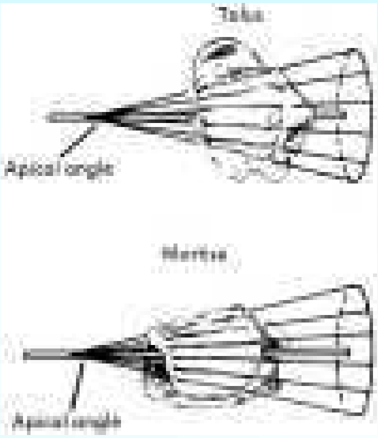
Management of Chronic Lateral Ligament Instability

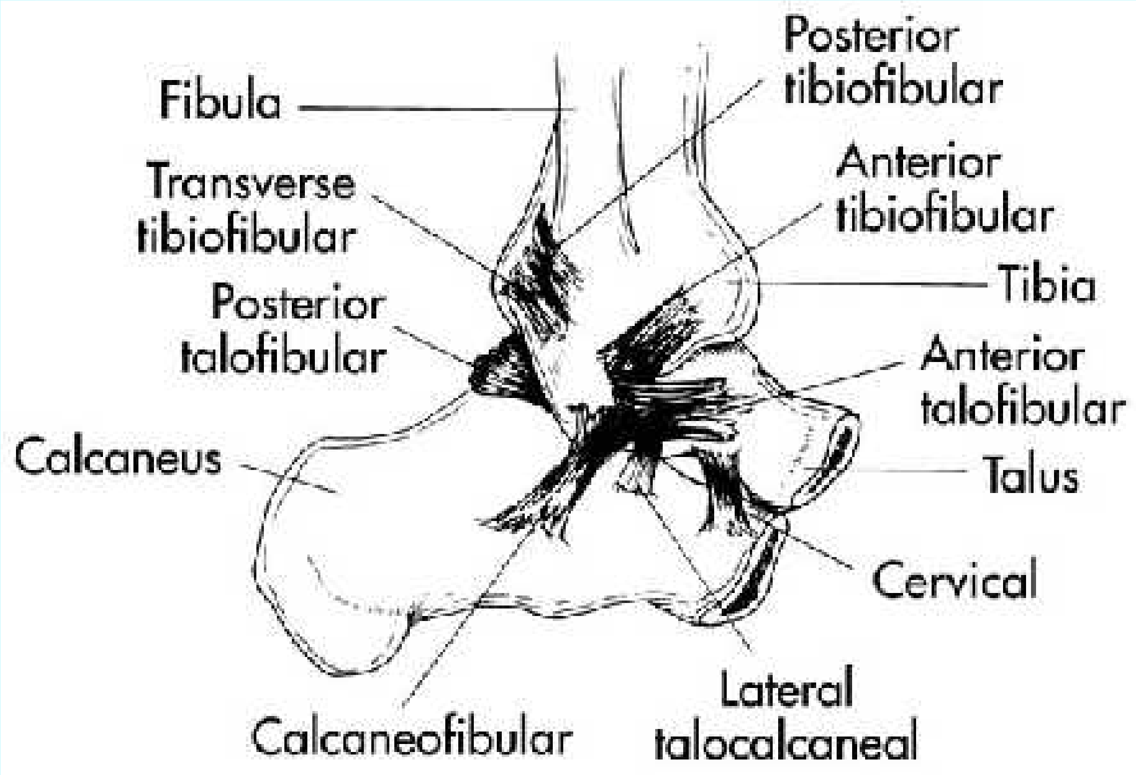
Bony Anatomy

- Curved trochlear surface of talus produces a cone-shaped articulation whose apex is directed medially; thus the fan-shaped deltoid is all that is needed for support medially
- A larger area of movement and the subtalar joint articulation laterally dictates more soft tissue involvement to produce stability, thus, more commonly injured



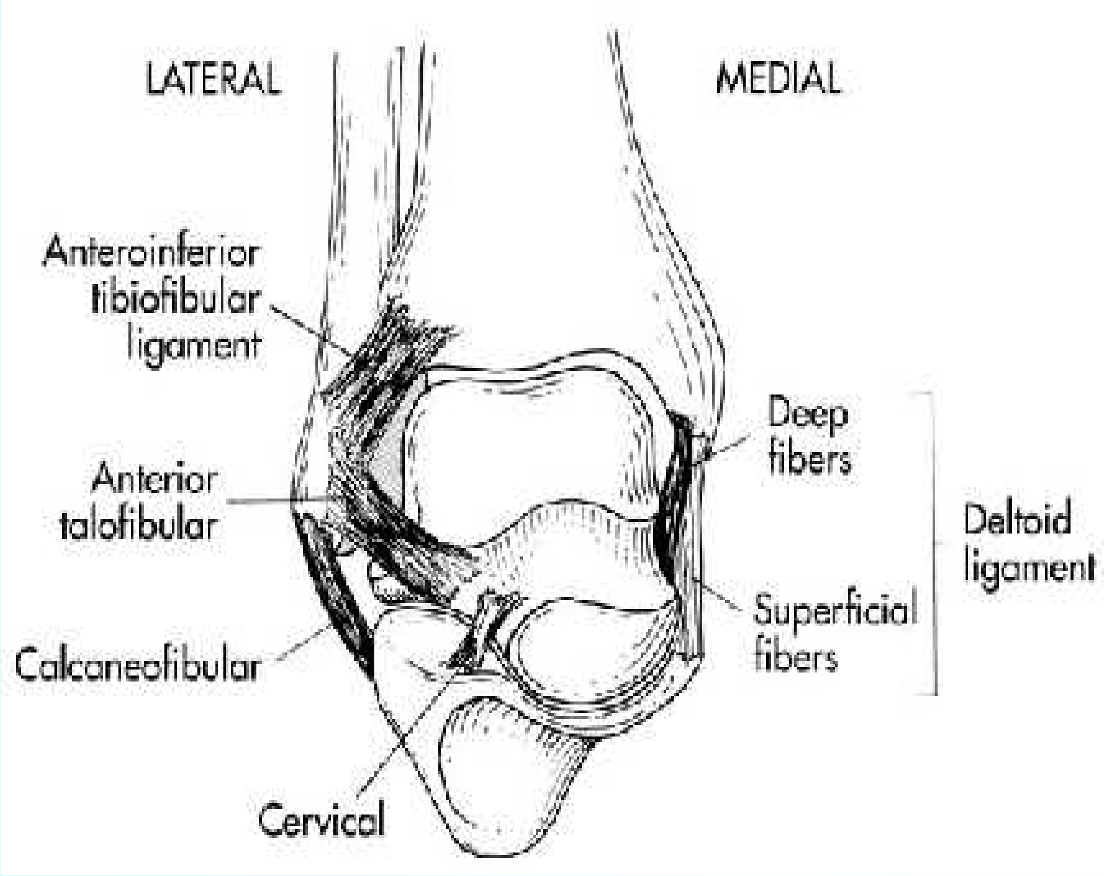
Anatomy of Ligaments

- The lateral ligaments should include not only the ATFL, CFL, and PTFL of the tibiotalar joint, but should also include the subtalar joint which is supported by the CFL, inferior extensor retinaculum, the lateral talocalcaneal ligament, the cervical ligament, and the interosseous talocalcaneal ligament
- Note: the CFL is included in both these joints and is crucial to the proper biomechanics of both joints



