral portion
  15. C-arm or intra-op radiographs may also be used
- **Anterior medial exostosis approach at tip of medial malleolus**
  16. Make secondary port approx 1-2 cm medially and slightly distal to ant-medial port
  17. Be sure to suture **close** all ports used

# Arthroereisis

- **Procedure**
  - **Patient set-up**
    - General or spinal
    - Thigh tourniquet
    - Pt heel is resting over edge of bed
  1. Incision over sinus tarsi
  2. **Blunt** dissect to sinus tarsi
  3. **Insert guide pin** so it abuts the anterior aspect of the body of talus. Advance pin until it tents the skin medially. Can C arm here, or at any step.
     a. **Axis**: distal lateral→prox medial. Proper insertion of probe should cause the distal aspect of the probe to exit just superior to the tibialis post tendon and anterior and slightly inferior to medial malleolus—this is the direction you're aiming
     1. The **torpedo shaped probe** is inserted until it tents the skin. Make incision.
  4. **Rotate probe** clockwise and counterclockwise to dilate the tarsal canal.
  5. The **guide pin** is then placed within sinus tarsi.
  6. Most often the 8 and 10 mm implants will be used. Use the **sizers**, the correct size should allow 2-4° of subtalar eversion.
  7. Next, use the **trial implant** of the above size. Check ROM, and clinical correction are assessed. Use C-arm at this point.
  8. Now use **actual implant** on screw driver with nose cone. Apply over guide pin. Screw in clockwise. Insert no more than 1 cm medial to calcaneal wall and no more than ½ way across talus
  9. Once inserted, the implant should be resting on floor of sinus tarsi. **Take x-ray**
  10. When satisfied, **remove guide pin and inserter**. Irrigate with NSS. Re-valuate motion, close in layers.

- **Post-op**
  - WB in cast for 2 weeks, gradual return to shoe gear.

# Arthrosurface 1st Metatarsal Head Implant

- **Indications**
  - Hallux limitus/rigidus + Good bone stock!
  - Also a good procedure if arthrodesis is not an option
- **Contraindications**
  - Significant bone demineralization or inadequate bone stock
  - Inadequate skin, musculotendinus or NV system status
  - Inflammatory, rheumatoid arthritis, sepsis, infection and osteomyelitis
  - Pts known to have sensitivity to metal alloys typically used in prosthetic devices

- **Simple Technique Guide Steps**
  - Step 1 – **Drill Guides,** match with **Articular Component**
  - Step 2 – **Cannulated Pin, Drills**
  - Step 3 – **Tap**
  - Step 4 – **Driver**
  - Step 5 – **Tap Cleaner**
  - Step 6 – **Trial Cap**
  - Step 7 – **Centering Shaft**
  - Step 8 – **Contact Probes**
  - Step 9 – **Circle Cutter and Surface Reamer**
  - Step 10 – **Sizing Trial**
  - Step 11 – **Implant Holder, insert Articular Component and Impactor**
  - **Size is usually 15**

- **Procedure**
  1. **Dissect** down and expose 1st metatarsal head (similar to an exposure for a bunion)
  2. Use **Drill Guide** to locate the axis normal to the articular surface and central to the defect
     a. Be sure to choose a Drill Guide where the diameter circumscribes the defect
  3. **Confirm Articular Component diameter** by matching it to the Drill Guide
  4. **Place Guide Pin** through the Drill Guide into bone
     a. **Make sure its central to defect**
     b. It is *very important* to verify that Drill Guide is seated on the curved articular surface such that **four points of contact** are established. A normal axis and correct Articular Component diameter are necessary for proper implant fit.
  5. Place **Cannulated Drill over Guide** Pin and Drill until the proximal shoulder of drill is **flush** to the articular surface
  6. **Tap hole** to etched depth mark on tap
     a. Optional – insert bone cement into pilot hole
  7. Place **Driver onto** the **Taper Post** over the guide pin and advance until the line on the Driver is flush with the height of the original articular cartilage level
     a. Optional – advance the Driver further to decompress the joint
  8. **Remove guide** pin
  9. **Clean taper** in Taper Post with Taper Cleaner

