Ankle Injuries

Mary Lloyd Ireland, M.D.

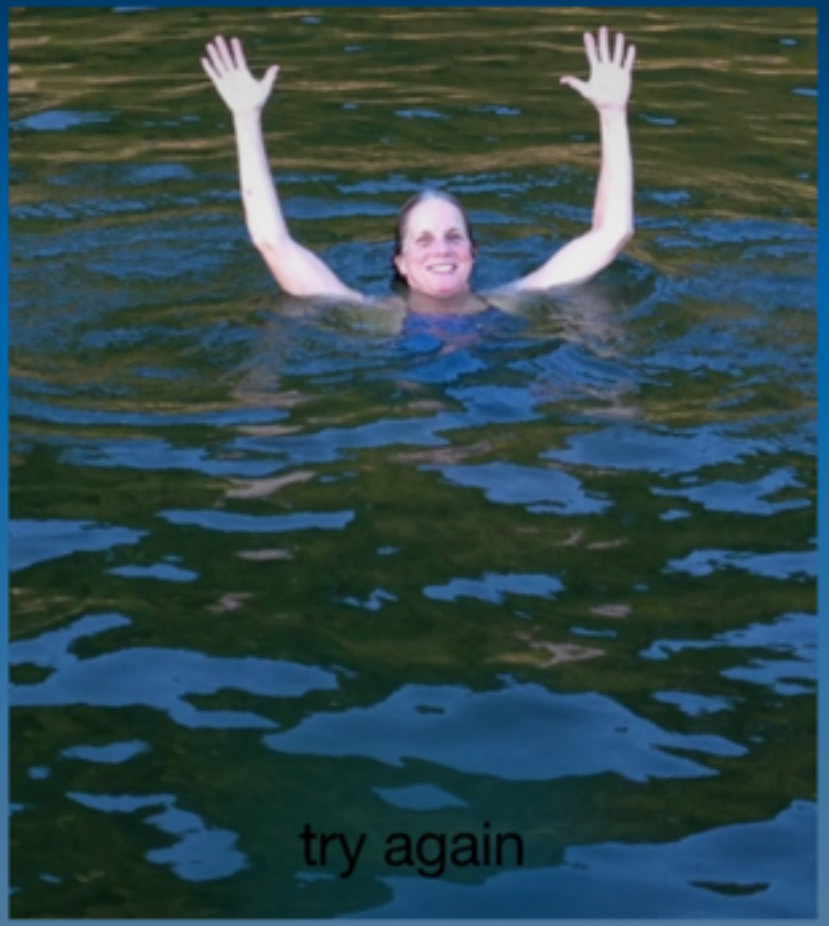
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MEDICAL COLLEGE OF WISCONSIN

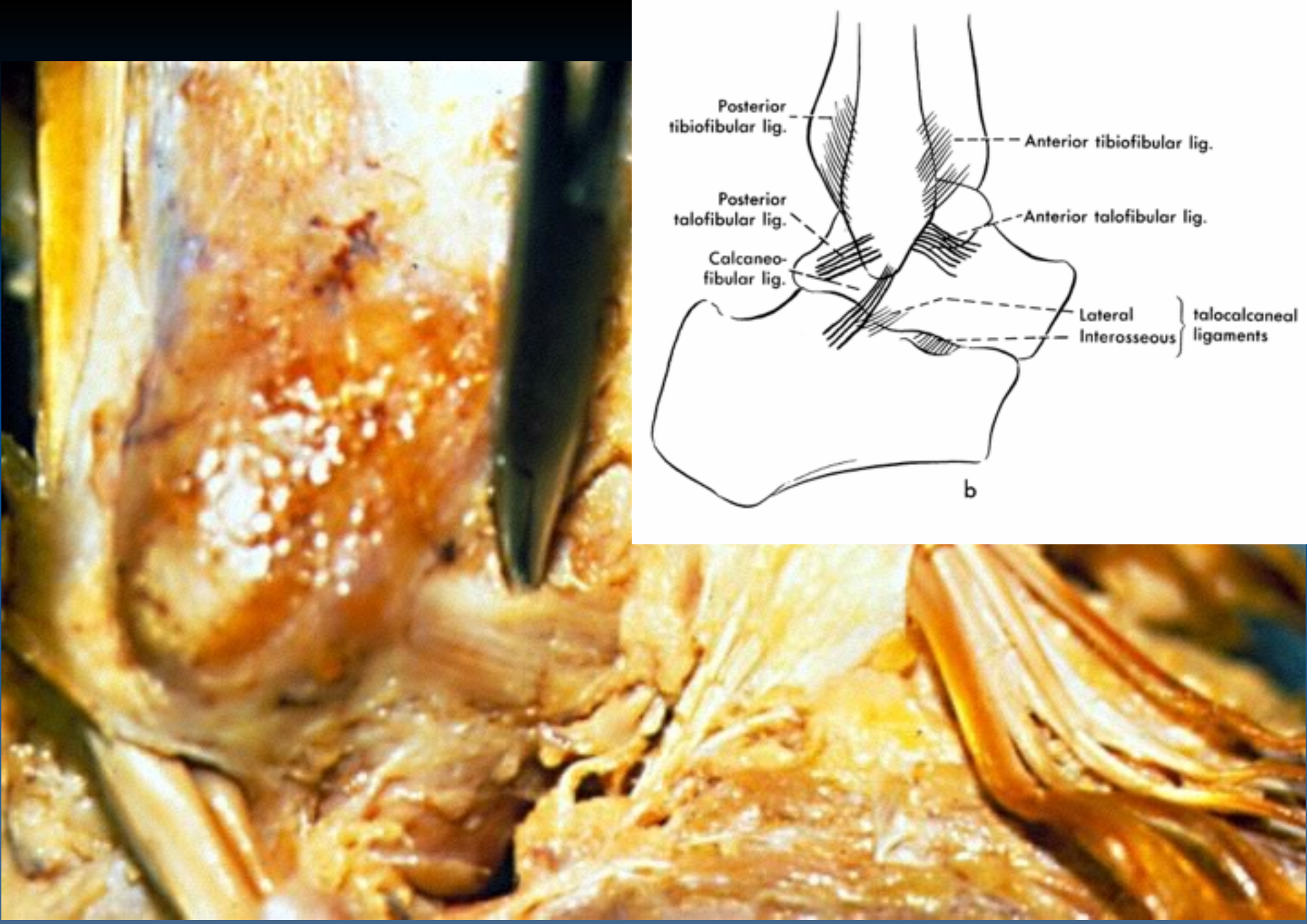
27th Annual
MEDICAL COLLEGE OF WISCONSIN
SPORTS MEDICINE SYMPOSIUM
March 19 & 20, 2015

I have nothing to disclose



Ankle: Modified Hinge Joint

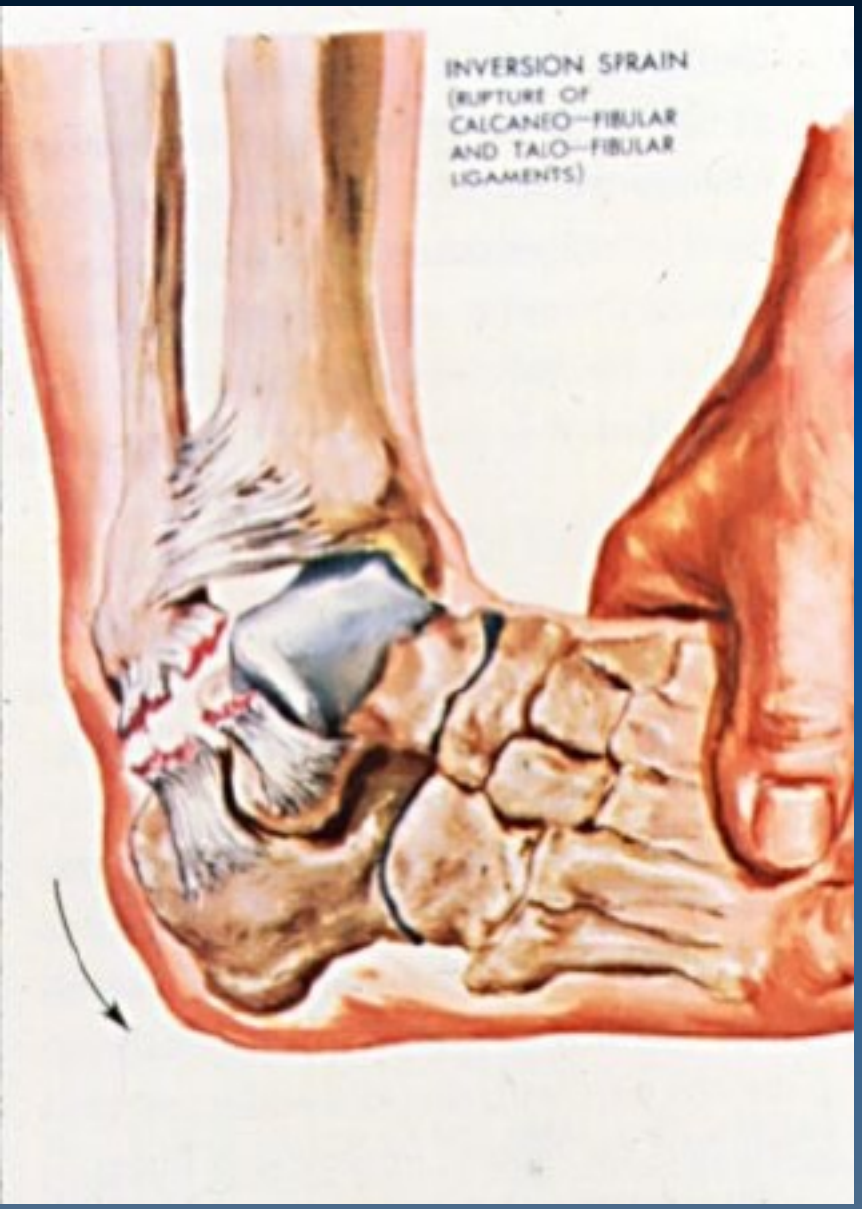
- Bony configuration
  - Mortise
  - Circular Pretzel
- Ligamentous stability
  - ATF and CF laterally
  - Deltoid superficial and deep medially
  - Syndesmosis superiorly


Posterior tibiofibular lig.
Anterior tibiofibular lig.
Posterior talofibular lig.
Anterior talofibular lig.
Calcaneo-fibular lig.
Lateral
Interosseous
talocalcaneal ligaments
b

Lateral Ligaments

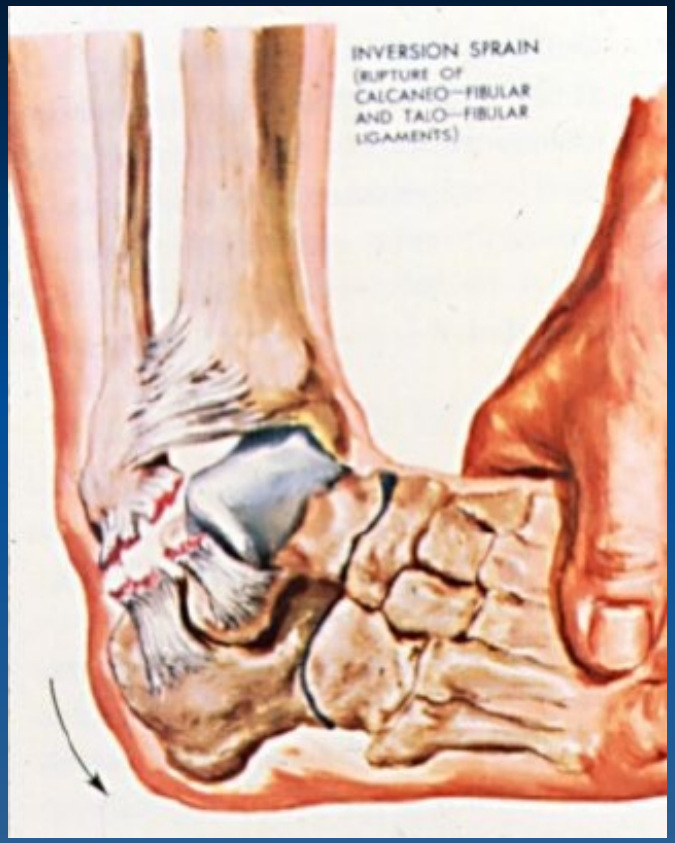
- Anterior Talofibular
- Calcaneofibular
- Posterior Talofibular




INVERSION SPRAIN
(RUPTURE OF
CALCANEO—FIBULAR
AND TALO—FIBULAR
LIGAMENTS)



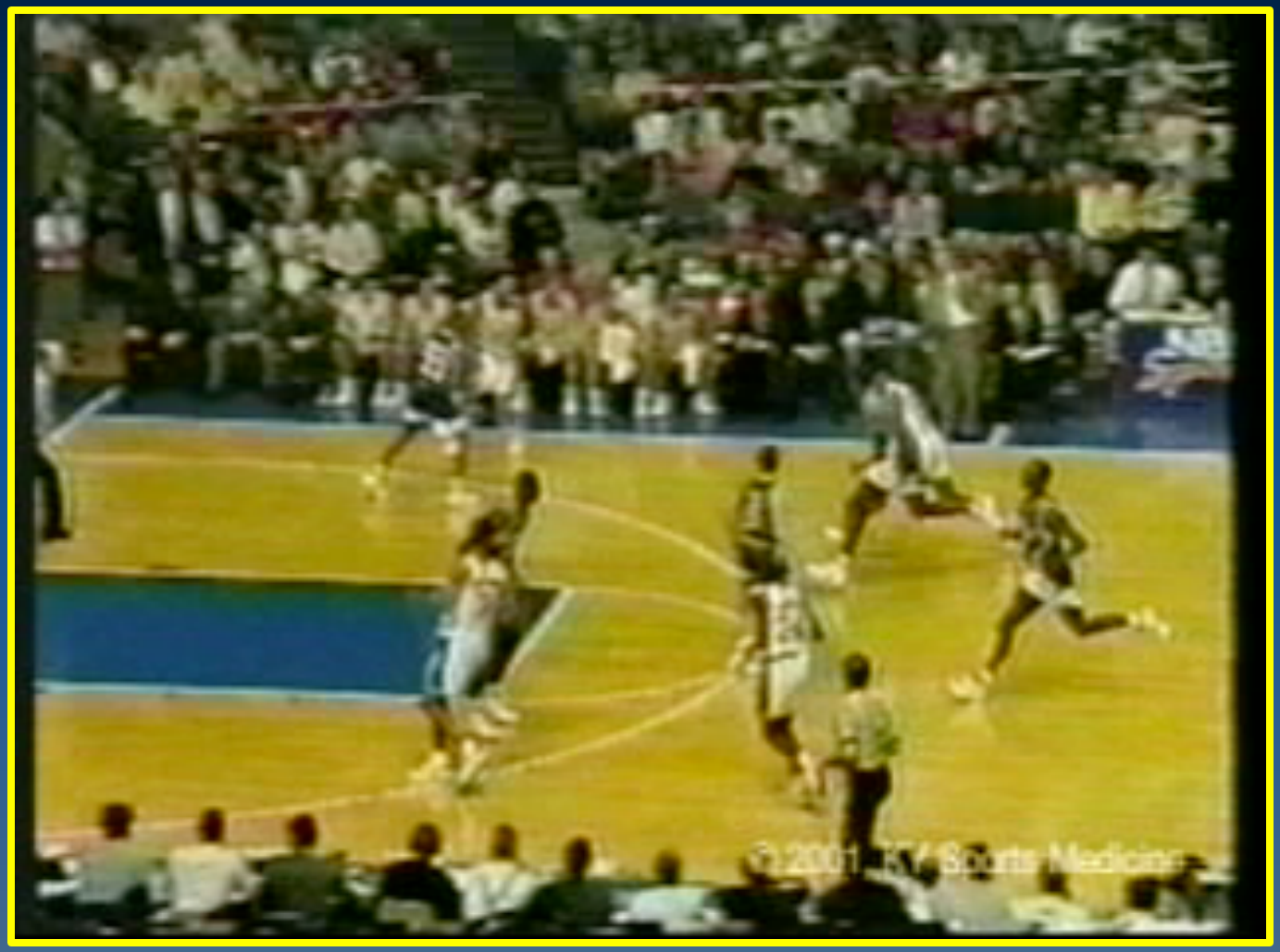



INVERSION SPRAIN
(RUPTURE OF
CALCANEO—FIBULAR
AND TALO—FIBULAR
LIGAMENTS)