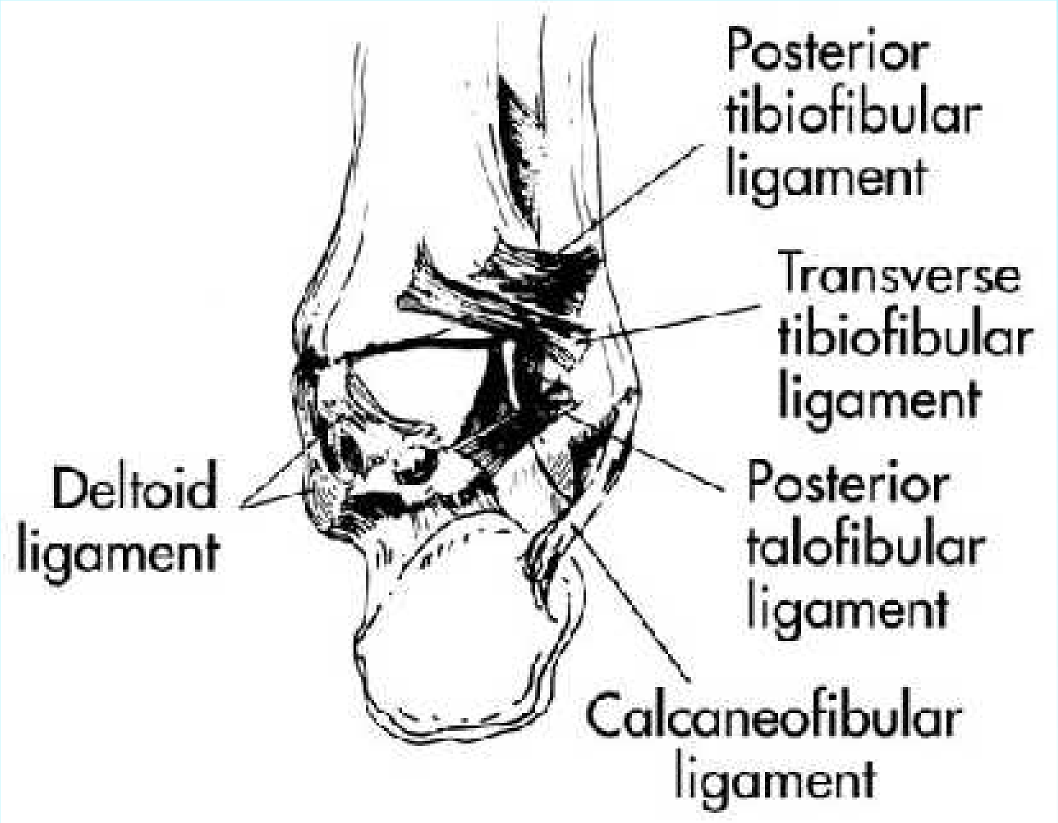
Anatomy of Ligaments

- ATFL - originates at the distal anterior fibula and inserts on the body of the talus just anterior to the articular facet (not unto the talar neck)
- ATFL - Makes an angle of approximately 75° with the floor from its fibular origin



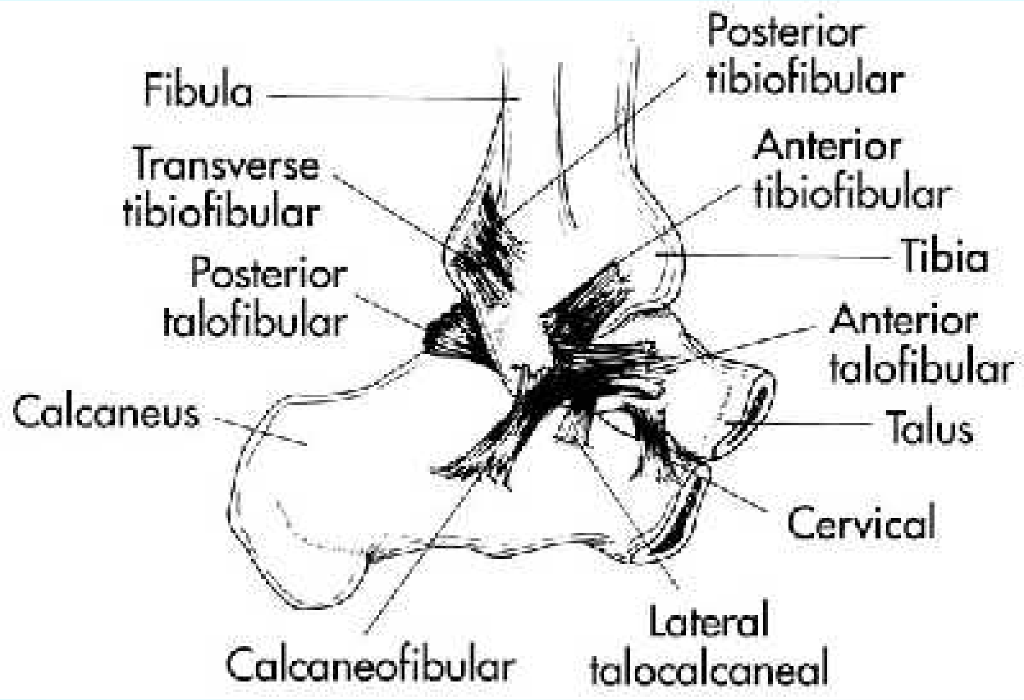
Anatomy of Ligaments

- PTFL - originates from the medial surface of the lateral malleolus and courses medially in a horizontal manner to nearly the entire posterior lip of the talus



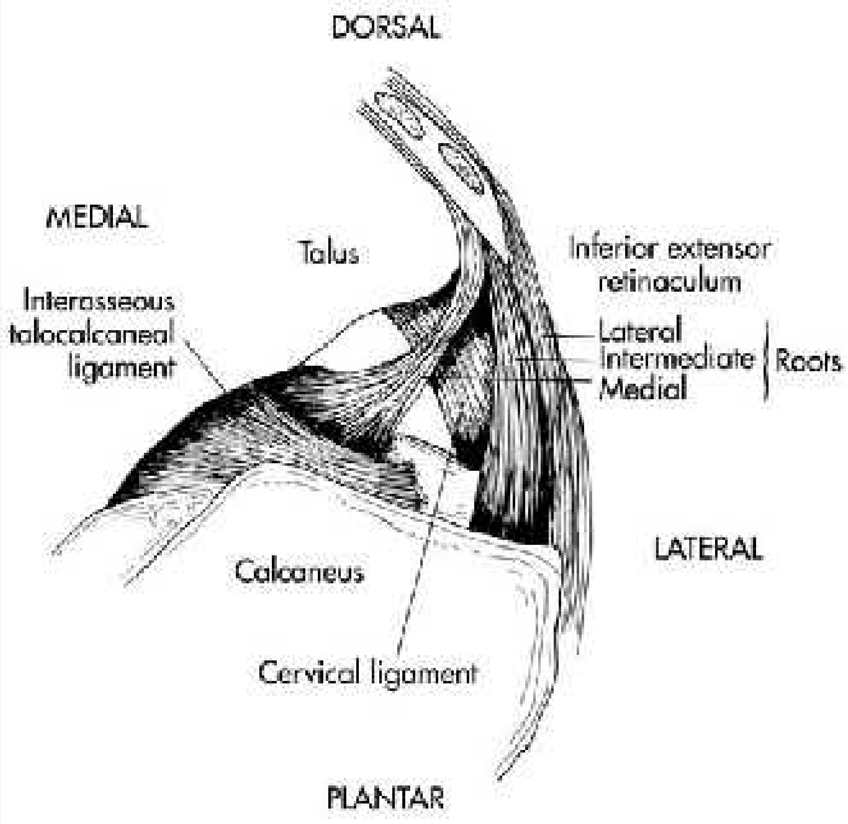
Anatomy of Ligaments

- CFL - originates from the anterior border of the distal lateral malleolus just below the origin of the ATFL and courses medially, posteriorly, and inferiorly from its fibular origin. It's attachment on the calcaneus blends with the peroneal tendon sheath and inserts on a small tubercle posterior and superior to the the peroneal tubercle. It runs approximately 10° to 45° posterior to the line of the longitudinal axis of the fibula
- Burks and Morgan showed ATFL and CFL had adjacent attachments on the anterior distal fibula 8 to 10 mm from the tip