10. Place **Trial Cap into taper post** to confirm correct depth of Taper Post
    a. The **peak height of the trial cap** must be flush or slightly below the existing articular cartilage surface to avoid the articular component from being place above the surface of the defect
        i. Adjust depth using the driver to rotate the taper post (clockwise to advance)
11. Place **Centering Shaft into Taper Post**
12. Place **Contact Probe over Centering Shaft** and rotate around Centering Shaft. **Read contact probe** to obtain offsets at **four indexing points**.
    a. Superior/inferior and medial/lateral
    b. **Select appropriate** Articular Component using Sizing Card
13. **Remove Centering Shaft** and replace with **Guide Pin**. Advance Circle Cutter back and forth.
    a. *Don't* bend guide pin
    b. **Score articular cartilage** down to subchondral bone
14. Choose appropriate Surface Reamer based on the offsets. **Drill Surface Reamer** over Guide Pin until it contacts the top surface of Taper Post.
    a. Begin rotation of Surface Reamer *prior to contacting bone* to avoid chipping articular rim
15. **Remove Guide Pin and clean Taper Post** to remove any debris from implant bed
16. Place the **Sizing Trial** into the defect that matches the offset profile selected
    a. Confirm that the Sizing Trial is equal or slightly recessed to edge of articular cartilage
    b. If the Sizing Trial is proud at the edge of articular cartilage, ream with the next appropriate sized reamer and matching Sizing Trial
17. **Use the Implant Holder** (attached to suction wall tubing) and **align the Articular Component** on the holder with appropriate offsets
18. **Insert implant** into Taper Post
19. Tap the Impactor gently against the implant to **seat it against the bone**.
20. Check ROM of 1st MPJ and **close** in appropriate layers

# Brostrom-Gould Repair

- **Indications**
  - Chronic ankle instability unresponsive to conservative treatment
  - Athlete with ankle instability
- **Contraindications**
  - Fixed varus heel type (need to correct with Dwyer)
  - People over 200-225 lbs (use Evans with PB repair)
  - Peroneal weakness (i.e. CMT)

- **Procedure**
  - Patient set-up
    - Supine with bump (to internally rotate leg)
    - Thigh tourniquet
    - General or spinal
    - Optional – Bump under foot

  2. Incision curvilinear over anterior border of fibula, stop at peroneal tendons
     a. *Be careful* of sural nerve, intermediate dorsal cutaneous nerve, peroneal tendons
     b. You will may have to ligate lesser saphenous branch of nerve
  3. **Dissect** down to capsule, incise it from 2-3 mm from border of fibula
     a. Leave a cuff for later attachment
  4. **Find CFL** by reflecting peroneals and incise it
  5. Put **foot in neutral DF and slight eversion**
  6. Resect necessary capsule, **reapproximate** using 0 or 2-0 absorbable (or non-absorbable) **suture** starting with the CFL then ATFL (extend incision if necessary)
  7. **Test** for full range of DF and PF (gently)
  8. Identify extensor retinaculum (should be distal), its fibers run perpendicular to ATFL and CFL (extend incision if necessary)
  9. **Mobilize extensor retinaculum**. Pull it over the repaired capsule and attach to the tip of the fibula using 2-0 absorbable suture.
  10. Check again for ROM and stability
  11. **Close**

- **Post-op**
  - Posterior splint 3-5 days
  - BK walking cast for 3-4 weeks
  - Air-type stirrup for an additional month with ROM exercises