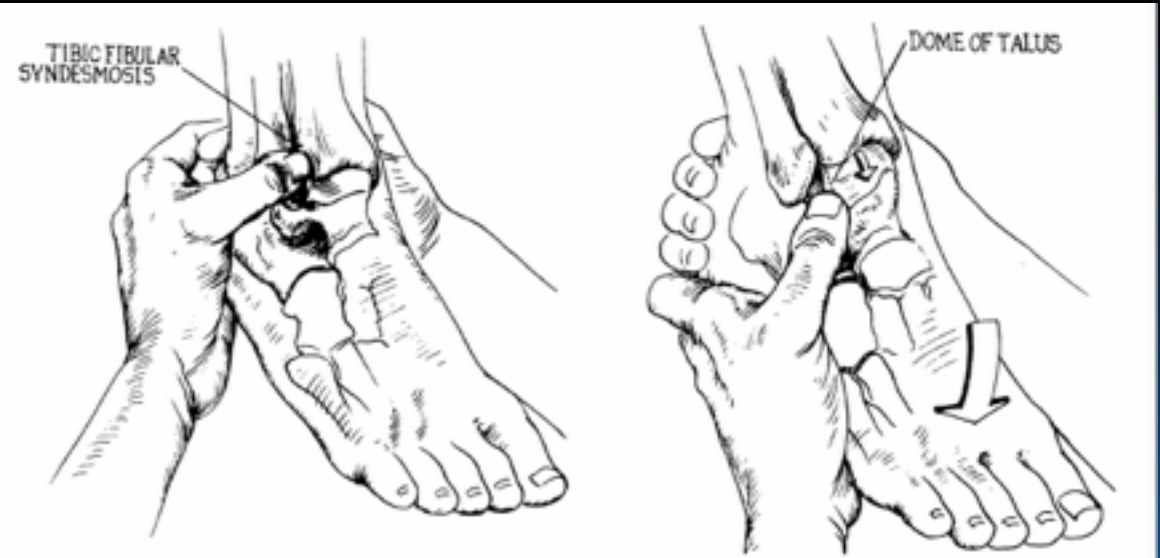
Basketball Injury Mechanism



Summary of Findings From the National Collegiate Athletic Association Injury Surveillance System on Foot and Ankle Injury.*

Sport	Game Injuries Relating to the Ankle (%)	Game Injuries Relating to the Foot (%)
Men's baseball	7.4	0
Women's softball	10.3	0
Men's basketball	26.2	2.6
Women's basketball	24.6	2.4
Men's football	15.6	1.1
Men's lacrosse	11.3	0
Women's lacrosse	22.6	1.3
Men's soccer	18.8	4.2
Women's soccer	19.4	2.7

*in Anderson, RB, Hunt KJ, McCormick JJk, "Management of Common Sports-Related Injuries About the Foot and Ankle," JAAOS Sept. 2010, Vol. 18, No 9, 546-556. Table 1, p. 547.



Figs. 20, 21. Palpation of the lateral edge of the dome of the talus (anterolateral portion). Plantar flexion of the foot exposes a larger surface of the talar dome.

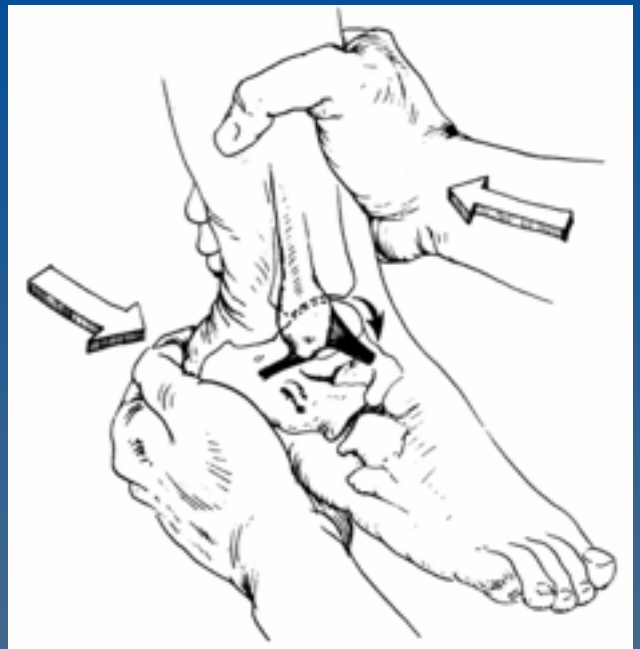


Fig. 61. The anterior draw sign test to evaluate the intactness of the anterior talofibular ligament.

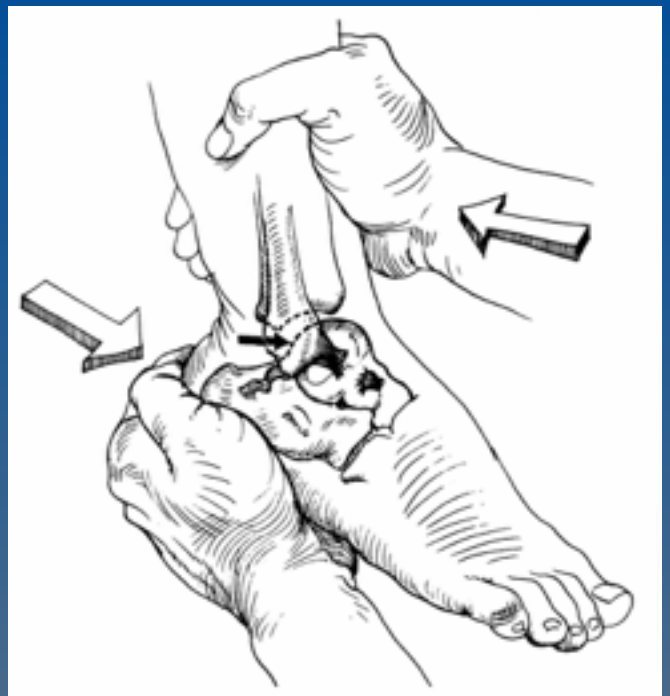


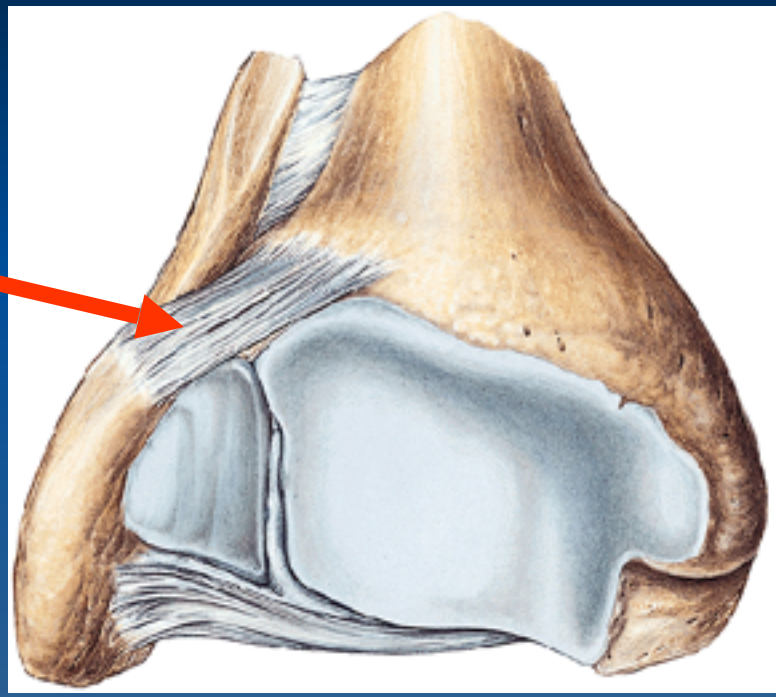
Fig. 62. A positive anterior draw sign.

EUA Gross instability, right ankle



Tibiofibular Ligament

- Dense fibrous structure maintaining ankle mortise (tibiofibular articulation)
- Source of "high ankle sprain"
- Prolonged morbidity!
- Injury occurs from eversion, especially with the foot dorsiflexed
- 1 mm lateral shift of talus within mortise reduces contact area 42%



Medial (Deltoid) Ligament

- Superficial & deep component; functions as single structure
- Primary resistance to eversion



Medial (Deltoid) Ligament

- Superficial deltoid fans out from the medial malleolus to insert on the:
  - Talus posteriorly
  - Calcaneus medially
  - Navicular anteriorly
- Deep deltoid ligament
  - Anterior fibers insert on the neck of the talus
  - Posterior fibers insert on the posterior medial tubercle of the talus

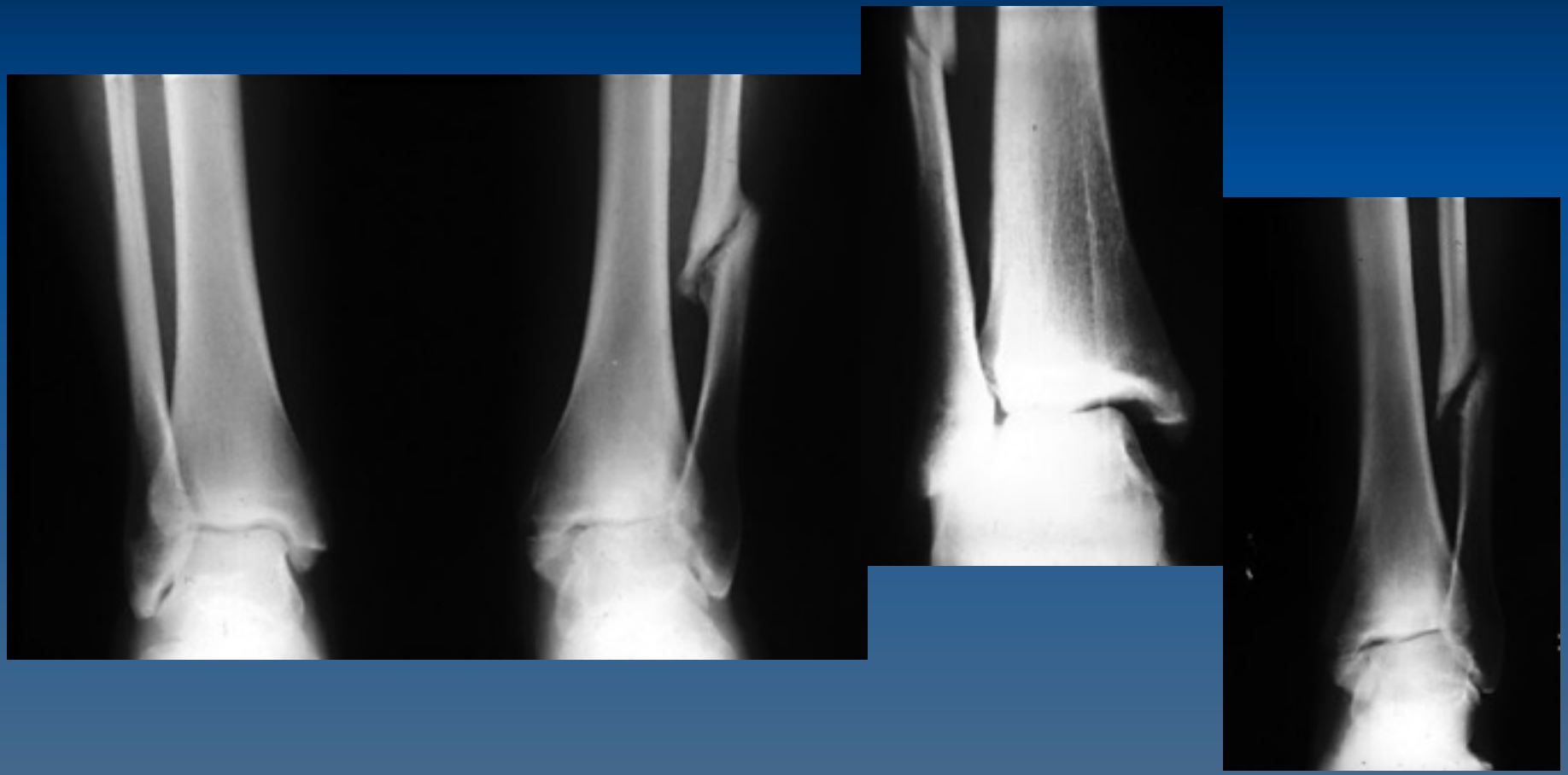


Physical Exam of the Foot and Ankle

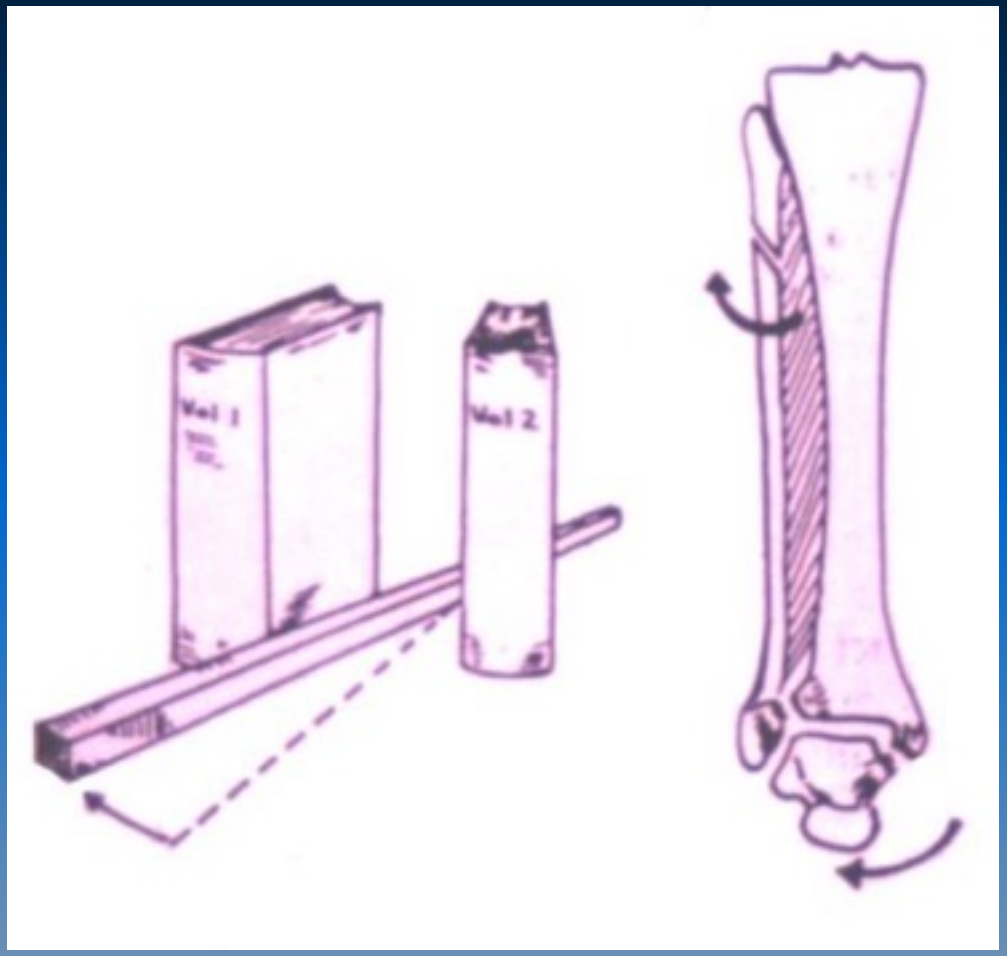


Maissoneuve fracture

Unstable mortise
Don’t miss this injury
Results in fibular nonunion and severe tibiotalar osteoarthritis



Fractures





Maisonneuve Fracture

Figure 4—*The mechanism of the supination-internal rotation injury to the ankle.*