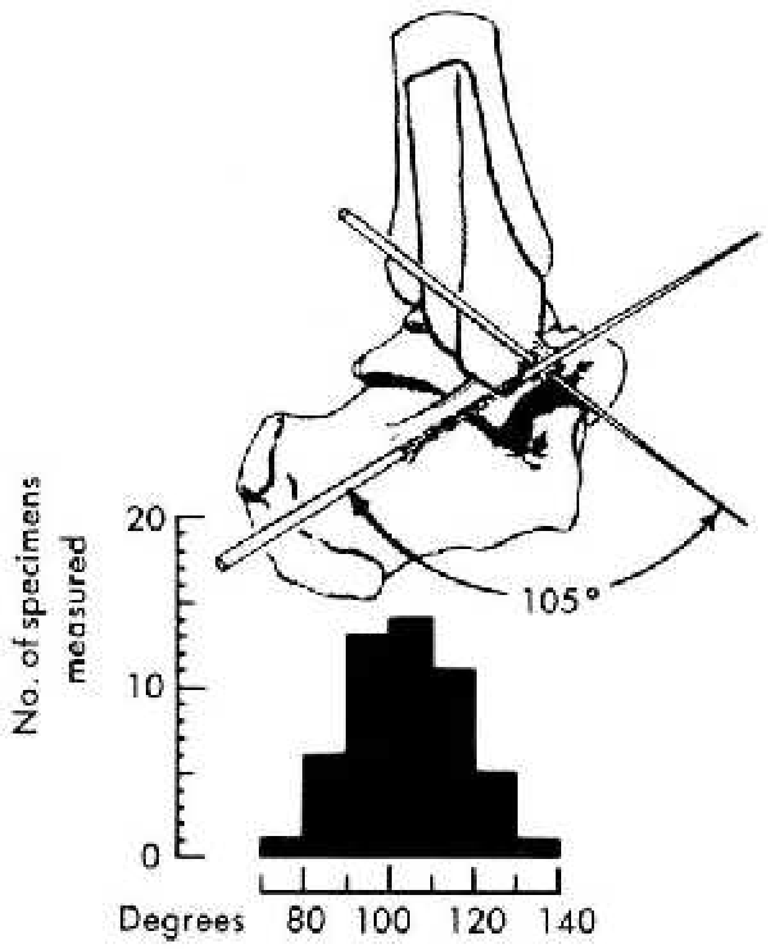
Anatomy of Ligaments

- Inferior extensor retinaculum is composed of 3 (lateral , intermediate, and medial); the CFL, LTCL, and the lateral root constitutes the superficial ligamentous support of the subtalar joint
- Lateral talocalcaneal ligament- originates from the lateral wall of the calcaneus just anterior to the calcaneal origin of the CFL and inserts on the body of the talus just inferior to the ATFL. This often blends with the CFL and ATFL (arcuate type)
- Cervical ligament- lies in the sinus tarsi and connects the neck of the talus to the superior surface of the calcaneus
- Interosseous talocalcaneal ligament – located at the most medial aspect of the sinus tarsi and extends from a ridge at the sulcus tali



Ligament Anatomy

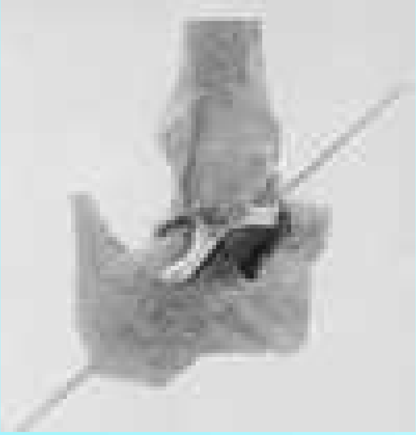
- The angle of CFL and ATFL in the sagittal plane averages 105°; this is clinically important in both the etiology of instability and for reconstruction
- Passing from dorsiflexion to plantarflexion causes a moment in time in which there may be decreased stability
- At 105° this is unusual, however, with an anatomical variant that displays a larger angle, there may be a larger interval of vulnerablity



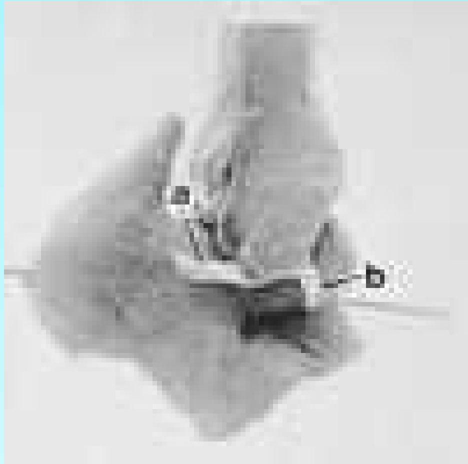
Biomechanics of Ligaments

- CFL is parallel to the subtalar joint axis in the sagittal plane; as the ankle is dorsi and plantar flexed, CFL and subtalar relationship does not change
- CFL is designed to allow motion in two joints simultaneously
- Neutral position, CFL is angulated posteriorly; in dorsiflexion it is brought in line with the fibula and becomes a true collateral ligament
- CFL in plantar flexion becomes parallel with the ground, and thus provides little support with resisting inversion
- ATFL is in line with fibula when the ankle is plantar flexed: collateral ligament
- ATFL in dorsiflexion positions the ligament horizontal to the ground and provides little resistance to inversion

Biomechanics of Ligaments



Relationship in neutral



Relationship in plantarflexion

Relationship in dorsiflexion

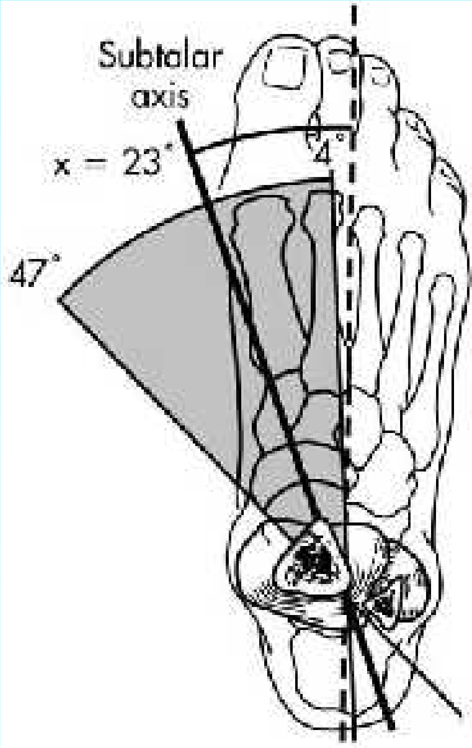
Biomechanics of Ligaments

- PTFL is maximally stressed in dorsiflexion and prevents external rotation in dorsiflexion
- *Attarin et al.* ATFL has a lower load to failure than the CFL (CFL 2-3.5 times greater)
- However, the ATFL is capable of undergoing greater strain which allows for the internal rotation of the talus during plantar flexion
- The ATFL inhibits internal rotation primarily; in plantar flexion it also prevents adduction
- CFL prohibits adduction and acts almost independently in the neutral and dorsiflexed positions. In plantar flexion it prevents adduction in conjunction with the ATFL

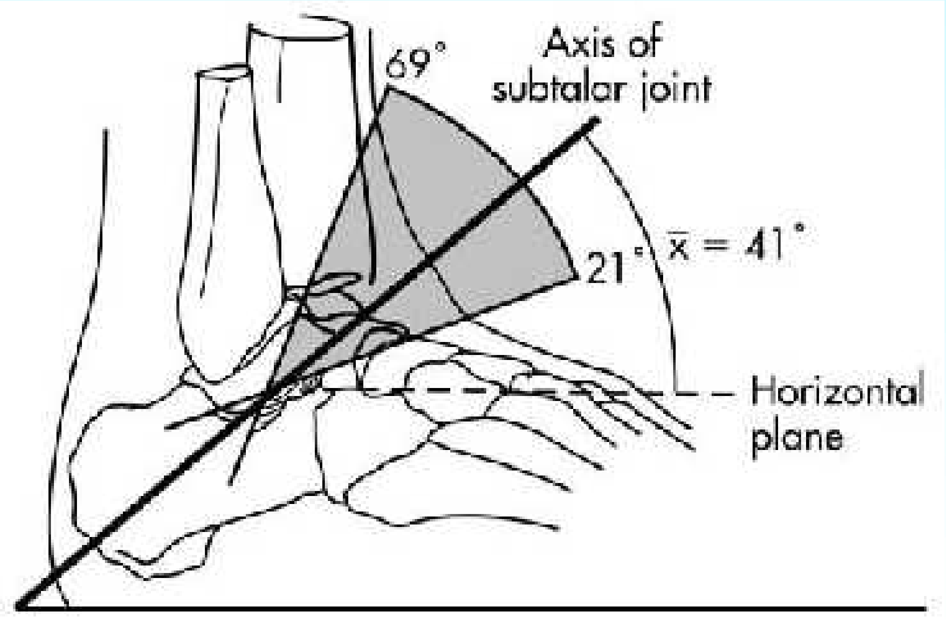
Biomechanics in Injury

- Forced dorsiflexion, PTFL ruptures
- Forced internal rotation ATFL ruptures followed by injury to the PTFL
- Extreme external rotation produces disruption of the deep deltoid lig.
- Adduction forces in neutral and dorsiflexion positions cause disruption of the CFL whereas in plantar flexion the ATFL is primarily injured
- *Kjaersgaard-Anderson et al.* – cutting of CFL increased talocalcaneal rotation by 20% and increased tibiotalar adduction by 61%-77%