# Fibular Derotational and Lengthening Osteotomy

- **General**
  - Tramatic displacement of talus is associated with displacement of lat malleolus
  - Malalignment is characterized by distal fibular shortening, lateral shift or malrotation
  - Increases pressure in mid-lateral and posterolateral quadrants of the talar dome
  - Goal of Fibular Derotational and Lengthening Osteotomy is to restore the sensitive WB area to normal anatomic relationship
- **Radiographs** (Can also use CT and MRI)
  - Abnormalities of talar position is seen on x-rays. Check for (compared to other side)
    - Widening of medial joint space
    - Talar tilt
    - Fibular shortening
  - **Mortise View—Check for:**
    - Equidistant and parallel joint space with no medial widening
    - Shenton's line of the ankle
      - A dense subchondral supporting bone creates a radiographic line that can be followed over the syndesmotic space from tibia to fibula (Kitoaka pg. 501)
      - This should be even and continuous between the two bones
    - Unbroken curve between the lateral part of the articular surface of the talus and the distal fibular recess
    - Talar tilt.
      - This should be parallel or within 3° of parallel
    - Abnormal seating of fibula in the incisura fibularis of the tibia. (Pg. 501)
      - Normal is less than 6mm as measure 1 cm above tibial plafond
      - If internal fibular rotation-increase in this measurement
      - If external rotation of fibula-measurement is normal or decreased. This is more common
- **Check for DJD**
  - If no DJD—Fibular Derotational and Lengthening Osteotom**y**
  - If severe DJD-ankle arthrodesis
- **Contraindications**
  - Infection
  - Neuropathy
- **Surgical choices**
  - Oblique osteotomy—can only gain 3-5 mm in length
  - Transverse osteotomy of fibula, uses iliac bone graft, with plate and syndesmotic screws through plate

# Ilizarov Method

- **Insertion of wires**
  1. Place wire with the frame already built
  2. Make stab incision
  3. Blunt dissection (with a hemostat)
  4. Wire is inserted via safe tract via clamp
  5. Remember to pulse the drill to avoid overheating
  6. Use a wet Ray-Tec sponge to keep wire cool and stabilized
- **Positioning the frame**
  - Proximal: 2 fingers between the frame and tibia
  - Distally: 3 fingers (to allow for swelling)
  - Frame should be 2-3 cm from the surface of the ground to allow for WB
- **Tibial wire insertions**
  1. Break the tibia into 6 segments (1st being most proximal and probably out of our scope of practice)
  2. At the **2nd segment**
     a. Put half pin perpendicular to subcutaneous surface of tibia (pretty much the general rule for insertion of half pin at the tibia)
     b. For the wire, try to engage the widest portion of the tibia. This means inserting the wire slightly oblique to the transverse plane of the tibia, thus exiting a little more ant-medial when compared the plane of tibia.
  3. At the **3rd and 4th segment**
     a. Similar to 2nd segment
  4. At the **5th segment**
     a. Wire is inserted almost perpendicular to frontal plane of tibia.
        i. *Note:* Often the tibial wires will be parallel so that the frame can be slid both medial and lateral
  5. At the **6th segment**
     a. Wire options
        i. Directly med → lat
        ii. More ant-lat → post-med
        iii. Through fibula and into tibia

# Osteochondral Lesions of the Talus

- *Conservative treatment indicated for Stage 1-2 and Stage 3 medial lesions*
- *Surgery indicated for Stages 3 lateral and Stage 4 lesions*

- **Procedure**
  - Patient set-up
    - Supine
    - Thigh tourniquet
    - General or spinal
  1. **Get scope portals**
  2. Use 2.7 mm scope, both 30˚ and 70˚. **Examine the joint**.
  3. With a probe, evaluate the articular cartilage. Look for any loose bone fragments beneath articular surface and the extent of the lesion over the talar dome.
  4. Type of surgery is dependent on type of osteochondral defect
     a. **Acute fracture is usually ant-lat**, more substantial bone base and better for internal fixation
     b. **Chronic post-med lesion** is more likely to have fragmented necrotic bone and poor articular cartilage. These lesions must be removed.
     c. In young patients without skeletal maturity, simple drilling may be enough if articular cartilage remains intact
  5. For drilling, use 0.062 K-wire to depth of 1-1.5 cm
  - For **post-med lesion**
    - Old method was to use trans-tibial approach.
    - New method is to use a guide and go through sinus tarsi into post-med portion
  - For **articular cartilage that is fragmented, loose and necrotic**
    1. For post-med lesions, use post-lat port for 70˚ scope
    2. Use probe to lift cartilage
    3. Remove cartilage with forceps
    4. Use angled cervical curette to **debride lesion to healthy**, bleeding bone
       a. Stopping the inflow will demonstrate bleeding
    5. If good bleeding, just remove all remaining bone fragments
    6. If not good bleeding, drill as previously described
  - For **bone grafting**
    - If cartilage is good and intact, but either there is a viable bone fragment or there is only edema of the underlying cancellous bone
    - Insert in the trans-talar approach (like drilling through subtalar)
    - **OATS Procedure**
      - For post-med lesion
      - Take a **plug of bone with articular cartilage** from knee and through a trans-tibial approach, **insert into the talus**

# Tarsal Tunnel Release

- Most often occurs in the fibro-osseous tunnel (bound by lacinate ligament), most often at the distal edge of the ligament.
- Division of nerve of medial and plantar nerve occur deep to lacinate ligament in 93% of people, and proximal in the other 7%
- The nerve is in the third channel (Tom, Dick and A Very Nervous Harry.)
- Need "peanuts," posterior splint, and Penrose drain.