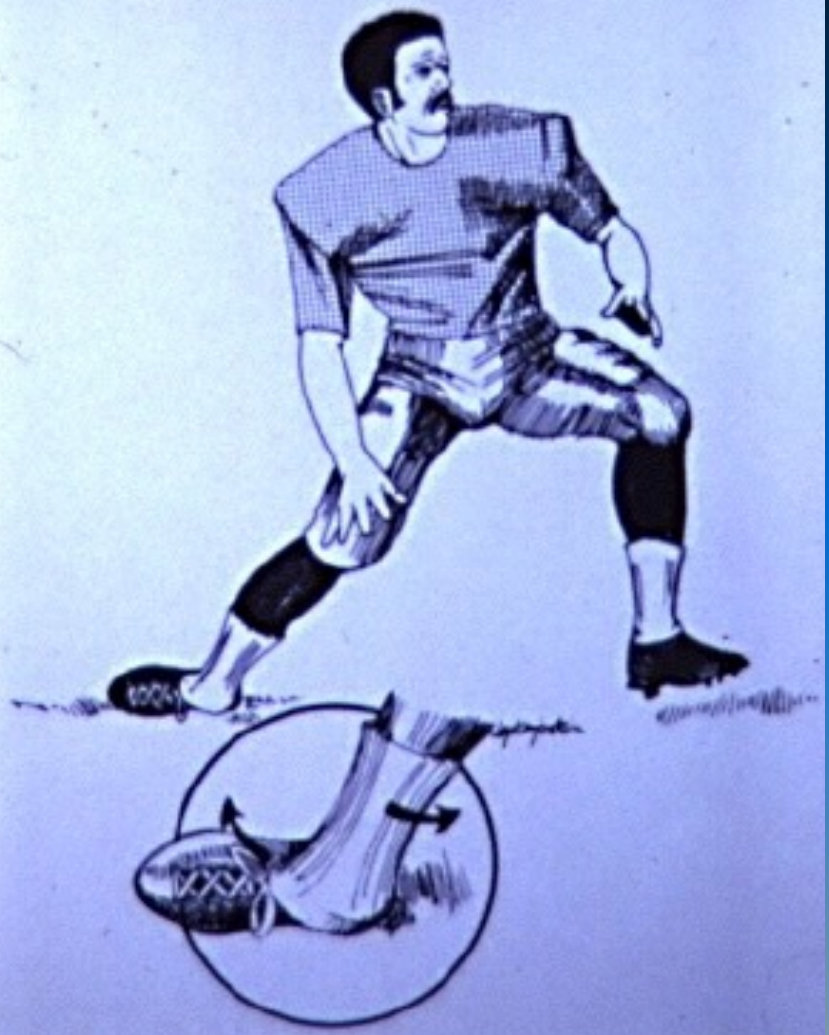
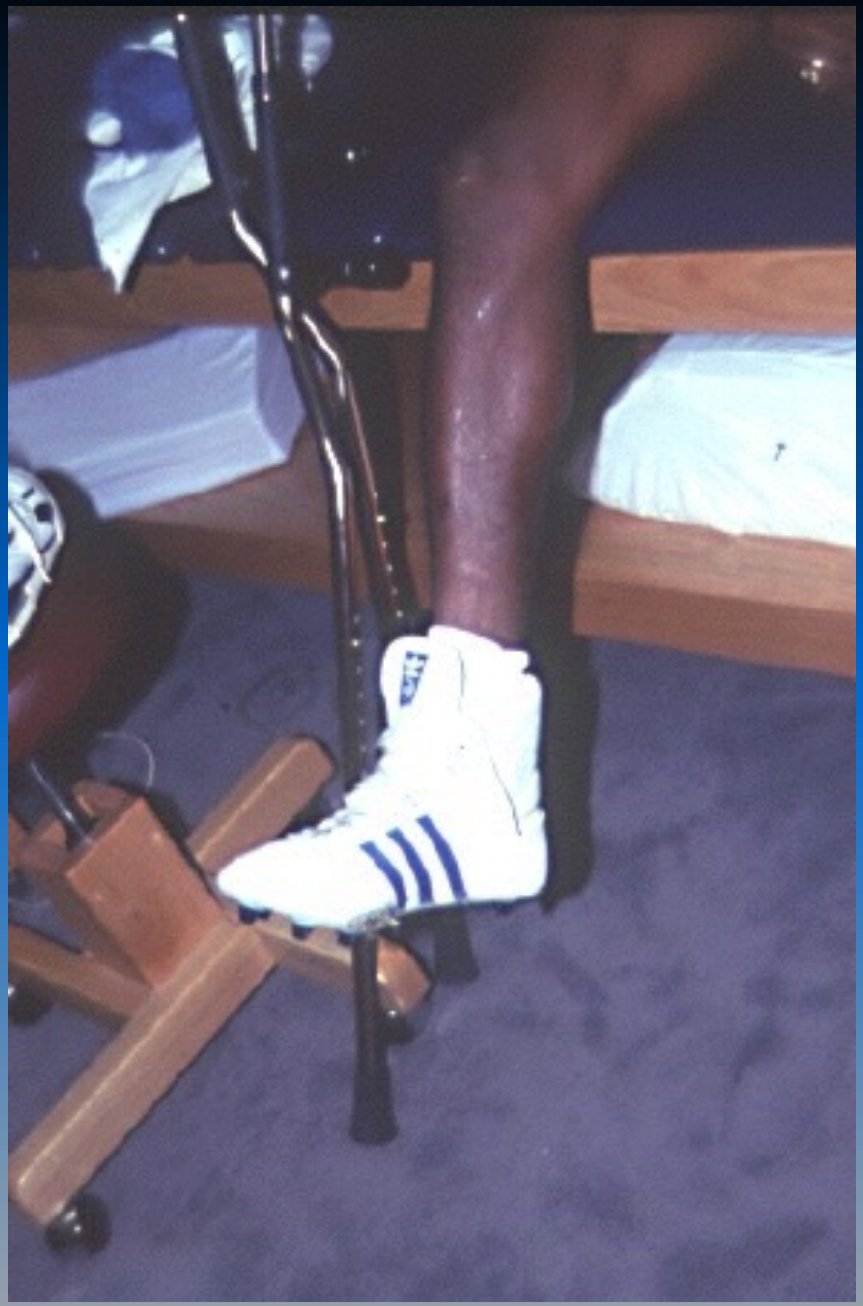


Figure 5—*The mechanism of the pronation external rotation injury to the ankle*







Don’t miss an acute syndesmosis injury

Stress views external rotation and eversion

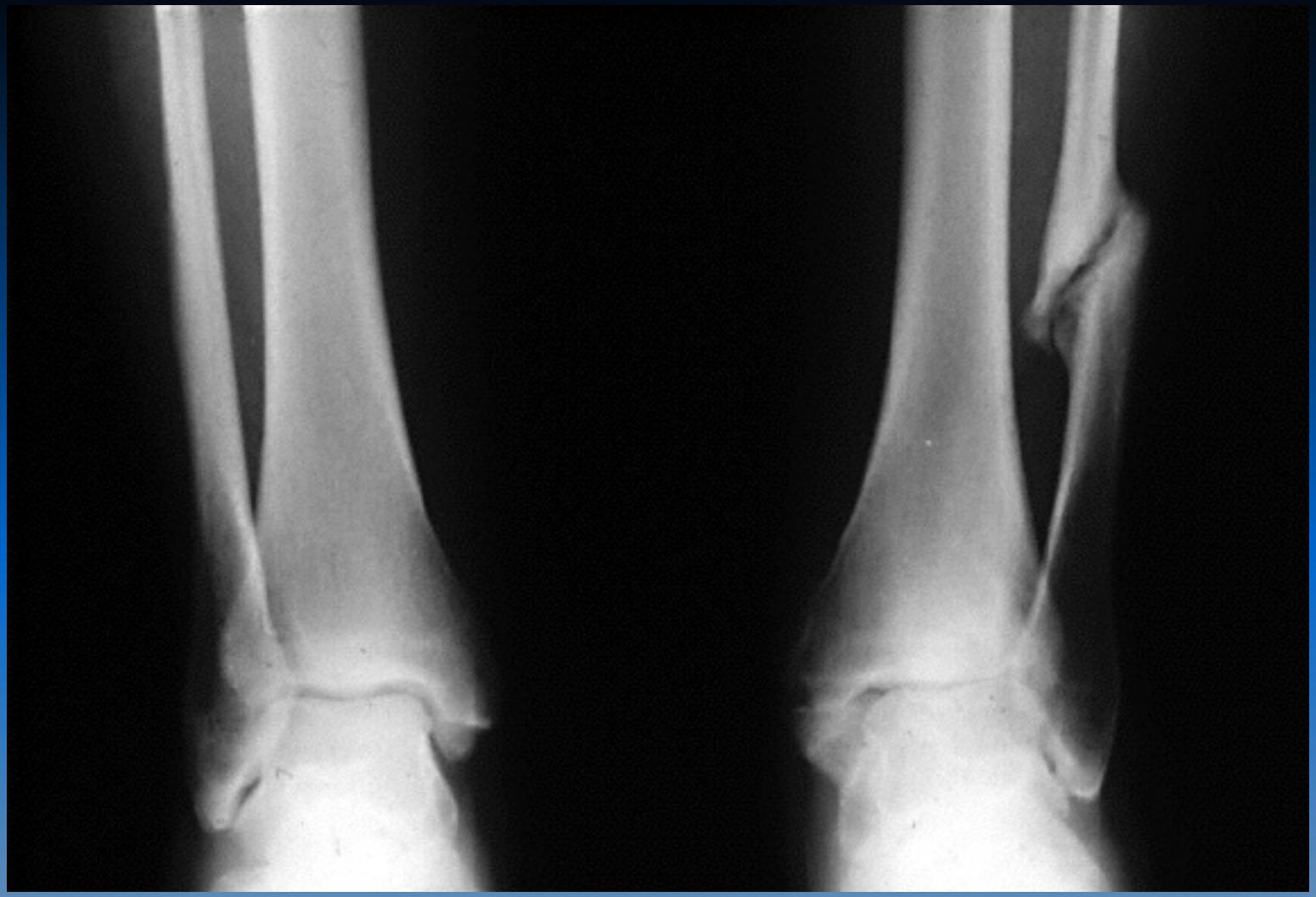


Stabilize the mortise



Ectopic Bone off tibia indicates repetitive syndesmostic stresses.





Non-treated Maisonneuve fracture rapid progression DJD non-union fibula



How I Treat. . .

- Control swelling
- Brace
- Acutely and during the entire season
- Proprioception
- Core
- Prevent recurrent sprains
- ? Ankle sprain preventable ?

Can we prevent ankle sprain?

Even this simple question –
Unknown by evidence-based studies.

Prevent – not proven, but we can lessen severity . . . Maybe!

Bahr R. "Can we prevent ankle sprains?" In: MacAuley D, Best T, Evidence-Based Sports Medicine. London: BMJ Publishing Company, 2002, p. 481.

Bahr R. "Can we prevent ankle sprains?" In: MacAuley D, Best T, Evidence-Based Sports Medicine. London: BMJ Publishing Company, 2002, p. 484.

Yes, maybe, but . . .

Assess the study critically.
Large-scale randomized trials
Prior history of ankle sprains
Unit of analysis: Ankles, not players

Ankle injury prevention programs

Table 25.1. Ankle injury prevention studies. The table shows all papers included in the present review, and whether they were identified in the current search or from review papers published within the previous five years (1999-2001). Evaluation scores from previous reviews are shown where available.

Study	Year	Study design	Current search	Evaluation scores in previous review papers					
				Verhagen 2000[8] (max. 14)	Quinn *et al* 2000[9] (max. 33)	Thacker *et al* 1999[10] (max. 100)	Hume & Gerrard 1998[11]	Robbins & Waked 1998[12]	Callaghan 1997[13]
Schumacher *et al*[30]	2000	Retrospective cohort	X						
Holme *et al*[28]	1999	RCT	X¤						
Amoroso *et al*[26]	1998	RCT	X	10	15*				
Bahr *et al*[25]	1997	Prospective cohort	X	9		32			
Sharpe *et al*[24]	1997	Retrospective cohort					x		
Wester *et al*[23]	1996	RCT	X						
Sitler *et al*[22]	1994	RCT	X	13	24	60	x		x
Surve *et al*[21]	1994	RCT	X	9	17	39	x	x	x
Barrett *et al*[20]	1993	RCT	X	13	19	68			
Rovere *et al*[19]	1988	Retrospective cohort	X	9		48	x	x	x
Tropp *et al*[18]	1985	RCT (of teams)	X	9	16	31	x	x	x
Ekstrand *et al*[17]	1983	RCT (of teams)				45	x		
Cameron[16]	1973	Prospective cohort				11			
Garrick & Requa[15]	1973	RCT	X	10		23	x	x	x
Simon[14]	1969	RCT				40			

*Referred to in abstract form as Ryan *et al* 1994[27] ¤Also published in Danish as Barkler *et al* (2001)[29]

Bahr, Roald, "Can We Prevent Ankle Sprains?, Chapter 25 in MacAuley D and Best T, *Evidence-based Sports Medicine* (London: BMJ Books, 2002), Table 25.1, p. 472.

Key Messages

- The preventive effects of taping and bracing have been clearly documented, although the evidence is more convincing for players with previous ankle injury than for healthy athletes.

Bahr R. "Can we prevent ankle sprains?" In: MacAuley D, Best T, Evidence-Based Sports Medicine. London: BMJ Publishing Company, 2002, p. 484.

Key Messages

- Although there are some indications that braces seem to be more effective in preventing ankle sprains than tape, this has not been clearly documented.

Bahr R. "Can we prevent ankle sprains?" In: MacAuley D, Best T, Evidence-Based Sports Medicine. London: BMJ Publishing Company, 2002, p. 484.

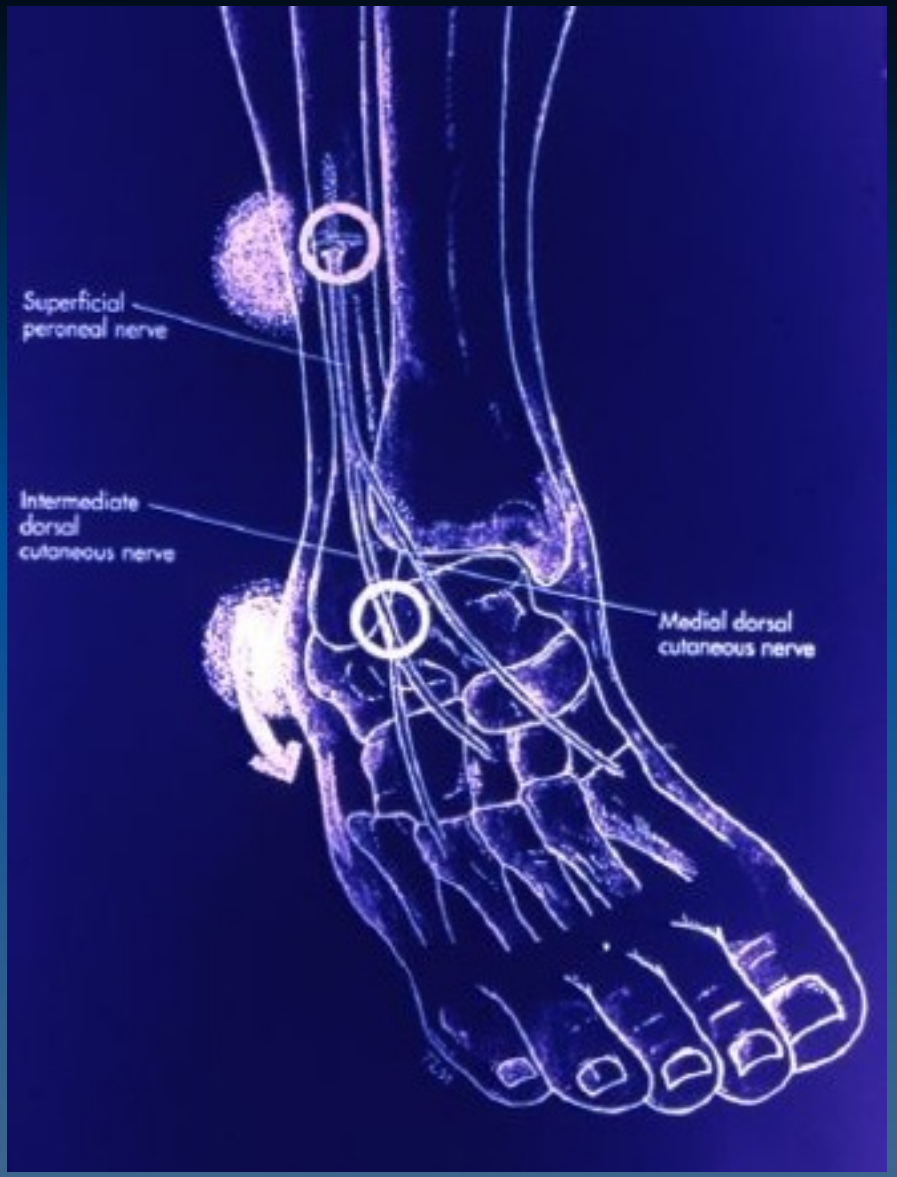
Key Messages

- The efficacy of wearing high-top shoes is unclear.