Biomechanics: Subtalar motion

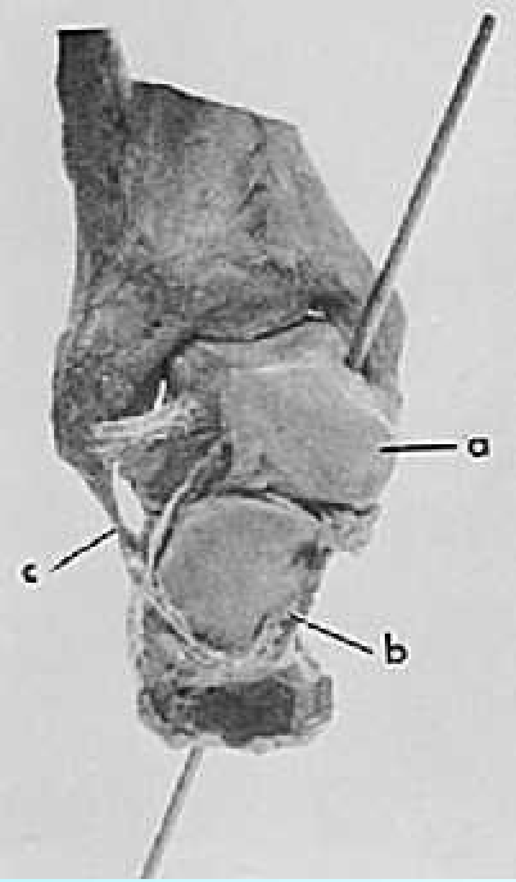


- Allows the leg to undergo an additional amount of internal and external rotation
- Joint moves around a single inclined axis and functions essentially like a hinge connecting the talus and calcaneus
- The axis in the transverse plane deviates approx. 23° medial to long axis of foot, and in the horizontal plane, the axis is approx. 41° to the floor



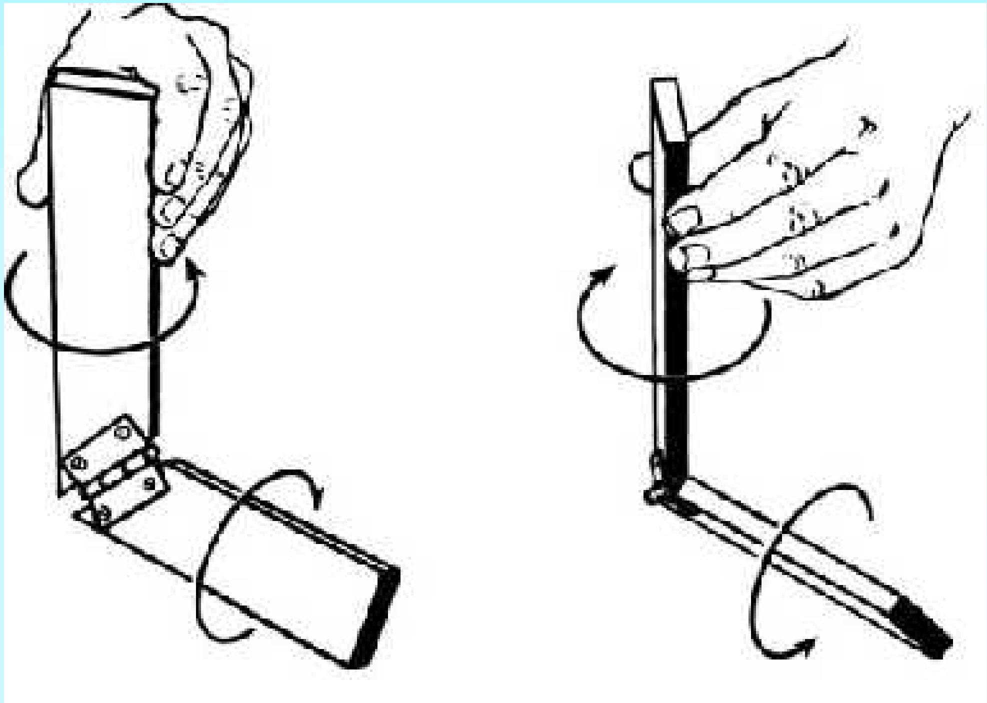
Biomechanics: Subtalar Motion

- CFL and subtalar joint relationship: subtalar deviates from medial to lateral as it passes from dorsal to plantar direction
- Axis is defined from head of talus to lateral calcaneus, and forms a cone shape motion with its apex intersecting with the calcaneal attachment site of the CFL
- This cone shape arc and the position of the CFL allows unrestricted motion of the ankle and subtalar joint



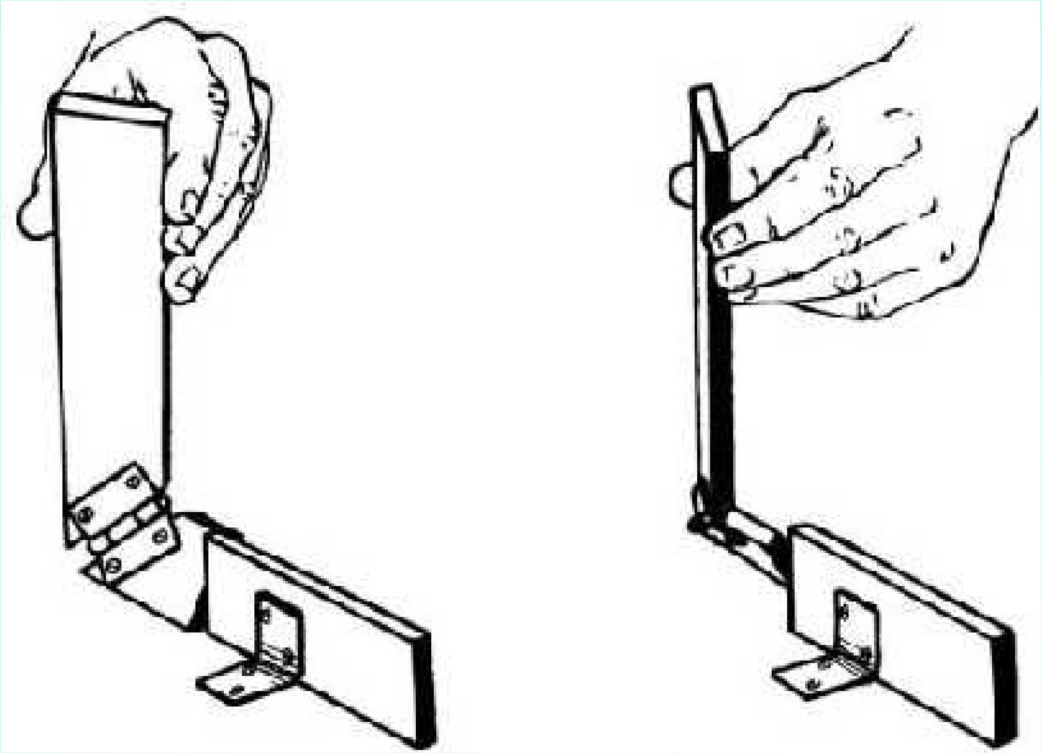
Biomechanics: Subtalar Motion

- Two boards attached with a 45° hinge illustrates a one to one relationship of torque.
- A more horizontal hinge creates more rotation of the horizontal member (acts much like a torque converter)

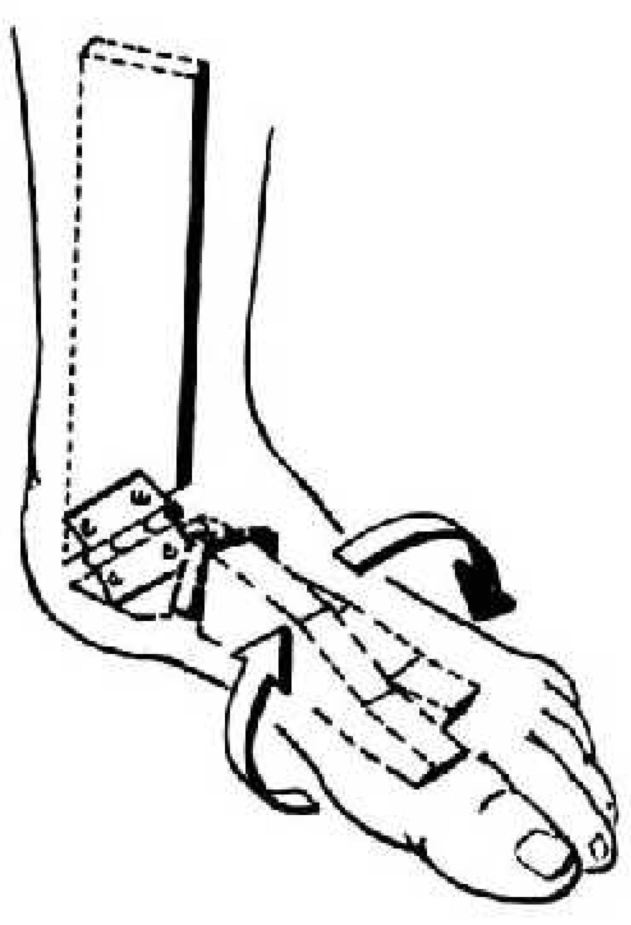


Biomechanics: Subtalar Motion

- To prevent the horizontal member from participating in the displacement, it can be divided into 2 members: a short proximal segment and long distal segment
- The distal segment remains stationary by pivoting with the short segment (the transverse tarsal joint): this short segment acts just like the subtalar joint