- **Procedure**
  - **Patient set-up**
    - General or spinal usually
    - Thigh tourniquet, deflate before closure.
    - **Don't esmarch** the foot, just elevate it.

  1. Incision 10 cm proximal to the tip of the medial malleolus and 2 cm posterior to the tibia. After the medial malleolus, gently curve plantar to the level of the talonavicular joint (plantar to TNJ). This should be about the midpoint of the abductor hallucis
     a. McGlamry—2cm proximal to superior edge of lacinate ligament and gently curving to the proximal margin of the abductor hallucis.
  2. With **hemostats**, **blunt dissect the SubQ**. A moistened 4x4 can be used. When in the SubQ, be careful of the medial branch of the nerve as it punctures the lacinate ligament.
  3. When at the **lacinate ligament**, feel for the pulse of the PT artery. Also palpate for the tendons of the PT and FDL. The FHL ($4^{th}$ compartment) can be palpated by moving the big toe.
  4. From proximal to distal, **make incision of the roof of the third canal**. May want to use hemostats and split them, or may use groove channeler/director.
  5. **Isolate the Tibial Nerve and all 3 branches** (medial and lateral plantar nerve, and the calcaneal branch) of its branches from all tissues.
  6. Remove any neoplasm. Be careful!
  7. Move varicose veins. Ligate veins if necessary, but make sure that you aren't ligating an artery.
  8. Follow nerve distally through the **abductor canal**. Section the abductor canal stricture.
  9. Go **proximal** and follow nerve upwards.
  10. Deflate tourniquet.
  11. **Closure**—but don't reapproximate the lacinate ligament (McGlamry says only partially reapproximated) and the subQ and skin are closed. If a lot of ooze, then use a drain.
  12. Marcaine at the end

- **Post-op**
  - Below the knee compression dressing is applied.
  - NWB or partial WB for two weeks.
  - Begin DF and PF of ankle after 2 weeks.

# Case Study 1

**A 23 y/o male presents to the ED with foot trauma.**

**What should you do first?**
Obtain a quick history and check neurovascular status
HPI – patient had foot run over at work. He complains of 10/10 pain and that his toes feel cold and numb.
PE – pulses are present. Toes feel cold. Patient cannot feel you touching his toes. Toes are changing color (purple or white). Patient cannot move his toes.

**What is your diagnosis?**
Compartment syndrome

**What is compartment syndrome?**
Condition with increased tissue pressure within a limited space which compromises the circulation and function of the tissues. It can lead to ischemia of the tissues.

**Is this a surgical emergency?**
Yes. Compartment syndrome is a clinical diagnosis, according to the AO Principles course. It is better to get the patient up to surgery than to find an instrument to measure the pressure.

**What are some causes of compartment syndrome?**
Fractures, crush injuries, prolonged limb compression, post-ischemic swelling. Practically any injury can result in compartment syndrome.

**What are the signs of compartment syndrome?**
- Pain out of proportion (most important)
- Paresthesia
- Pallor
- Pulses present
- Poikilothermia
- Paralysis

**What are some techniques for measuring pressure?**
Wick catheter, slit catheter, Synthes catheter, needle technique, continuous infusion technique. But as stated before, this should be a clinical diagnosis.

**What is the treatment?**
Fasciotomy of the compartment. In the leg, surgical access should be made to all four compartments. To do a leg fasciotomy, make one incision medial to the tibia and one lateral. From the medial incision, open the superficial and deep posterior compartments. From the lateral incision, open the anterior and lateral compartments.