- There is some evidence that balance training reduces the risk of ankle sprains in athletes with previous injury.

Bahr R. "Can we prevent ankle sprains?" In: MacAuley D, Best T, Evidence-Based Sports Medicine. London: BMJ Publishing Company, 2002, p. 484.




Superficial peroneal nerve
Intermediate dorsal cutaneous nerve
Medial dorsal cutaneous nerve

Basketball athlete
EUA prior to lateral ankle reconstruction



Renström, Per and Kannus, Pekka, "Management of Ankle Sprains," Operative Techniques in Sports Medicine (Vol. 2, No. 1, January, 1994), pp. 58-70. Figure 2.

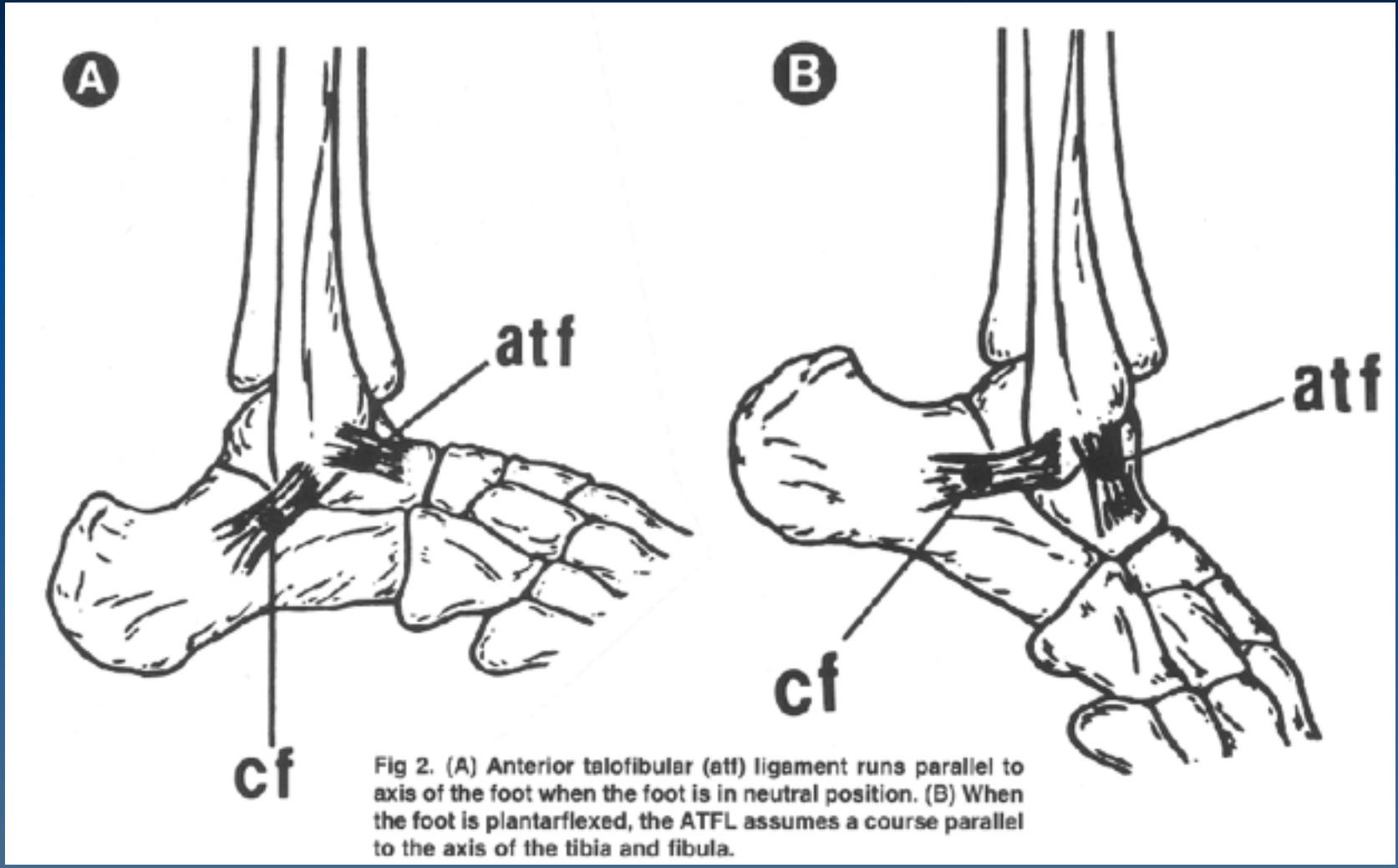


Fig 2. (A) Anterior talofibular (atf) ligament runs parallel to axis of the foot when the foot is in neutral position. (B) When the foot is plantarflexed, the ATFL assumes a course parallel to the axis of the tibia and fibula.

Renström, Per and Kannus, Pekka, "Management of Ankle Sprains," Operative Techniques in Sports Medicine (Vol. 2, No. 1, January, 1994), pp. 58-70. Figure 12.

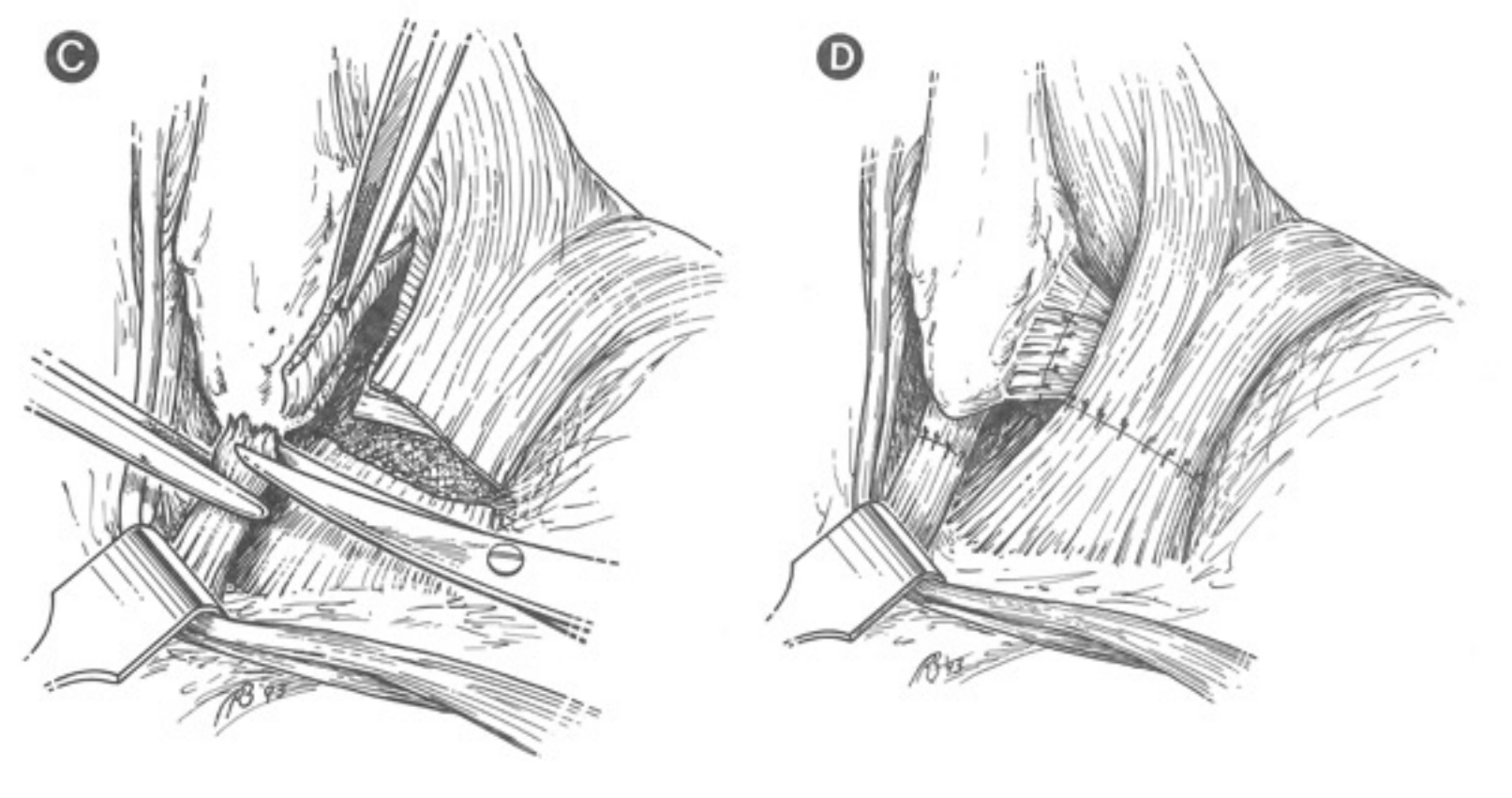


Fig. 12. Modified Broström technique.

(C) Trimming of stretched CFL
(D) Shortening and reattachment of attenuated ATFL and CFL.

Renström, Per and Kannus, Pekka, "Management of Ankle Sprains," Operative Techniques in Sports Medicine (Vol. 2, No. 1, January, 1994), pp. 58-70. Figure 9.

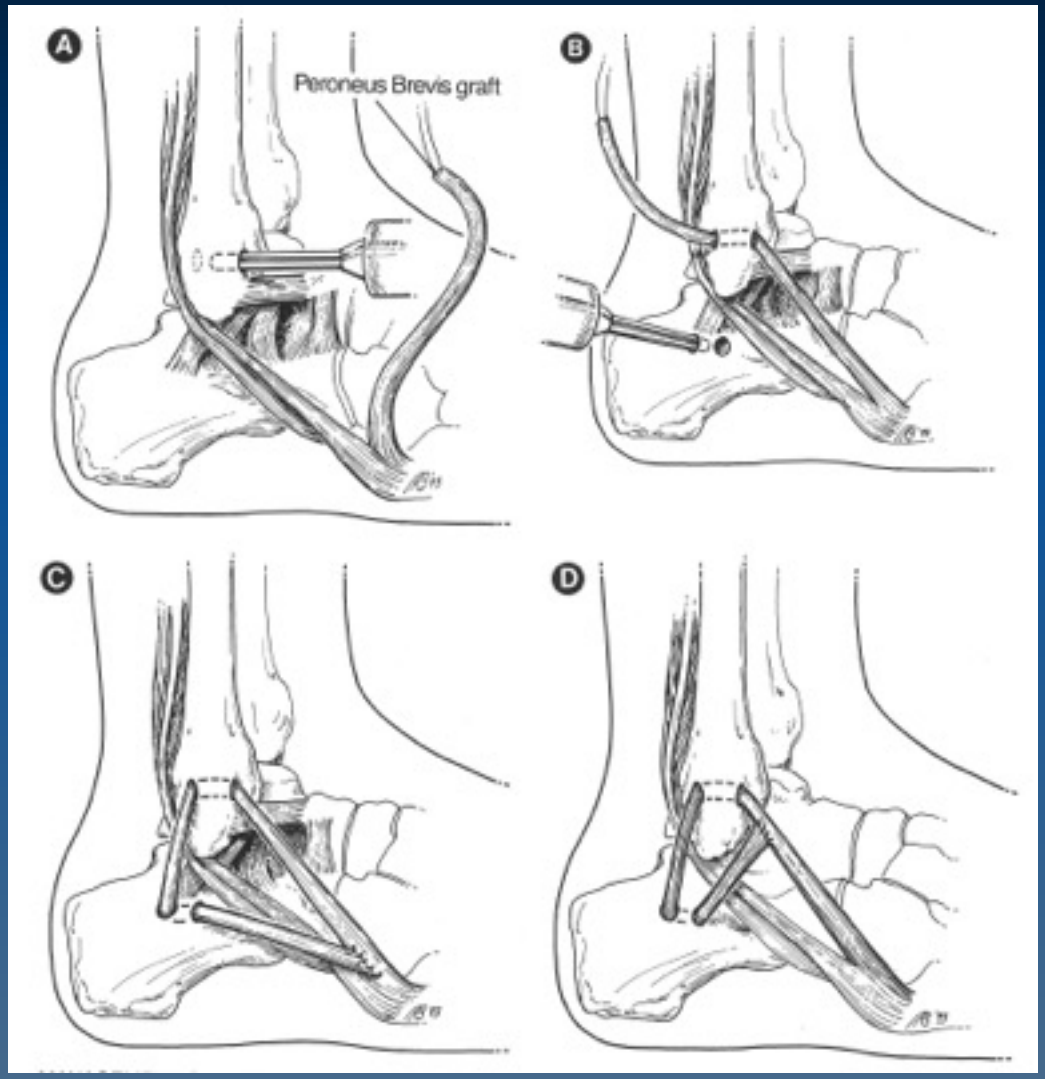


Fig. 9. Chrisman-Snook procedure (modified Elmslie).
(A) Split of peroneus brevis tendon.
(B) Mobilized half of peroneus tendon threaded through anterior talocalcaneal ligament (held by sutures) and then through hole in fibula.
(C) Completed reconstruction.
(D) Modification of original operation . . .

LATERAL ANKLE PAIN

- Sprain ATF and/or CF
- Sinus Tarsi Syndrome
- Subtalar Joint
- Arthrosis Fracture
- Cuboid Subluxation
- Peroneal Dysfunction

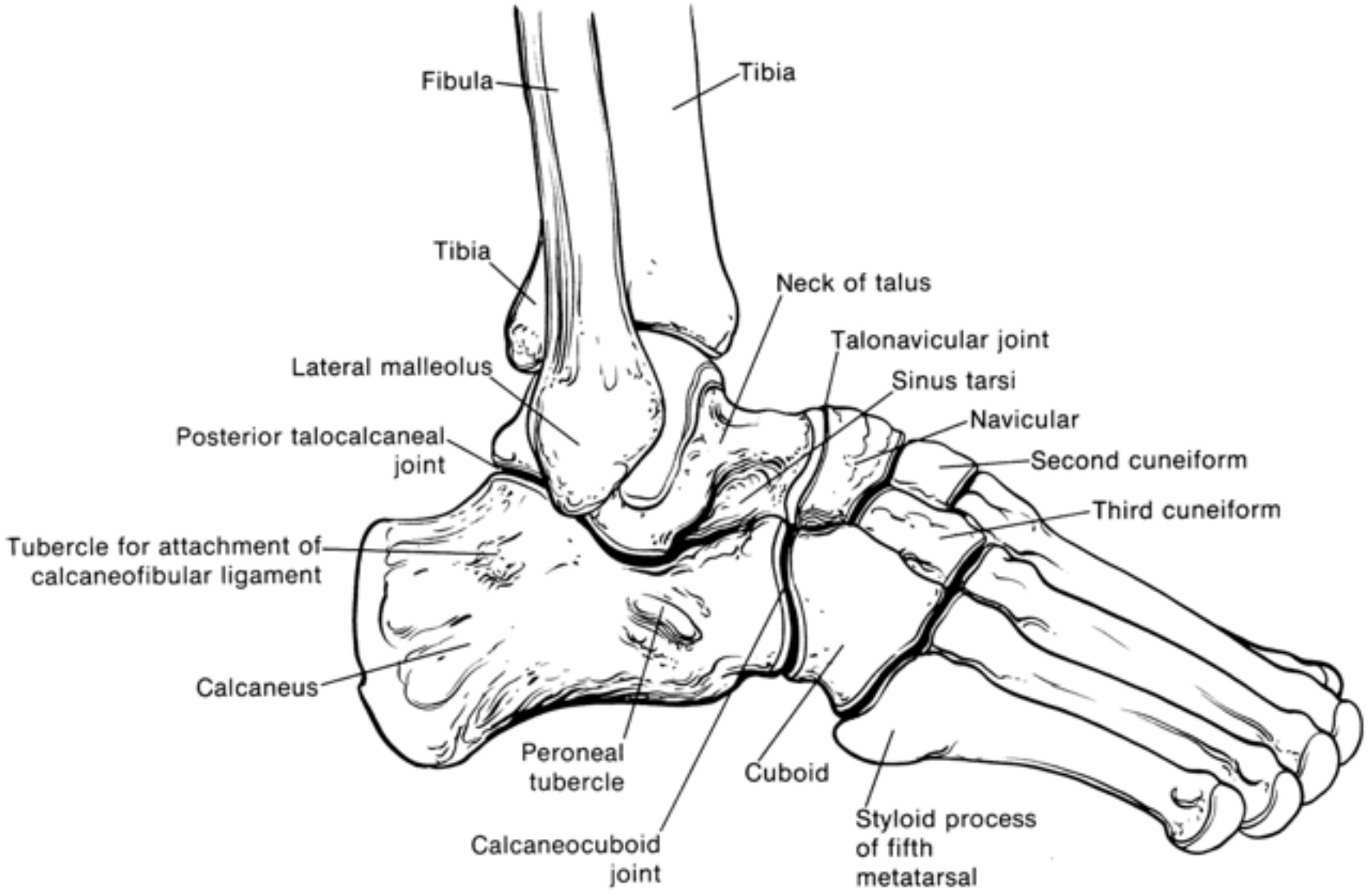


FIG. 11-61. Osteology of the lateral side of the foot and ankle.