Biomechanics: Subtalar Motion



- Conversion of the distal segment into rays will create an anatomical foot model where external rotation of the leg causes inversion of the heel, elevation of the medial side of foot, and depression of lateral side
- Clinical: Patients with pes planus have a more horizontal subtalar joint so that with little leg rotation, they have more supination and pronation

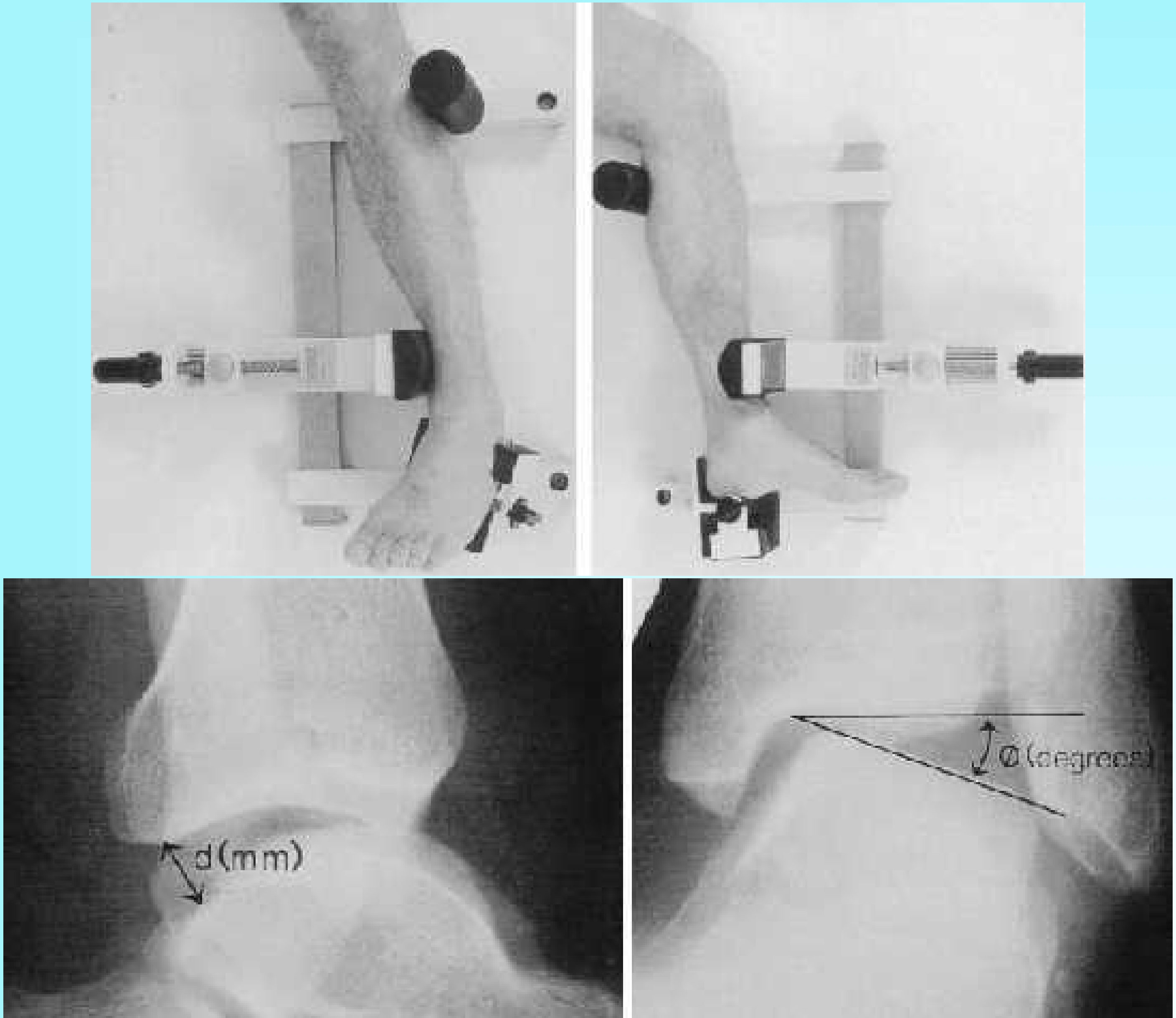
Epidemiology

- Acute sprains account for 16%-21% for all athletic injuries
- Lateral injuries account for 85% of all ankle sprains
- 10%-30% of all acute sprains result in chronic symptomatology
- Instability can be thought of in two ways: functional and mechanical
- Functional = subjective complaint with proprioceptive disorder that is rehab able
- Mechanical = objective instability that is determined by anterior drawer and talar tilt stress tests and often requires surgical intervention
- O'Donaghue classification most commonly used: Grade I, II, III

Exam

- Anterior drawer test- performed in relaxed plantar flexion
- Talar tilt test performed in neutral with hindfoot locked
- Freeman described modified Romberg's test performed on injured and uninjured leg (positive = proprioceptive defects, rehab)
- Telos stress test: 1) anterior draw > 10mm and talar tilt > 9°. 2) difference of anterior drawer of symptomatic ankle from asymptomatic should be > 3mm. 3) difference b/n talar tilt of symptomatic versus asymptomatic should be > 3°. Karlsson et al. found > 90% sensitivity, specificity, and predictive values with above criteria

Telos stress test



Treatment

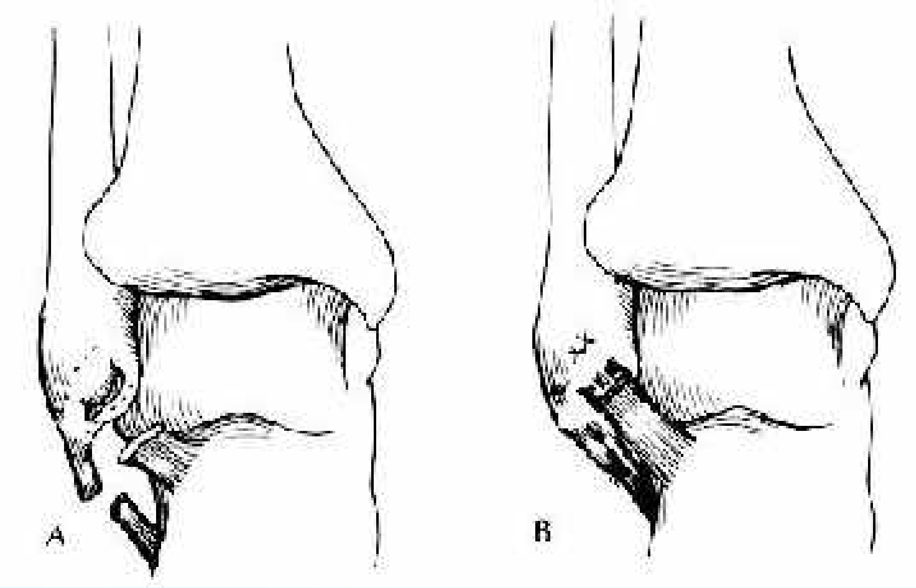
- Conservative management should be attempted first
- Peroneal strengthening, coordination training, and aggressive PT
- Failure of conservative management is variable
- Surgical treatment can be broken into three groups: 1) delayed primary repair (Brostrom Repair) 2) Tenodesis procedures (Watson-Jones, Chrisman-Snook, Lee, Evans, Elmslie) 3) Anatomic reconstruction
- Varus hindfoot deformities should be repaired prior to any of the above procedures
- Kibler et al. found intra-articular problems in 83% of ankles scoped prior to performing modified Brostrom (indication to scope before procedure)

Surgical Classification

- Stability determined by talar tilt and anterior drawer test: type I negative and Type II positive
- Type I receive functional treatment
- Type II positive anterior drawer and/or talar tilt: split into Group I and Group II
- Group I = non-athlete or older and get functional treatment
- Group II = young athlete which gets broken into Type A and Type B
- Type A = negative stress X-ray get functional treatment
- Type B = positive tibiotalar stress x-ray (tilt > 15 and anterior draw > 1cm gets surgical treatment