**What are some absolute indications for a fasciotomy?**

- Tissue pressure above 30 mm Hg (normal 4 ± 4 mm Hg)
- Sensory and motor loss
- Pain out of proportion

# Case Study 2

**A patient who you prescribed pain medications has wheels, hives, itching, and trouble breathing after taking the medication.**

**What is most likely going on?**
Anaphylaxis

**What is anaphylaxis?**
Rapid, generalized immunologically-mediated event that occurs after exposure to foreign antigen substances in previously sensitized persons. This syndrome can affect any organ in the body, but it most commonly affects the pulmonary, circulatory, cutaneous, neurologic, and GI systems.

**What are the clinical symptoms of anaphylaxis?**
Mild (common)

- Urticaria, weakness, dizziness, flushing, angioedema, congestion, sneezing

Severe

- Upper respiratory tract obstruction, hypotension, vascular collapse, GI distress, cardiovascular arrhythmias, cardiac arrest

**What is the difference between anaphylaxis and anaphylactoid reaction?**
Clinically, they present the same, but anaphylactoid reaction is not mediated by the IgE antibody and does not necessarily require previous exposure to the inciting substance

**What is the treatment for anaphylaxis?**
Stop the offending agent, and if necessary, D/C all meds
If the patient is having life-threatening problems, get them to the ED
Treat the symptoms

- Airway – bronchospasm
  - $O_2$ 40-100%
  - Epinephrine 0.3-0.5 mL 1:1000 soln SC or IM q15min
  - Albuterol 0.5 mL 0.5% in 2.5 mL NS nebulized q15min
  - Benadryl 50 mg PO q4-6h
  - Methylprednisolone 2-60 mg PO daily
- Cardiovascular – hypotension
  - IV fluids 1 L q20-30min prn
  - Maintain systolic pressure >80-100 mm Hg
  - Epinephrine 1 mg 1:1000 in 500 mL D5W IV at rate of 0.25-2.5 mL/min
  - Norepinephrine 4mg in 1 L D5W IV at 0.5-3 mL/min
  - Benadryl 50 mg PO q4-6h
- Cutaneous reactions
  - Epinephrine 1:1000 0.3-0.5 mL SC or IM q15min
  - Benadryl 50 mg PO q4-6h

Document offending agent and educate patient on future avoidance

**What is the best way to prevent anaphylaxis?**
Thorough history and elimination/avoidance of the offending substance

# The Interviews

For some people, the social interview is harder than the academic interview. In my opinion, the reason that it is harder is because people don't prepare for the social interview. After sitting through 2 years of interviews, I'm amazed at how some people don't seem ready for the social questions. Many of these ideas are from my past as a salesperson on a job interview. Essentially that is what you are…a person selling themselves for a job.

-Brett Chicko

The amount of Social vs. Academic Interviewing will vary from program to program. Some will only ask social questions (but pimp you when you rotate with them) and some may ask only one social question and a battery of academic questions. Review this section so you have some baseline answers for common social questions and review the rest of the book for common academic questions. Overall: be yourself and relax!

-Hubert & Sandi

**Hint #1 – Look and dress appropriate!**

- Men
  - Wear a pressed shirt, tie, and suit. (Suggest a dark suit with a blue or white shirt.)
  - Hair should be neat and combed and facial hair clean cut.
- Women
  - Wear a conservative suit. Keep the skirt length and shirt neckline appropriate.
  - Hair should be neat and combed.
- Sitting in the interview chair
  - When you sit in the chair, sit back with good posture. NO SLOUCHING!
  - Your hands should be in your lap (when you're not talking to them).
  - Keep your feet flat on the floor for men or legs crossed for women.
  - Do not lean your arms on the table in front of you…you're not at your desk at home!

**Hint #2 – Proper entrance/exit from interviews**

- Do not be late for your interview!
- When you enter the room, sit in the chair and give a proper greeting.
  - Say hello at least.
  - Say "nice to see everyone again" or something similar if you've rotated with the program.
- Make sure to make eye contact with everyone in the room and SMILE! (But don't be too cheesy about it.)

- When you leave the room, it is appropriate to only shake hands with the director unless the other members of the room offer to shake their hands.
- Thank the interviewers for their time.