Physical Exam of the Foot and Ankle



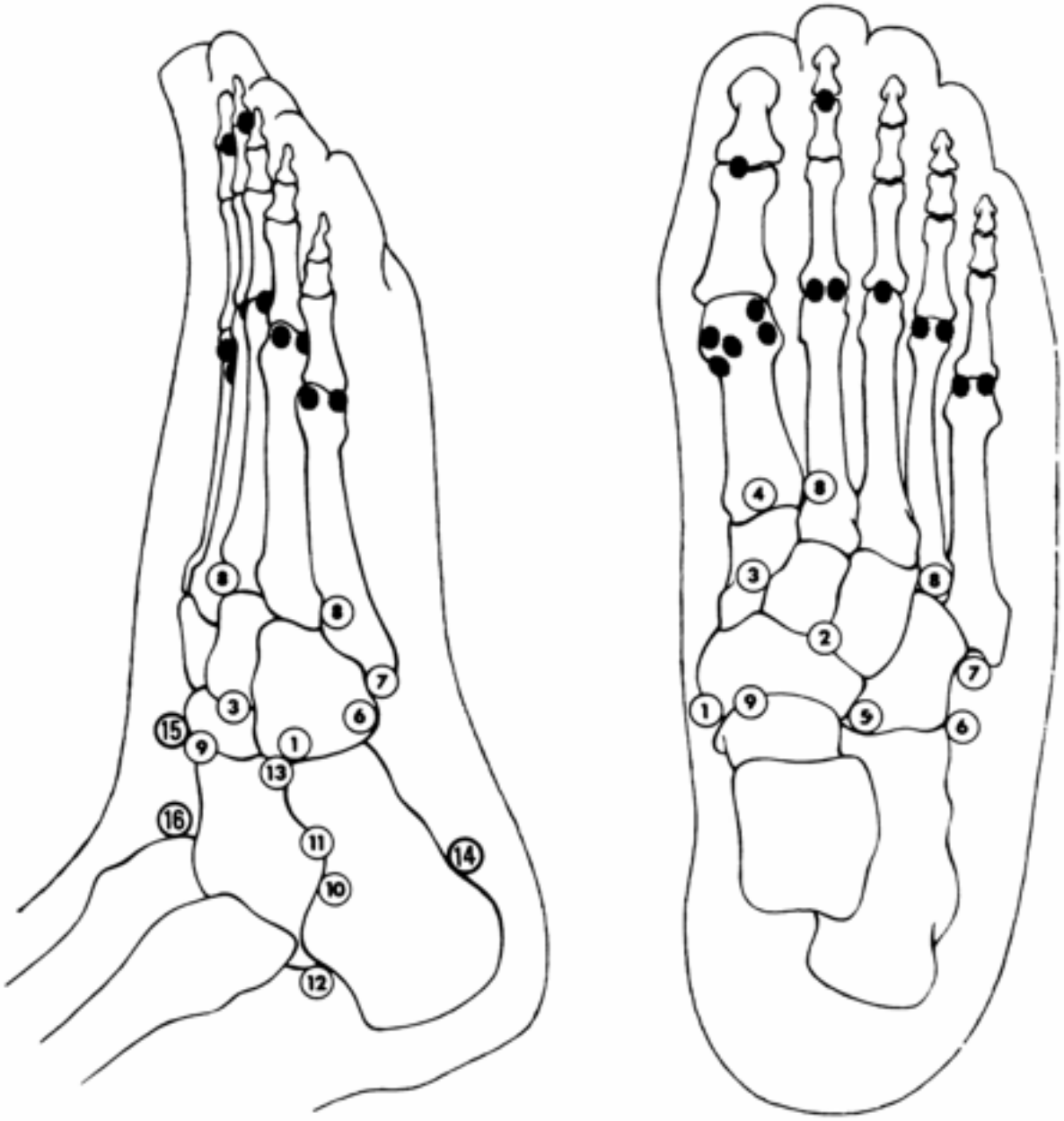


Fig. 19-25. Lateral (*left*) and anteroposterior (*right*) drawings of the foot indicating the location of the commonly found accessory bones (*circles with numbers*) and forefoot sesamoids (*shaded circles*). (1) Os tibiale externum, (2) processus uncinatus, (3) os intercuneiforme, (4) pars peronea metatarsalia 1, (5) cuboides secundarium, (6) os peroneum, (7) os vesalianum, (8) os intermetatarseum, (9) os supratalare, (10) talus accessories, (11) os sustentaculum, (12) os trigonum, (13) calcaneus secundarium, (14) os subcalcis, (15) os supranaviculare, (16) os talotibiale. (Keats, T. E., An Atlas of Normal Roentgen Variants That May Simulate Disease, 2nd ed., p. 371. Chicago, Year Book Medical Publishers, 1979.)





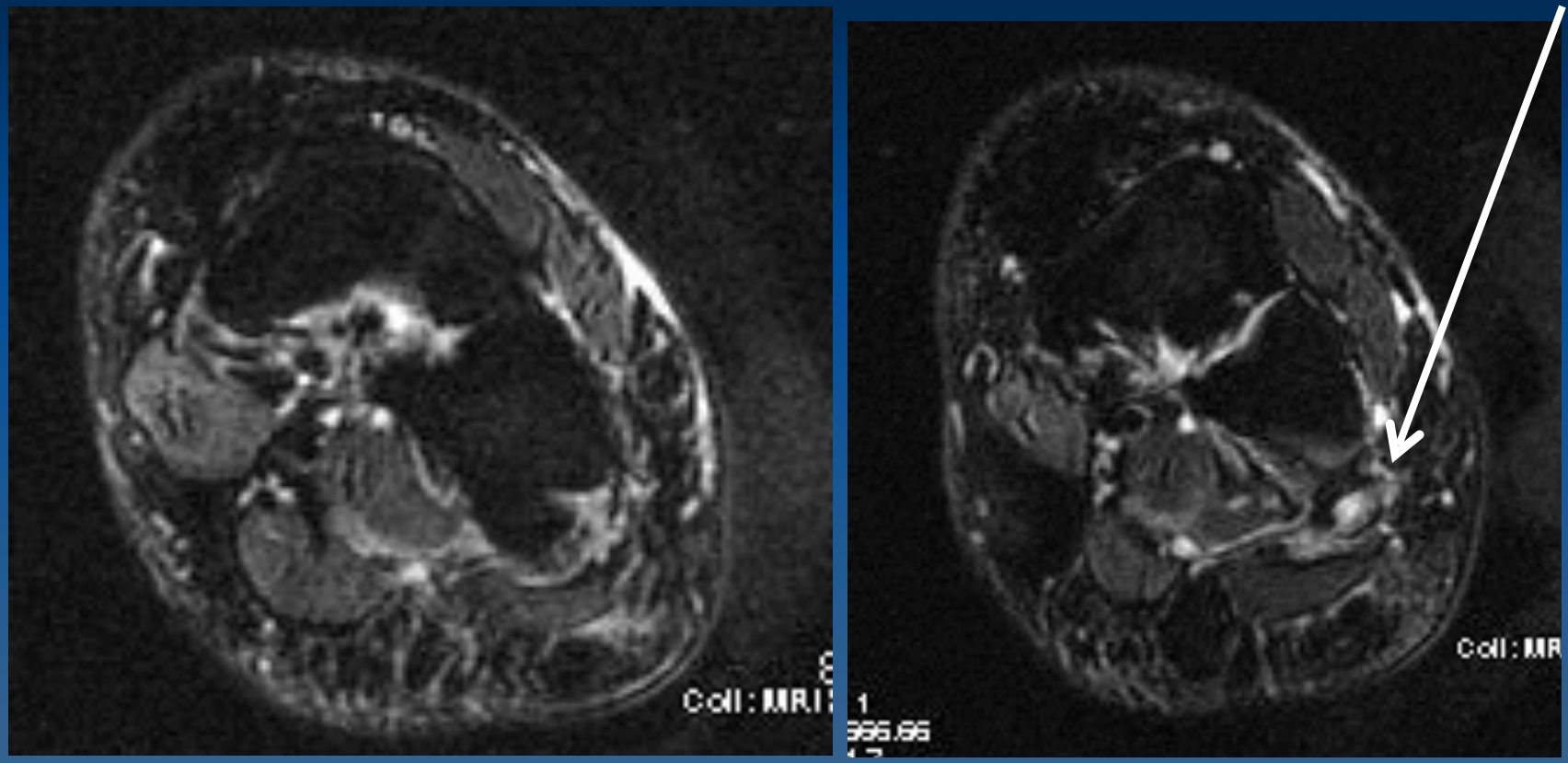
173

19 YO basketball player Os vesalianum bilateral feet.

Os peroneum

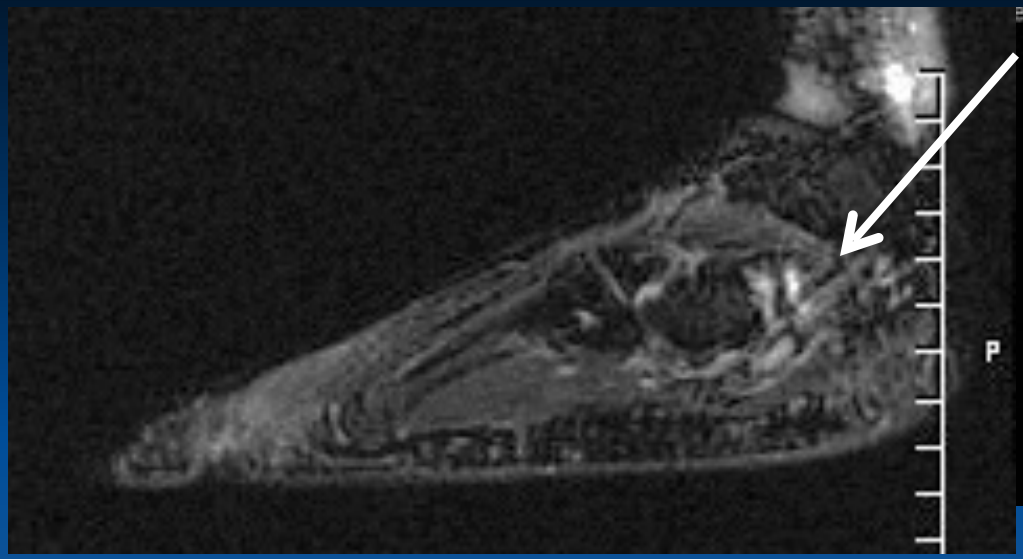


PAINFUL OS PERONEUM



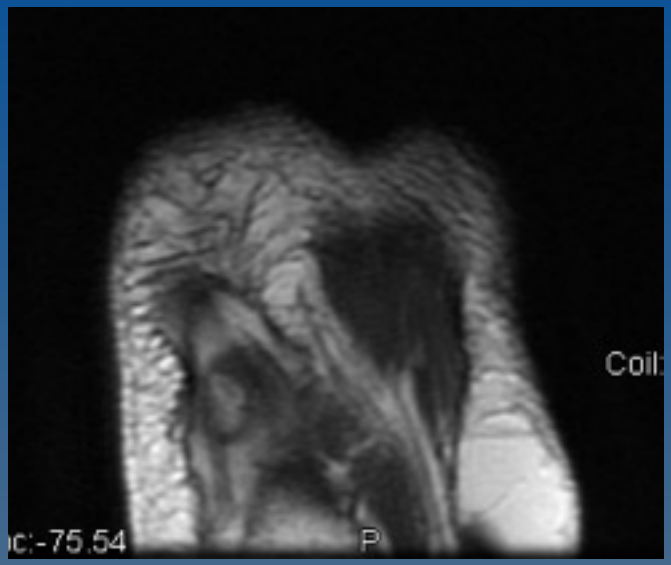
Courtesy UK Radiology

PAINFUL OS PERONEUM









Courtesy UK Radiology

Think About Peroneal Tendon Involvement If:

- Recurrent Ankle Complaints
- Sprain Not Getting Better
- Pain, Swelling Higher in Peroneal Tendon Sheath