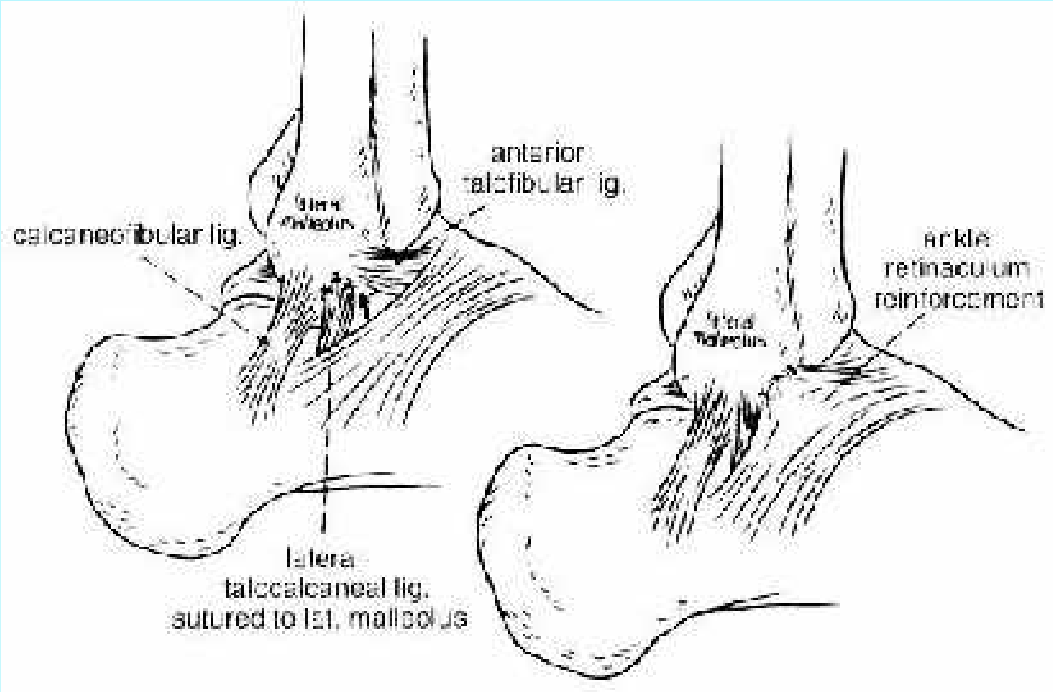
Direct repair (Brostrom type procedure)

- Originally described in 1966 to repair ATFL and CFL if disrupted
- Many modifications have been introduced since then
- Not indicated for patients with: 1. Generalized hypermobility 2. Long-standing ligamentous insufficiency (>10 years) 3. Patients with previous ligamentous surgery to the ankle 4. Obese patients > 225
- Gould et al. in 1980 described the modification of advancement of inferior retinaculum to address subtalar instability
- Karlson modification was to simply imbricate the attenuated ligament during the direct repair



Brostrom-Gould

- Once through skin, enter the anterolateral capsule at the plafond and then dissect distally to expose the ATFL. If ligament is simply attenuated imbricate.
- Address the CFL by opening the peroneal sheath and judge the quality of the ligament. May be able to simply imbricate or suture to bone.
- If ligaments are attenuated and scarred to capsule, they may be elevated subperiosteally to re-create the ligament
- Before closure, the inferior extensor retinaculum is imbricated or sutured to the periosteum over the fibula



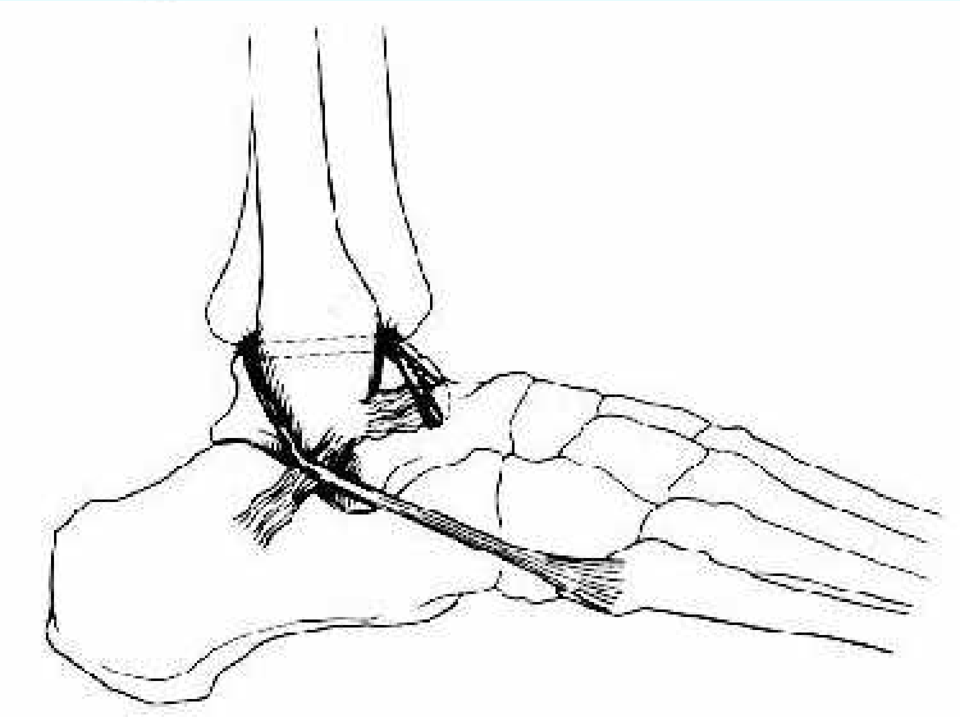
Keller et al. Lateral Ankle Instability and the Brostrom-Gould Procedure. The Journal of Foot and Ankle Surgery. 36(6): 1996.

- 39 patients followed for 67 months after above procedure
- 5 presented with acute on chronic, 2 patients were elite athletes with severe acute injury, and 37 were chronic (5 lost to follow up)
- Results were rated as poor, fair, good, excellent (good and excellent back to normal ADL's and athletic activity)
- 2.5% poor, 0 fair, 12.8% good, and 84.6% excellent

Tenodesis Procedures

Watson-Jones

- Watson-Jones – brevis used to reconstruct the ATFL; prevents inversion of the foot and restricts subtalar motion
- Persistent subjective instabiltiy 20%-90%



Bahr et al. Biomechanics of Ankle Ligament Reconstruction. An In-Vitro Comparison of the Brostrom Repair, Watson-Jones Reconstruction, and a New Anatomic Reconstruction Technique. AJSM: July/Aug, 1997.

- First cadaveric model that allowed measurement of ligament force and simultaneous joint motion
- 8 cadavers were used and ankles were put through 3 rotations (dorsi-plantar flexion, supination-pronation, and internal-external rotation) and three translations (anterior-posterior, medial-lateral, and joint compression-distraction)
- Force and motion recorded in unloaded and loaded state at dorsiflexion, neutral, plantar flexion, pronation, and supination
- Motion and force recorded during application of anterior translation and during talar tilt
- Testing was performed in specimens with ligaments intact, sectioned ATFL and then sectioned CFL, and then with above mentioned reconstructions

Bahr et al. Biomechanics of Ankle Ligament Reconstruction. An In-Vitro Comparison of the Brostrom Repair, Watson-Jones Reconstruction, and a New Anatomic Reconstruction Technique. AJSM: July/Aug, 1997.

- ATFL stress increased with increasing plantar flexion in compression mode while CFL was unchanged
- 15° of supination increases stress in CFL and posterior grafts, however, different than normal (Watson-Jones was associated with reduction in total joint plantar flexion and internal rotation)
- Anterior translation remained at an increased injury level after Brostrom repair
- No changes in ATFL force in intact and grafts during anterior drawer and talar tilt and there was no difference b/n intact ankle and posterior grafts of any reconstruction during an anterior drawer
- An increase in posterior graft force was seen during talar tilt after Watson-Jones

Bahr et al. Biomechanics of Ankle Ligament Reconstruction. An In-Vitro Comparison of the Brostrom Repair, Watson-Jones Reconstruction, and a New Anatomic Reconstruction Technique. AJSM: July/Aug, 1997.

- All three reconstructions significantly reduced the laxity demonstrated when the ATFL and CFL were sectioned
- Joint motion was restricted after Watson-Jones procedure
- The graft force patterns of the Brostrom and anatomic reconstruction resembled those recorded in normal ankle

Sugimoto et al. Long-Term Results of Watson-Jones Tenodesis of the Ankle. JBJS 80A: November 1998.