**Hint #3 – Do your homework**

- At the end of many interviews, the host will ask the interviewee if he/she has any questions.
    - Brett says: You should not. "You should have done your homework by this point. Why would you spend your money and time to interview at a place you don't have any information about (other than what is in the CASPR book)? To ask questions in the interview that should've been asked on a visit makes you look unprepared and uninterested.
    - Hubert & Sandi say: It is okay to ask any burning questions you may have about the program (rumors about taking 4 residents instead of 3, or hearing a program may be closing next year). Avoid simple questions that may be answered by reading a program's handbook or website.
- **By the time of your interview, you should have visited the program** (and in theory asked all your questions at that time)
    - If you live and attend school near a program you're interviewing with by golly you BETTER HAVE VISITED there by the time of the interview!
    - If you live too far away (airplane ride distance) then a phone call to one of the residents will work (track down a resident's pager number or contact info through the number given in the handbook for each program)
        - During this phone call, get your questions answered.
        - As always, be prepared and have a good list of questions for the resident.
        - If any questions do arise after the visit/phone call then it is perfectly acceptable to call or re-page or email the resident.
- A good response to this question: "Do you have any questions about our program?"
    - "No Sir/Ma'am, all of my questions were thoroughly answered by Dr. So-and-So on my visit (or phone call). I feel as if I have a good understanding of the opportunities of your program."

**Hint #4 – Ask for the program**

- Brett says:
    - I know some people feel that by showing up for the program their presence alone means they want the program. I still feel like one should go the extra yard and ask for the program. I do not mean suck up to them, but state to the interviewers that you want the program in a mature and professional manner.
    - By asking for the program or stating that you want the program it shows the program that you want to be there and that this is not a practice interview
    - I know personally that if there are 2 women I want to date, the one who expresses an interest me versus one that is indifferent, I will always choose the one who expresses an interest
    - Proof? All the interviews I've been a part of, only 4 people asked for the program (over a 3 year span) and all 4 have gotten the program.

- Hubert & Sandi say:
    - Getting a good program's spot (like Crozer's) is highly competitive, and many students have learned to sneak in "I love your program" or "I definitely want to come here" as many opportunities as they can.
    - Proof that this doesn't always work? Since this book was written, the occasional student who has said they wanted the program has turned in to more like 60-75% of the students coming through with visits or externships that "ask for the program." Trust us, your actions speak way louder than your words…
    - But if it makes you feel better to say this as a parting goodbye, you wouldn't be the first or the last!

**Hint #5 – Be enthusiastic**

- Don't be one of those people that walk around looking like they have a hangover or just took a sleeping pill.
- Get a good night's rest so your tiredness from studying/drinking doesn't overcome your alertness and enthusiasm.
- But don't be a cheeseball or act unnaturally.

**Hint #6 – Act like someone you would want to work with**

- If you've rotated with the program for a whole month, no matter how you act in the interview, they already know your personality. But acting like a big goof can hurt your chances.
- Continuing on Hint #5 and think about #7, be like a mature, responsible adult, or at least act like one.
- If you're picked, you'd be the one representing the program so you need to show you're a good person to work with.

**Hint #7 – Remember you're in a formal interview**

- Even if you joked around a lot on a visit or on a rotation, especially when answering academic questions, keep the ridiculously silly answers to yourself.
- Although you may have spent a month at a program, not everyone at the interview may have met or remember you. Make sure your first impression with them a positive one.
- You want to do well because sometimes a good or bad interview makes or breaks your chances with a program.

**Hint #8 – Prepare for the social interview**

- Go over some of the sample social questions and formulate some answers for a couple of them. Go over these answers with a classmate, a resident you're working with or are friends with, your mom, anyone really.
- Practice, practice, practice…
- Be creative, but please read your answers out loud to another human being so your creativity is not interpreted wrong or sound ridiculous.
- Don't ignore this part because you have a thousand other things to study for the academic portion!

**Hint #9 – Have fun**

- Seriously, this is the only way to get through these types of questions.
- This will show the program you are applying to a part of your personality and how you're handling the stress of interviewing.