In Acute Ankle Sprain, Assess Peroneal Function





Physical Exam of the Foot and Ankle



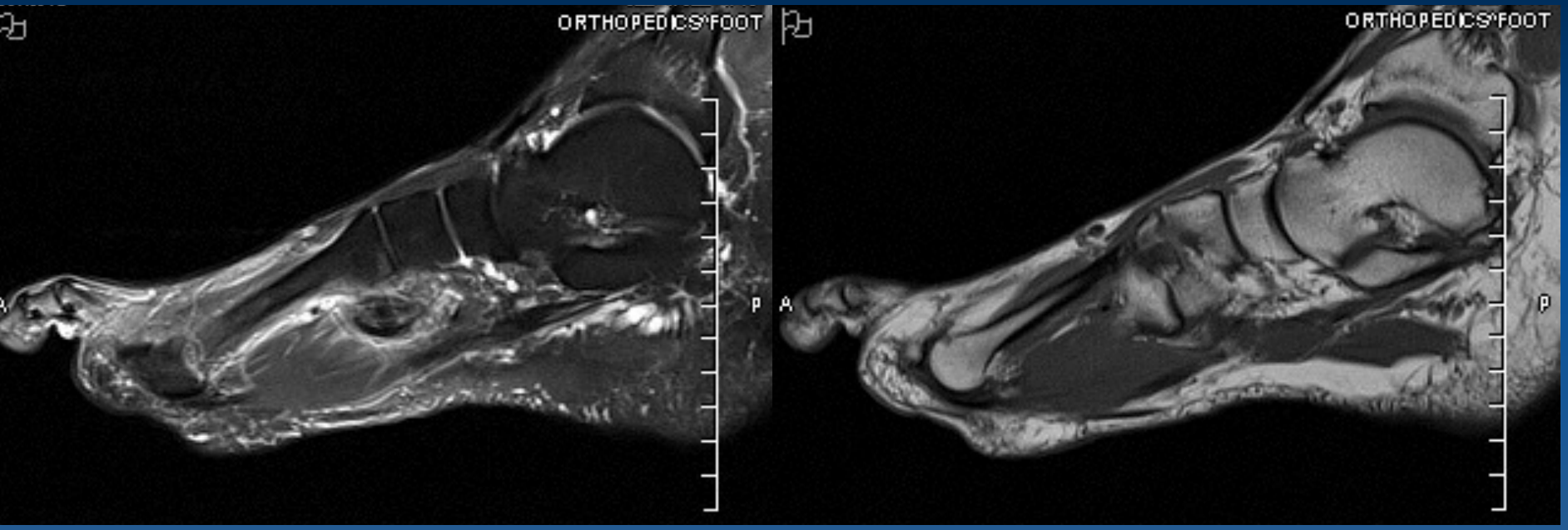
17 YO WM

High school Baseball/Football Player

C/O Repeated Inversion Ankle Sprains



PERONEUS LONGUS TENDON TEAR



Courtesy UK Radiology

18 YO Female Gymnast

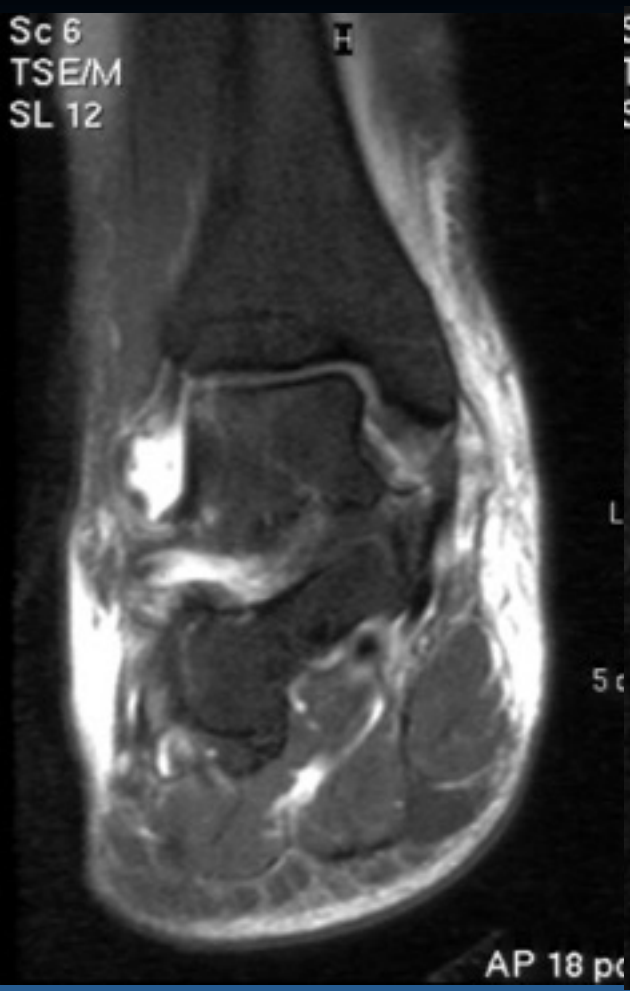
- Right ankle injury
- Landed awkwardly doing a back tuck
- Immediate pain and swelling, right ankle

Initial X-rays



Stress tests, L & R ankles



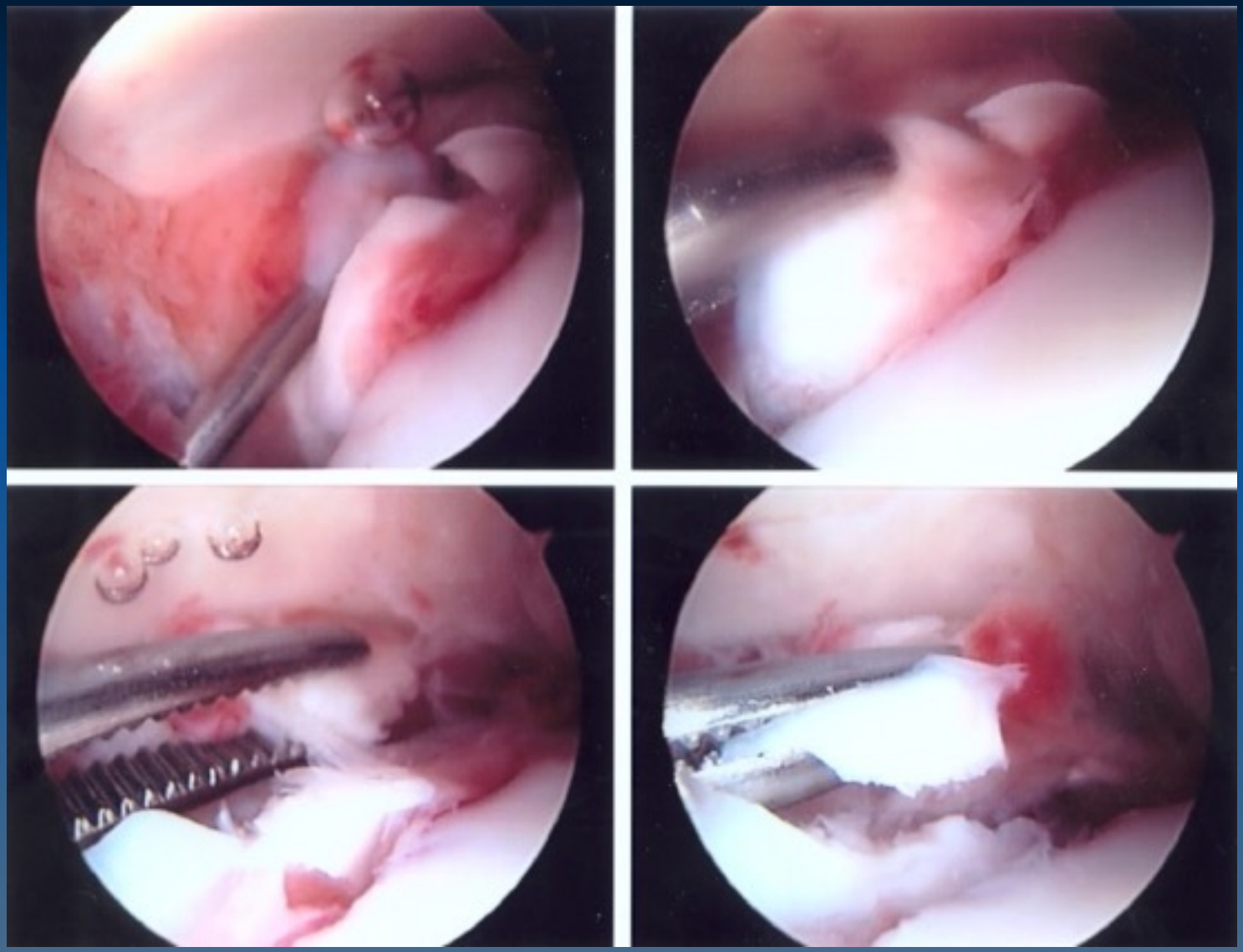


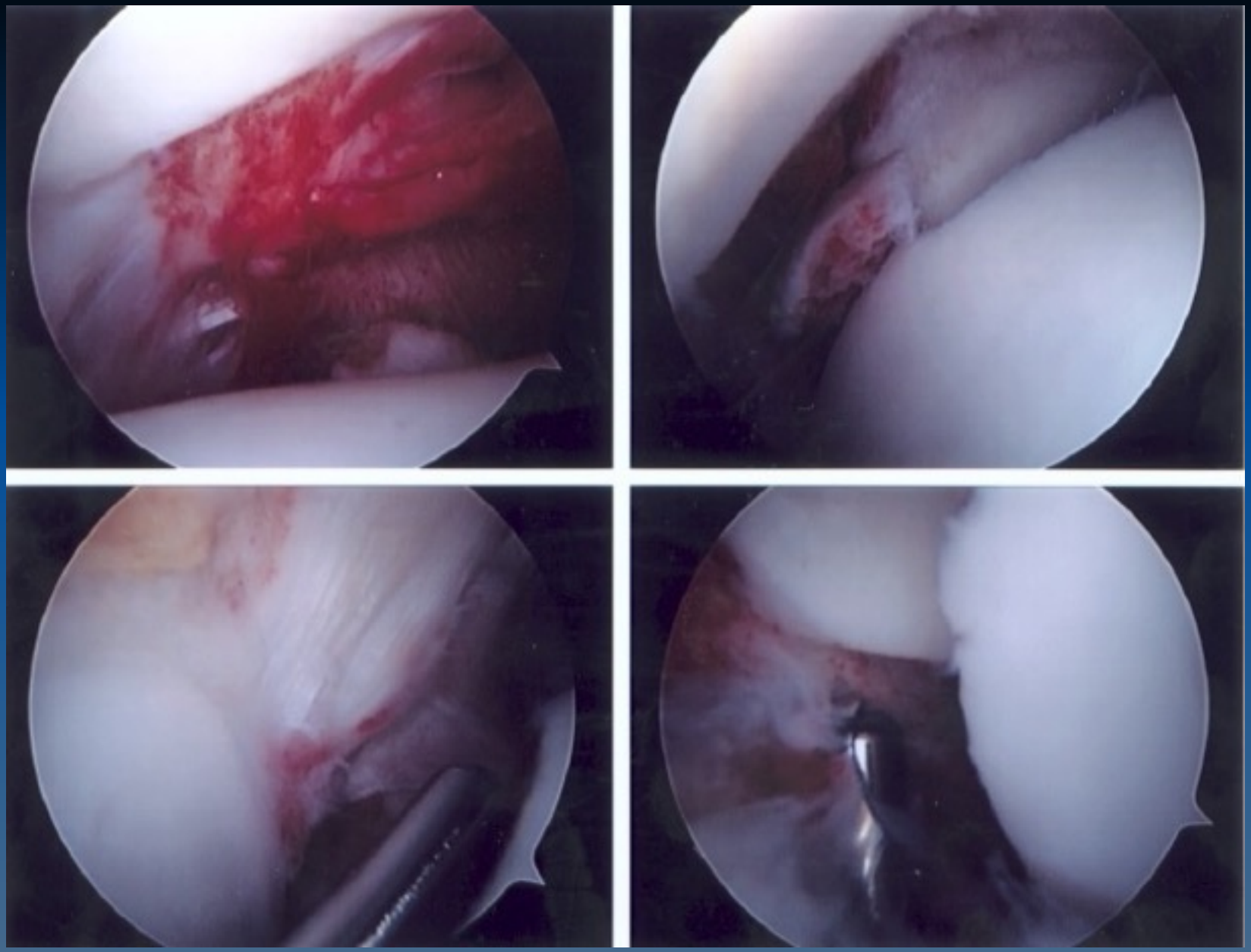




Dx lateral talus fracture displaced
Severe lateral ankle sprain

Surgery



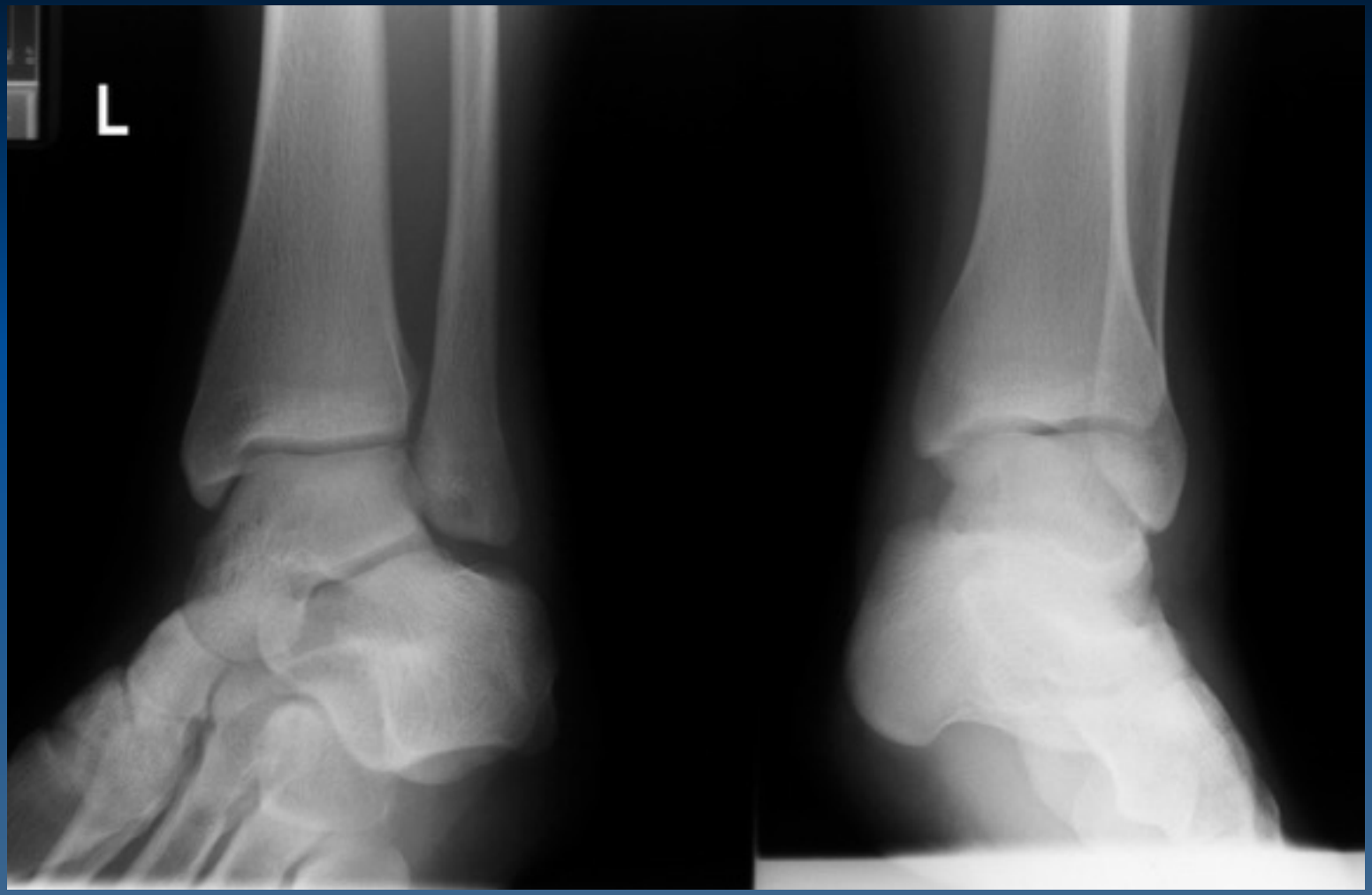


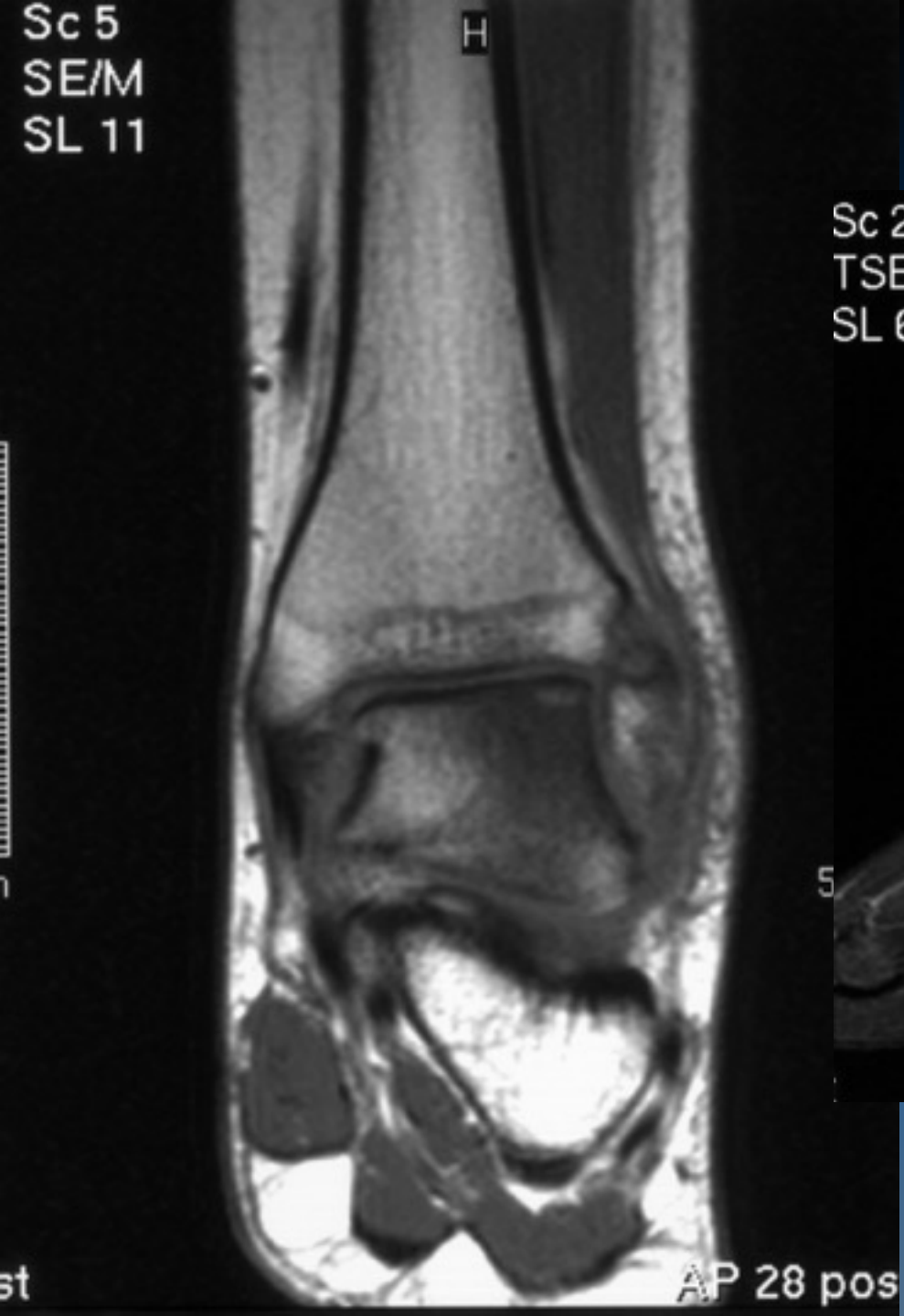

mm
1
2
3
4
STAINLESS

14 YO Female

- Soccer athlete
- Left ankle
- Acute lateral talar dome fracture
- Documented by plain films and bone
- Edema on MRI