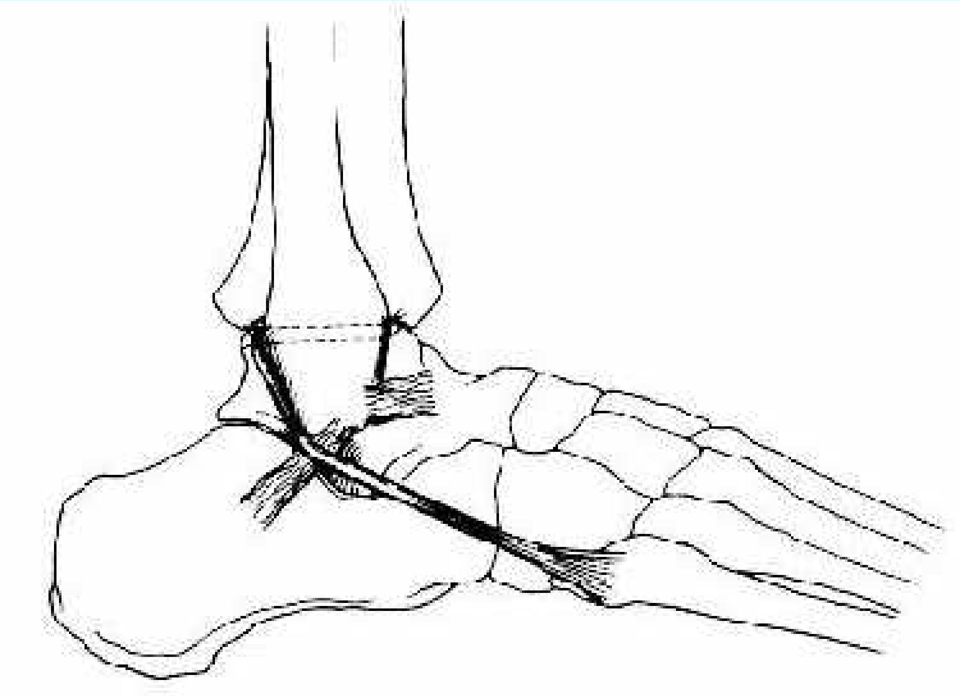
- 34 ankles followed for mean duration of 13 years 8 months
- 27 had manual examination while 6 were phone interviewed
- Pre op were evaluated by rating system of Good et al.
- Post op were evaluated by rating scale of Good et al. and American Orthopaedic Foot and Ankle Society
- Circumference of calf , goniometric measurement of hindfoot and sagittal motion, and manual strength testing to foot eversion were compared

Sugimoto et al. Long-Term Results of Watson-Jones Tenodesis of the Ankle. JBJS 80A: November 1998.

- 19 excellent, 11 good, 3 fair, and one poor
- 9 with mild restriction of sagittal motion
- 14 had mild or moderate restriction of hindfoot and seven had difficulty squatting
- Weakness of peroneals was not detected, however, all but two demonstrated atrophy of calf muscles

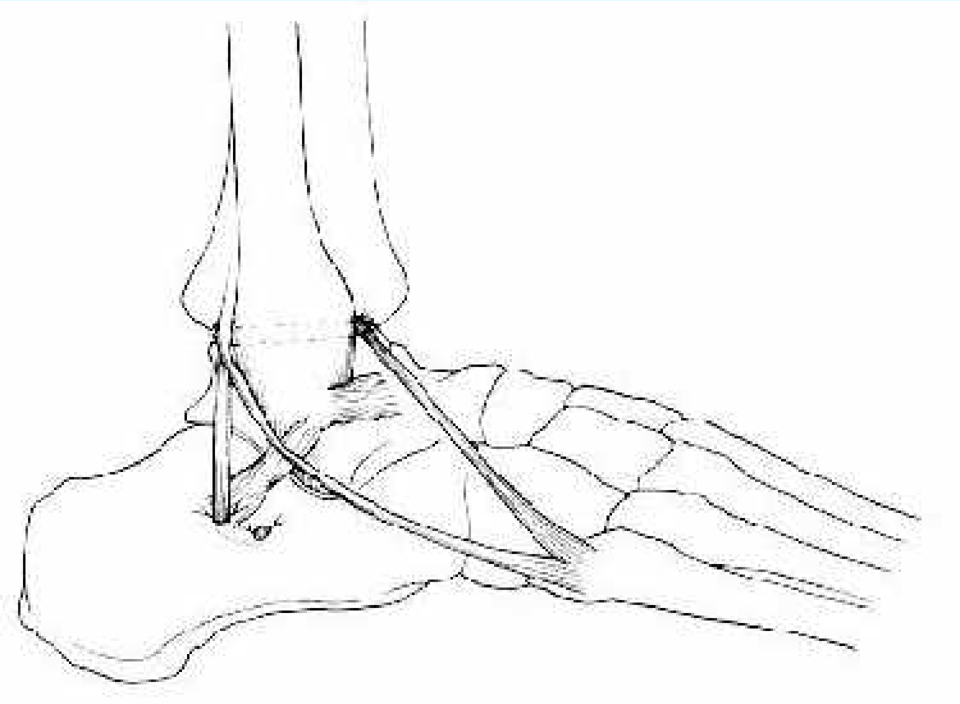
Evans

- Evans – routed brevis into lateral malleolus, prevents inversion and restricts subtalar motion
- Subjective instability 20%-33%
- Persistent anterior drawer is found 45%-60%



Chrisman-Snook

- Chrisman-Snook – split brevis graft (modification of the elmslie) designed to replace both ATFL and CFL and to prevent inversion and anterior translation; restricts subtalar motion
- Subjective instability 13%-30%



Snook et al, Long Term Results of the Chrisman-Snook Operation for Reconstruction of the Lateral Ligaments of the Ankle. JBJS 67-A: Jan. 1985.

- 10 year follow up of 48 of 60 ankles originally performed
- 36 had complete evaluation, 12 had phone conversation
- 4 ratings had to be met : 1) elimination of patient-perceived instability 2)restoration of function, both occupational and recreational 3) maintenance of a near-normal range of motion of the ankle in all directions 4) lack of sensory changes consequent to surgical manipulation of sural nerve
- **Stated loss of < 20 of inversion is not associated with functional limitations, however, reported on 3 patients known to have > 20 loss and limited inversion (not reported as failures in this study)**

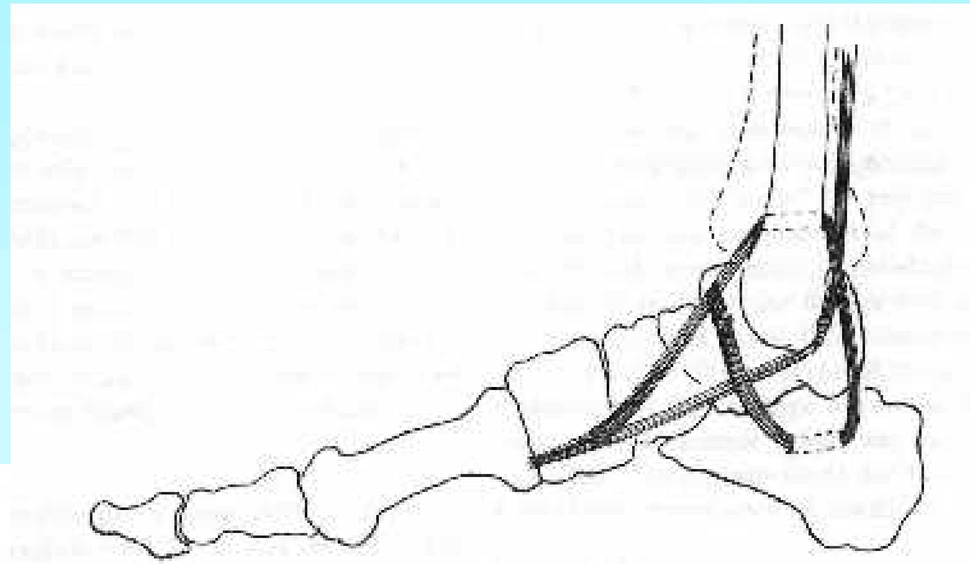
Snook et al, Long Term Results of the Chrisman-Snook Operation for Reconstruction of the Lateral Ligaments of the Ankle. JBJS 67-A: Jan. 1985.