**Hint #10 – Don't over think things**

- With nerves and anywhere from 2 to 15 people interviewing and watching you, even the most confident person can show some nervousness.
- With a few exceptions of certain known hard-core academic programs, most programs just want to see your scope of basic knowledge and reasoning when working up a case study or working through the questions.
- If it looks like a dog, smells like a dog...it's probably a dog. Meaning, if you think you know the answer, you probably do!
- And if you hear hoofbeats, think horses – not zebras…

**Hubert & Sandi's Bonus Tips**

- The Match for students with programs is designed to work in favor of STUDENTS NOT PROGRAMS
- **Rank programs the way YOU want them**. Don't let rumors influence how you rank your programs. (Ex: If you rank a program you really want and they don't end up picking you, it just bumps you down to your #2 pick, but at least this way, if you've put them #1 you've given yourself the strongest chance of matching with your first pick!) After all, no one knows how you ranked programs except YOU (or the people you tell…).
- **When evaluating a residency program**, in addition to making sure you'd get the cases and experience you're looking for, evaluate the senior resident class and how they're performing. Think about it...if they're good, that's how you would be if you graduated that program! (Ex: Are they excellent surgeons who are confident doing a variety of cases? Are they getting skin-to-skin cases? Are they having trouble getting their numbers? Are they knowledgeable? Are they happy they went there??)

## Sample Social Questions

**Tell us about yourself**

- Keep this one short. Three sentences is a good length (i.e. who you are, what you are and what you like to do).
- Keep this to the point and under 15 seconds.

**Who is your hero?**

- Obviously, besides "Jazzy" Jeff Lehrman, DPM (Crozer attending extraordinaire and graduate of the Crozer program).
- It's probably not wise to say someone in your class or a cartoon superhero…but anything else is probably appropriate.

**Why did you pick podiatry?**

Foot fetish is NOT okay.

**Why should we take you over the other applicants?**
Just don't personally call out any of the other applicants when answering this.

**What do you know about our program?**

**What did you learn on your externships?**

**What is your favorite externship and why?**
Yup, what you're thinking is correct…it is not wise to name a different program than the program that asks this silly question.

**Did you visit our program?**

- If yes, what did you learn (or like) about our program?
- If no, why didn't you visit our program?
    - If you live close to the program (i.e. Temple students and our program), there really aren't many good excuses that sound acceptable. The "I didn't have time" or "My schedule didn't allow it" just don't cut it…

**Tell us about some of the current events**
Just a question to make sure you don't live in a bubble.

**What was the last book you read?**
But please have read the book, cause if it's some unknown title, someone may ask you what it's about and it's kinda strange to say "I've just started it so I don't know yet."

**Tell us a joke**

- Keep it clean!
- Brett's joke:
    - Sherlock Holmes & Doc Watson were camping. They went to sleep and were sleeping soundly until Sherlock woke up Watson. Sherlock said "Watson, look up. What do you see?"

      Watson looked up at the sky and saw millions and millions of stars and the moon. Realizing that The Sherlock Holmes asked him the question, Watson wanted to give an impressive answer.

      Watson thought about it for a second and answered:

      "From an astronomical point of view, I see the Milky Way and many different constellations to the North.
      "From a holographic point of view, I see the clouds are coming from the East and we may have a chance of rain tomorrow.
      "From a theological point of view, it shows how vast and powerful God is and how insignificant we are when compared to God.
      "From an astrological point of view, I see that the moon is in Jupiter and if you are a Scorpio, you are going to have a good day tomorrow."

Watson then asked, "Why, what do you see Sherlock?"

Sherlock took a drag on his pipe and replied, "Someone stole our tent."

- Hubert & Sandi say: Good luck remembering a long joke like that, but only tell a joke if you can tell the whole thing and remember the punch line. Please!

**What do you do in your free time?**

- Usually the program isn't looking for a geeky answer like "I read podiatry articles."
- Mention a hobby or activity you like to do on the weekend (like back in undergrad, when you had a life…and no, going to frat parties is not an acceptable answer).

**Be prepared to answer a question about one of your lower grades (if you have any)**
Especially if you have to re-test or re-take a class to pass.

**Who was your favorite resident? Who is your least favorite resident?**
Proceed to think of an answer with mucho cuidado (much caution)!

**What is your favorite color?**
Wouldn't advise you to say black or white, cause technically those aren't colors and it's totally lame if you do say them.

**If you can be any animal, what would it be and why?**

**Who is your favorite clinician in school and why?**

**Who is your mentor?**
Please don't say someone in your class!

**Who is our director?**
Please don't ever mess this one up!

CROZER-KEYSTONE
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