Initial X-Rays




Sc 5
SE/M
SL 11
H
AP 28 pos

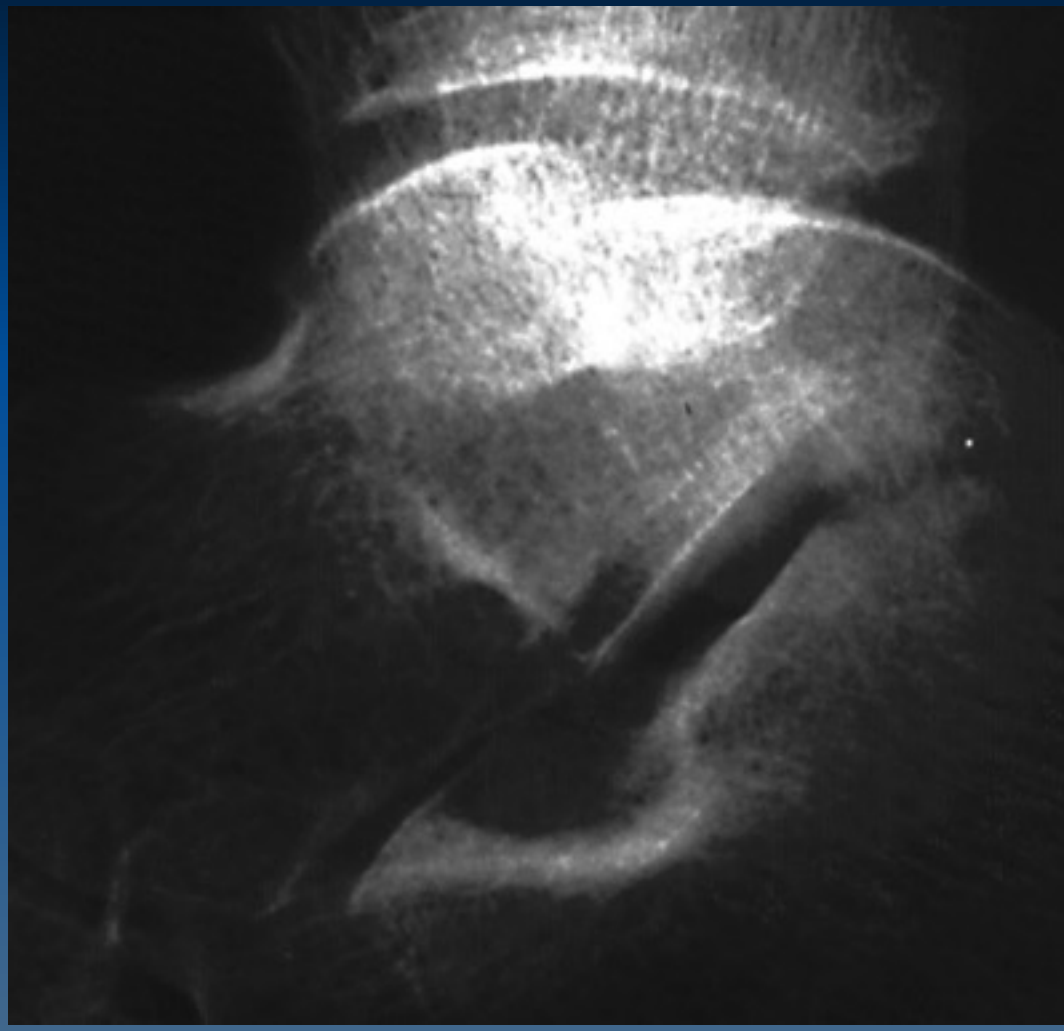

Sc 2
TSE/M
SL 6
H
P
5 cm
RL 13 left

1 Month after Initial presentation



Talar Dome Fracture-45YO Golfer



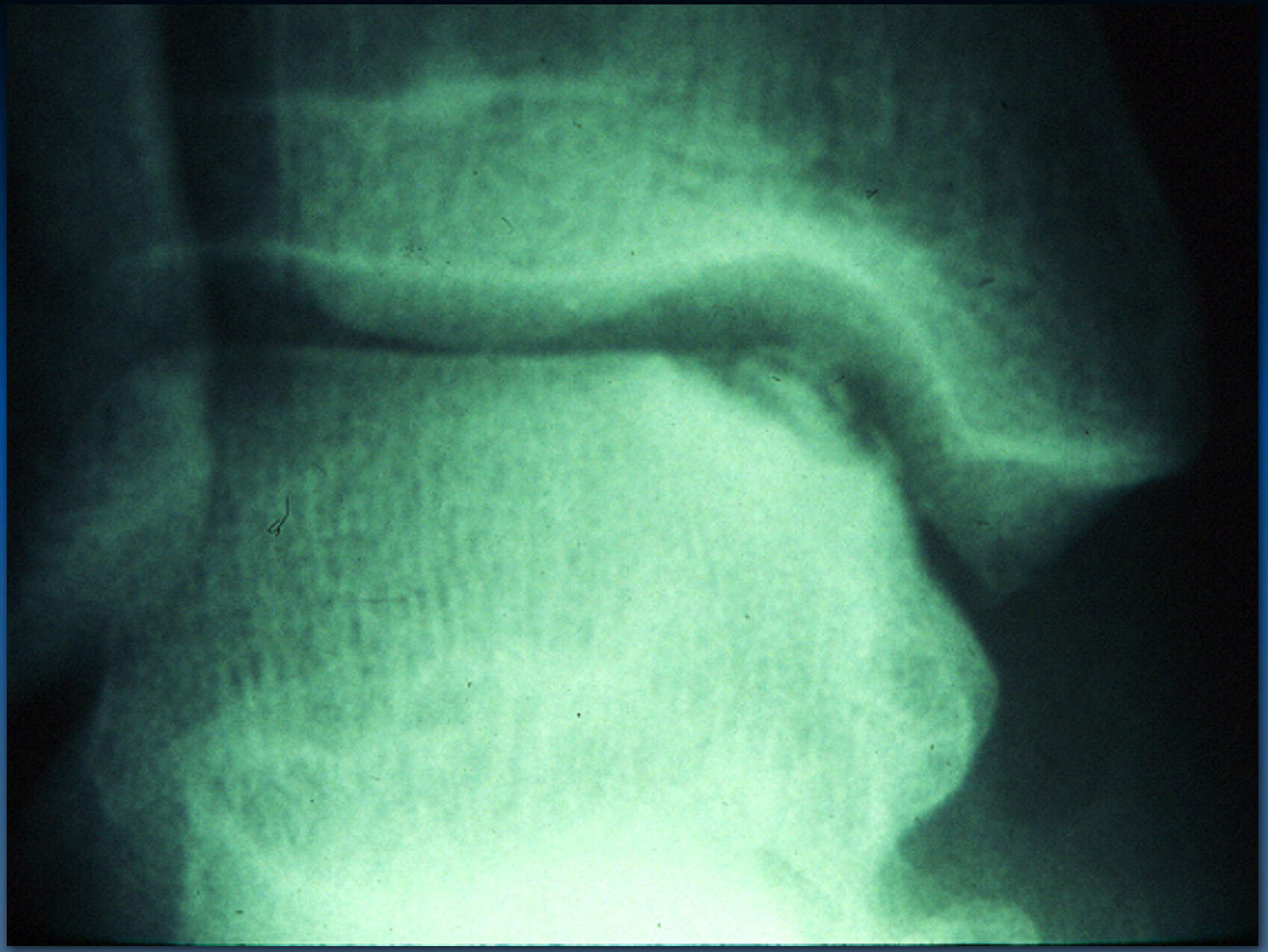


Osteochondral Talar Lesions

- Berndt, A.L. and Harty, M.: "Transchondral fractures of the talus" – JBJS 41 –A:988, 1959

- Osteochondritis Dissecans
  - Male 3 : 1 Female
  - Medial 2 : 1 Lateral

- Etiologies
  - Trauma
  - Vascular
  - Repetitive Loading



Football athlete:
Left Ankle Injury on Astroturf




© 1995 Ky Sports Medicine

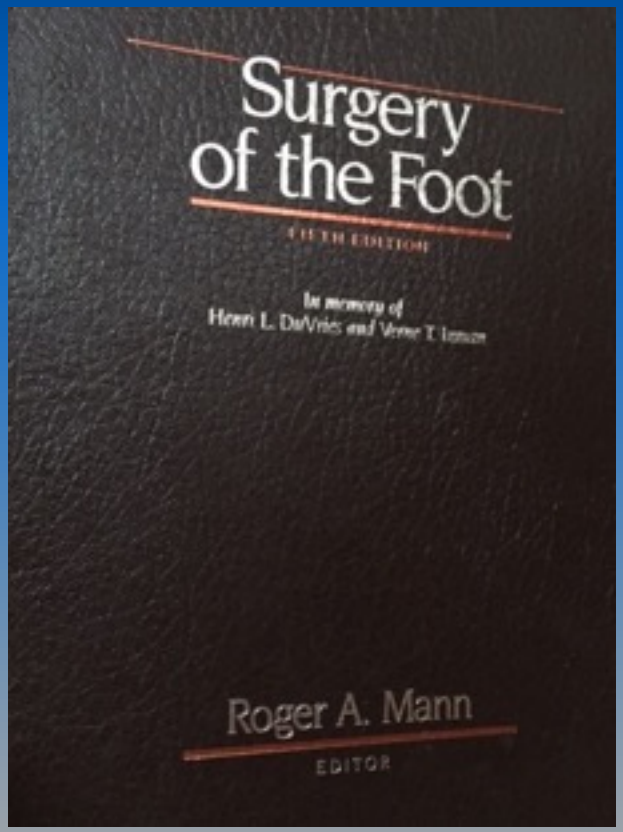






Surgery of the Foot Roger A Mann Editor CV Mosby 5th Edition 1986

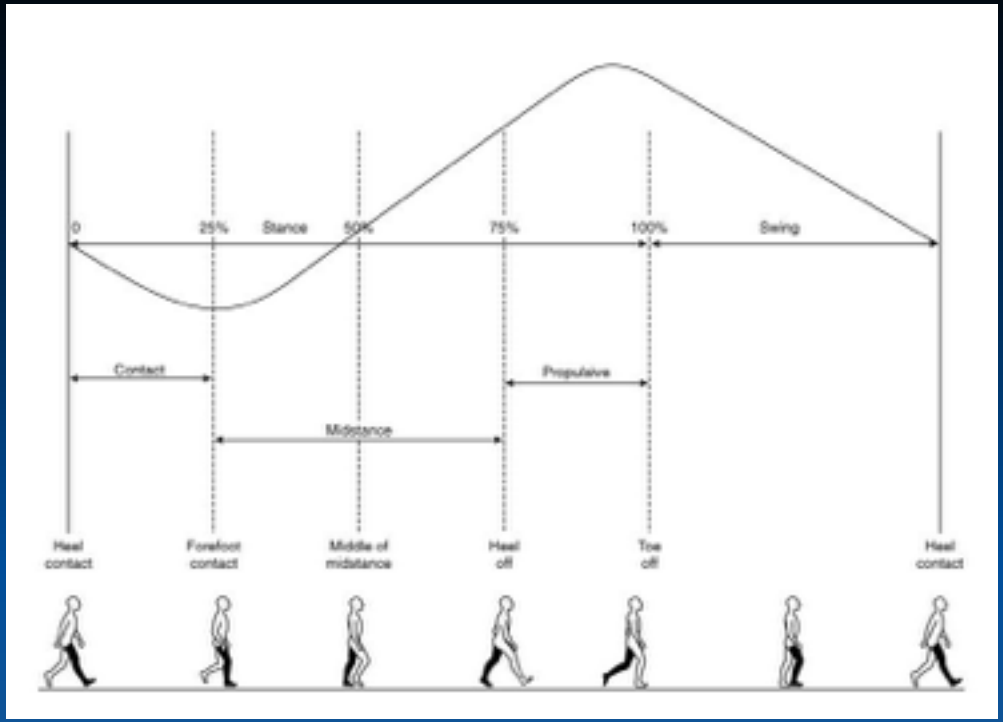




Biomechanics of the Foot and Ankle by Roger A Mann Chapter 1

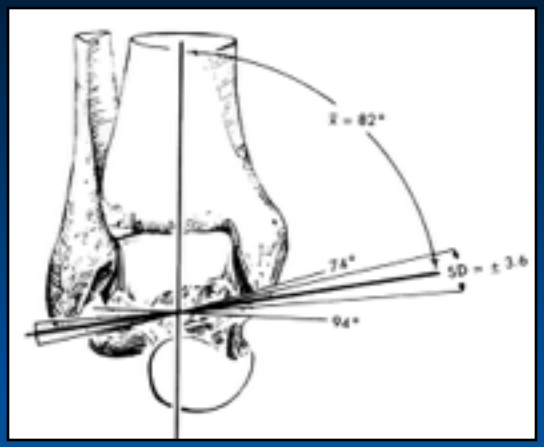
Function

- Propulsion
- Support
- Flexibility
- Rigidity
- Gait mechanics: ankle and foot motions



Ankle Axis: Opposite with foot fixed

- With foot fixed, dorsiflexion / Plantarflexion results in rotation of the leg
  - Dorsiflexion results in internal rotation
  - Plantarflexion results in external rotation