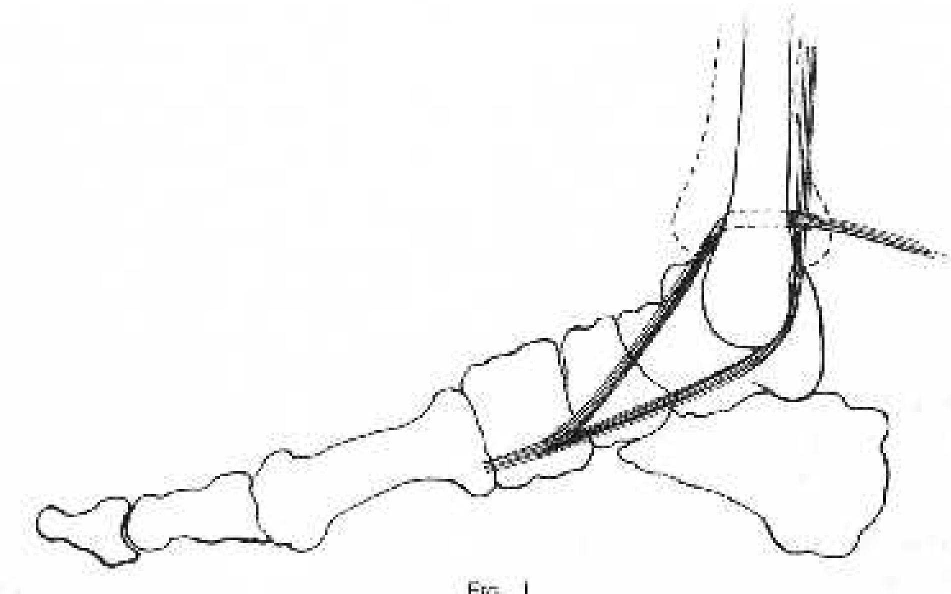
- Original description is to pass graft from anterior to posterior through fibula at the level of the tibiotalar joint
- The graft is then passed distally over the longus and remaining brevis and pulled into a trough in the lateral calcaneus where CFL inserts.
- Original description was to sew back into base of the fifth but now recommends sewing into leading anterior hole of the fibula
- Modifications: 1. Drill hole in calcaneus instead of trap door 2.suture into anterior fibula instead base of fifth 3. ***Mild rather than forced eversion of the foot while graft is sutured in place to eliminate painful limitation of inversion.***

Snook et al, Long Term Results of the Chrisman-Snook Operation for Reconstruction of the Lateral Ligaments of the Ankle. JBJS 67-A: Jan. 1985.

- Results: largest loss in motion was 20° inversion in two patients without functional complaints, 45 ankles had excellent or good results, 3 had unsatisfactory result
- 3 unsatisfactory results were recurrence of lateral ankle instability all secondary to severe injury
- Believe this reconstruction is vital to restore tibiotalar and subtalar stability (referenced that the Brostrom repair only fixes the ATFL and most people with chronic instability have both ATFL and CFL tears)

Snook et al, Long Term Results of the Chrisman-Snook Operation for Reconstruction of the Lateral Ligaments of the Ankle. JBJS 67-A: Jan. 1985.





Modified Chrisman-Snook Procedure

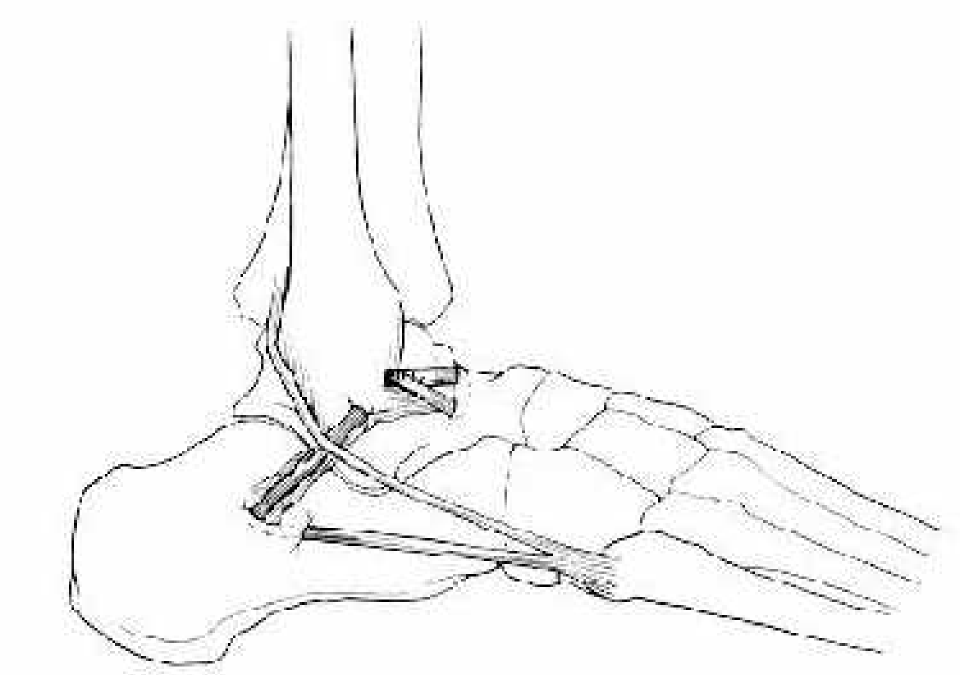
- Used in generalized ligamentous laxity, failed imbrication or tenodesis or in athletes with long history of laxity(>10 years of instability)
- Long lateral incision 11 cm proximal curving at the tip of fibula and ending in the vicinity of the calcaneocuboid joint
- The peroneal retinaculum is split except for the superior part in line with the incision
- Arthrotomy is made just proximal to the superior border of the ATFL
- The peroneal sheath is opened distal to fibula to prepare the tendons for transfer
- Subperiosteal dissect deep to peroneal tendons to locate calcaneal drill hole site
- Harvest half of brevis starting distally and ending proximal 2-3 cm

Modified Chrisman-Snook Procedure

- First drill hole is placed in lateral neck of talus and the second is in the distal anterior fibula directing this anterior to posterior at level of tibiotalar joint
- The third hole goes from the posterior fibula to the anterior distal fibula near the tip where the CFL originates
- The final two holes are made in the calcaneus to replicate insertion of the CFL
- The graft starts in talus to fibula anterior to posterior then back into fibula and into calcaneus
- ***No anterior directed force or eversion*** and sew old ATFL to grafts

Colville

- Split brevis graft that is used to anatomically reconstruct the CFL and the ATFL
- Easy to harvest, good biomechanical testing
- Bigger incision than Brostrom and may therefore have slightly higher nerve complication



Colville et al. Reconstruction of the lateral ankle ligament. A biomechanical analysis. AJSM; 20(5). 1992.

- Cadaveric analysis on 15 ankles comparing the Evans, Chrisman-Snook, Watson-Jones, and a new anatomic repair
- Believe that symptoms are a result of excessive anterior talar translocation, internal rotation, and talar tilt.
- The above and subtalar motion were evaluated and compared.
- Isometry of bone tunnels were compared from 20° dorsiflexion to 30° plantarflexion
- All grafts were tensioned with the ankle in eversion and neutral dorsi/plantar flexion

Colville et al. Reconstruction of the lateral ankle ligament. A biomechanical analysis. AJSM; 20(5). 1992.

Isometry

- ***Evans*** - 5% decrease change of graft.
- ***Watson-Jones*** – graft from fifth meta. to posterior fibula decreased 5% while graft from anterior fibula to talus increased 17%.
- ***Chrisman-Snook*** – graft from base of fifth to anterior fibula increased 15% while graft posterior fibula to calcaneus decreased 24%.
- ***Anatomic*** – graft from anterior fibula to talus increased 6% while graft from posterior fibula to calcaneus decreased 10%.

Colville et al. Reconstruction of the lateral ankle ligament. A biomechanical analysis. AJSM: 20(5), 1992.

Biomechanical Testing

- Watson-Jones and anatomic repair had limitation of internal rotation while C-S and Evans displayed a lack of restricting internal rotation
- C-S and Evans allowed significant greater anterior translocation, while W-J and anatomic were similar to intact ligaments
- Talar tilt was significantly greater with the W-J and Evans while C-S and anatomic were similar to each other and similar to intact ligaments
- Anatomic repair allowed statistically similar subtalar motion compared to intact ligaments, **while all three tenodesis reconstructions significantly had decreased subtalar motion compared to normal.**

Colville et al. Reconstruction of the lateral ankle ligament. A biomechanical analysis. AJSM; 20(5). 1992.

- Evans: restored internal rotation however anterior translocation and tilt were poorly controlled and subtalar motion was restricted
- Chrisman-Snook: did well especially with limiting the talar tilt, but restricted subtalar motion
- Watson-Jones: most effective in reducing anterior translocation and internal rotation, however had significant increase in talar tilt and restricted subtalar motion
- Anatomic: mechanics were restored most closely and subtalar motion was not limited

Burk and Morgan

- Anatomical reconstruction with graft material (autograft or allograft)
- Good biomechanical testing
- Again bigger incision

Anderson

- Plantaris tendon is used and routed medial to lateral through the calcaneus and used to reconstruct both the CFL and the ATFL
- Good reconstruction, bad for harvesting