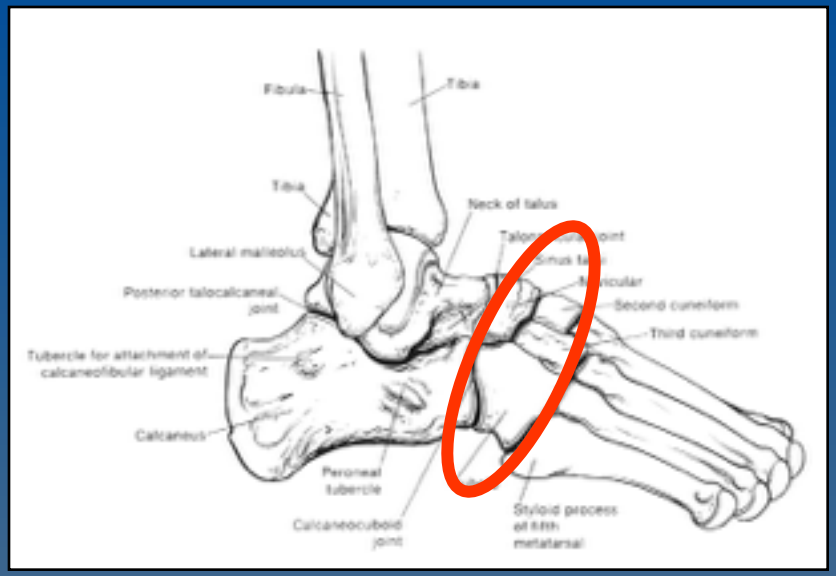
Subtalar Joint

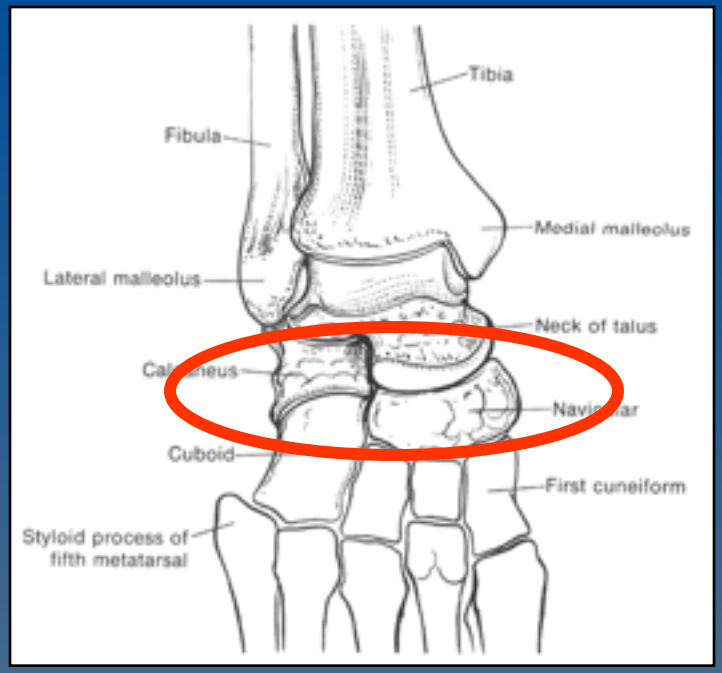
Eversion and inversion of the subtalar joint are directly tied to internal and external rotation of the tibia



Transverse Tarsal Articulation

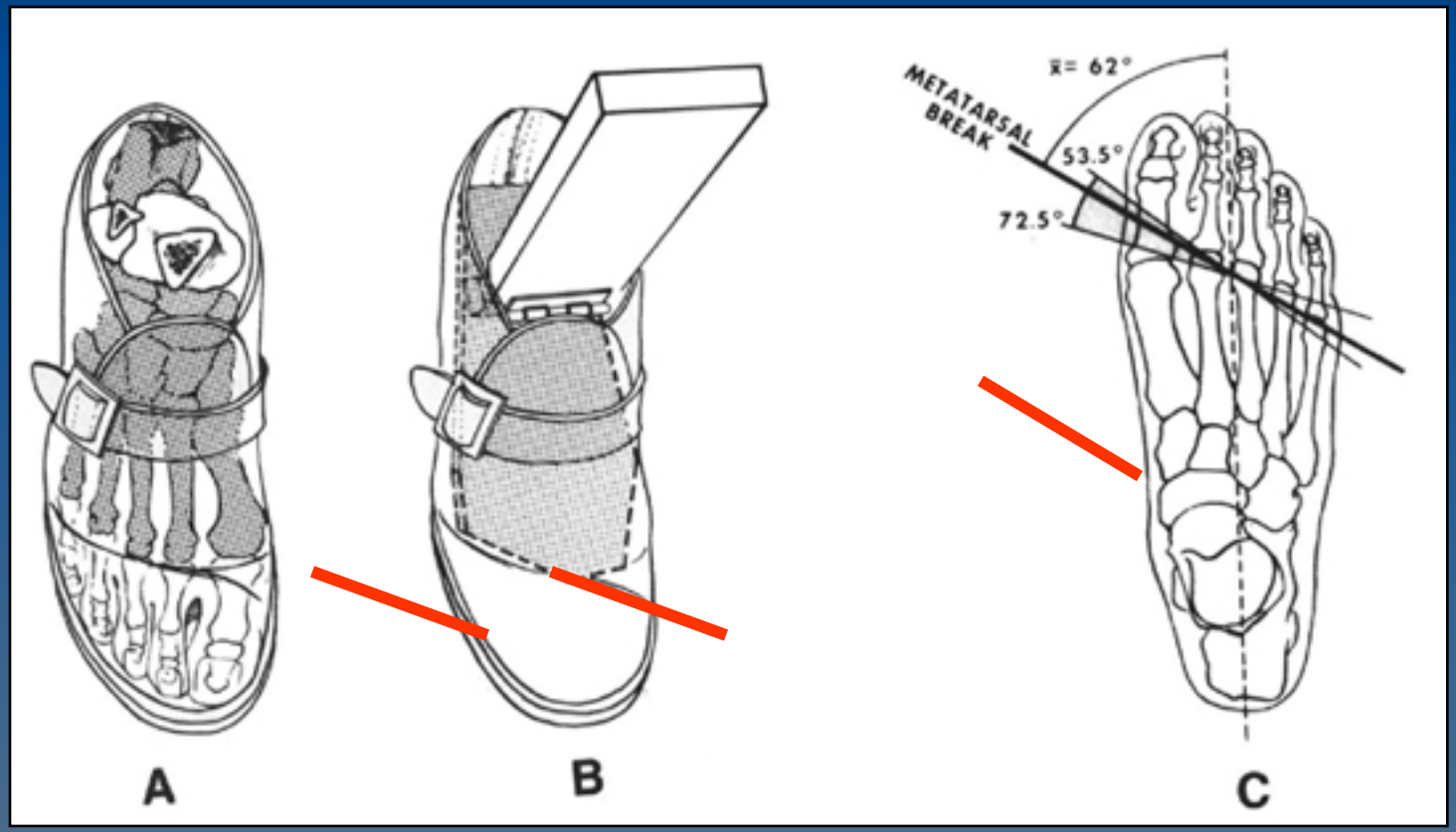
- Comprised of Calcaneocuboid & Talonavicular articulations
- Functions as one joint





Metatarsophalangeal Break

When the heel is elevated, the weight bearing forces are evenly distributed across the metatarsal heads



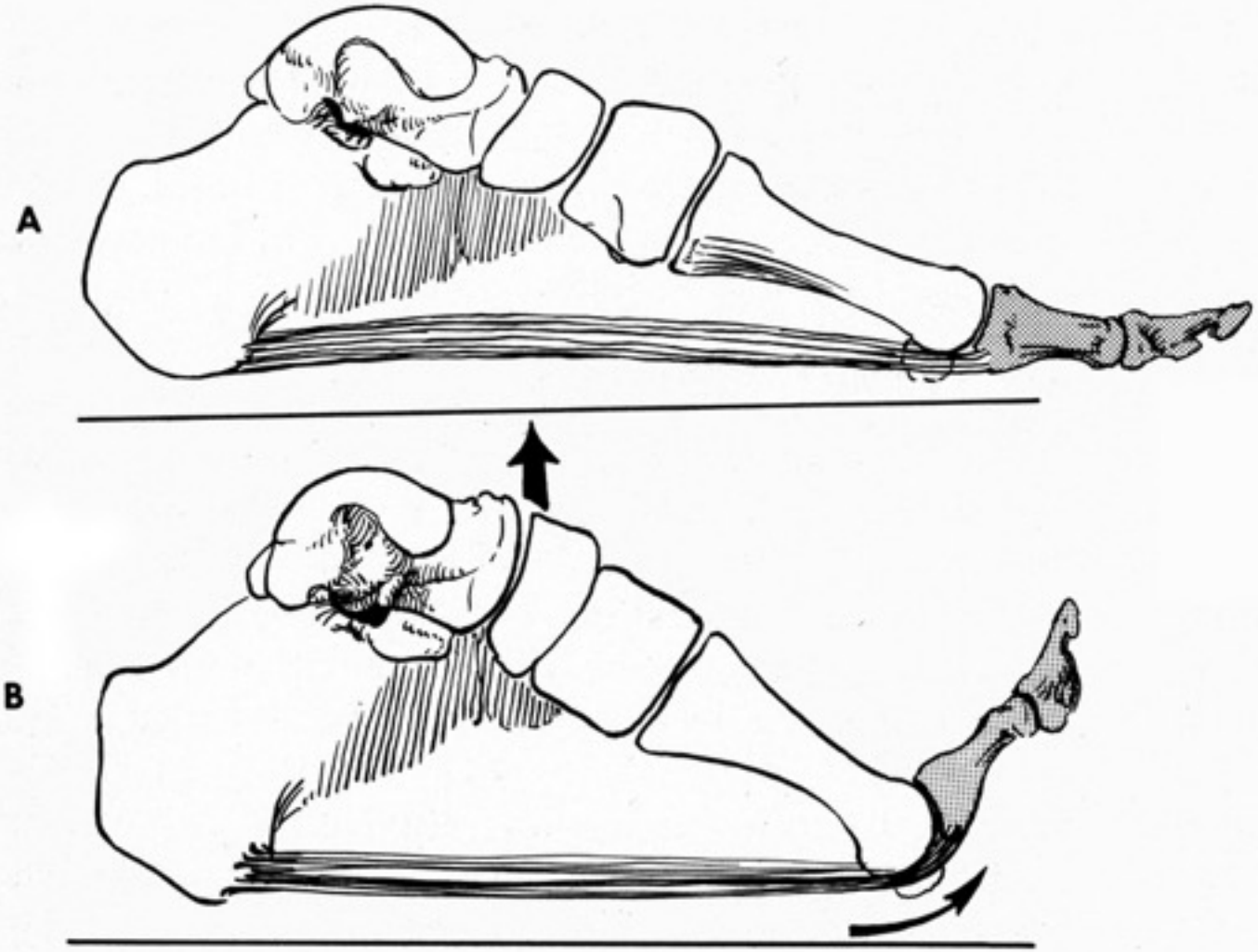


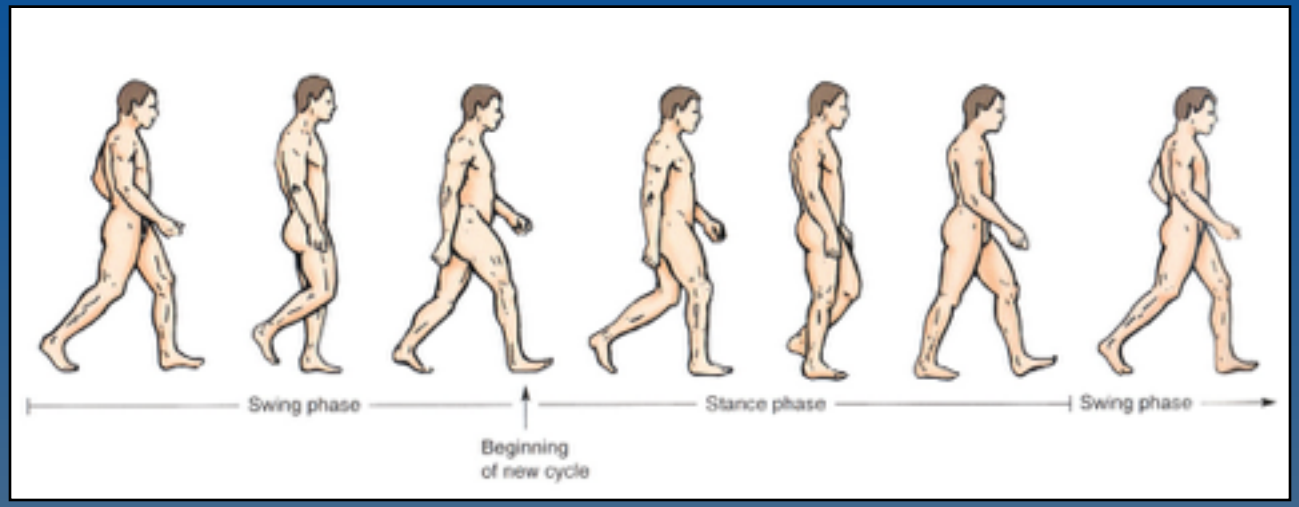
Fig. 1-9. Diagrammatic representation of "windlass action." **A,** Foot flat. **B,** Increased tension of plantar aponeurosis caused by dorsiflexion of the toes with resultant elevation of longitudinal arch.

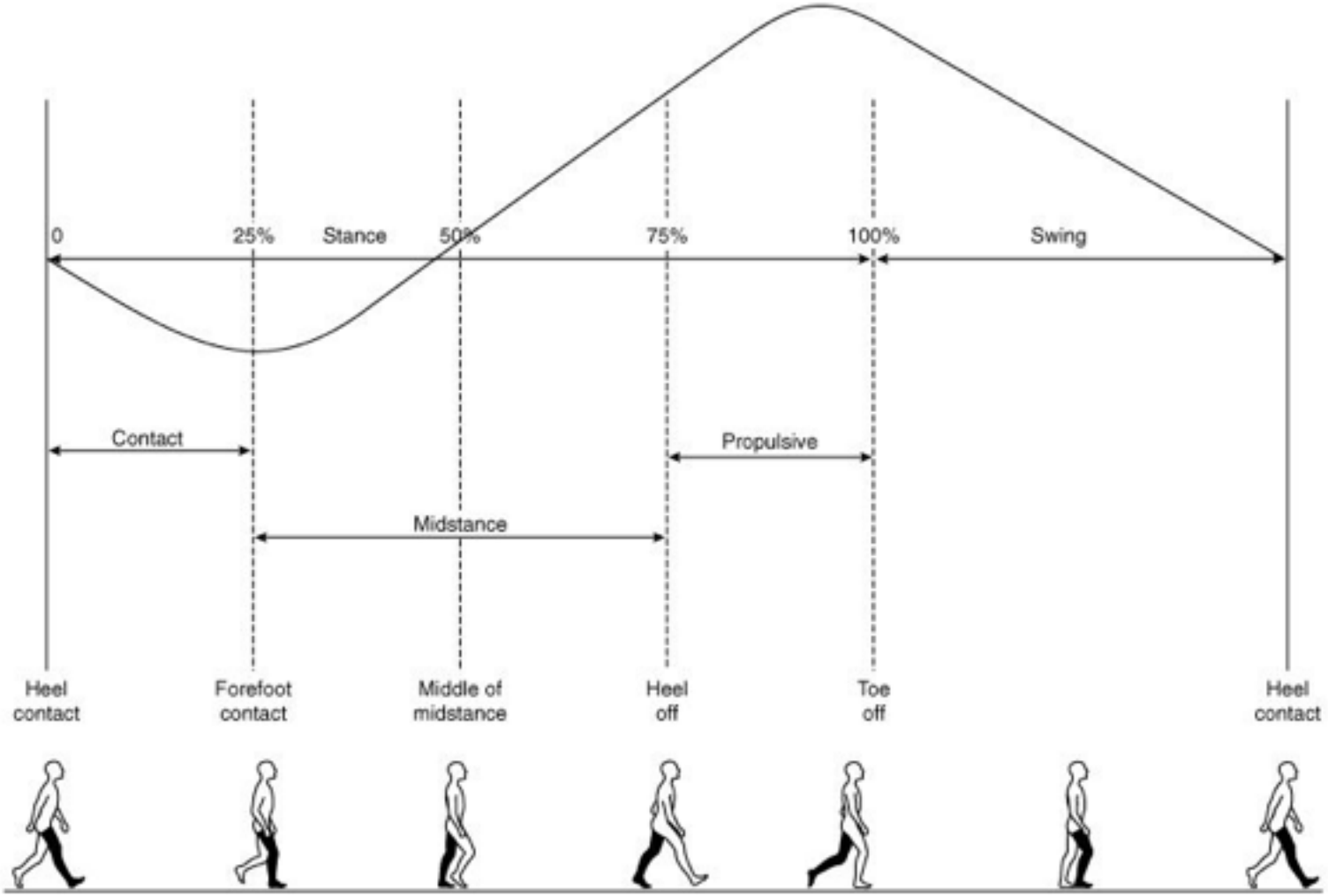
Biomechanics of Gait for the Foot and Ankle

J.W. Thomas Byrd, M.D.

Walking Cycle

- Stance phase (60%); Swing phase (40%)
- Double limb support (10%): both feet on ground



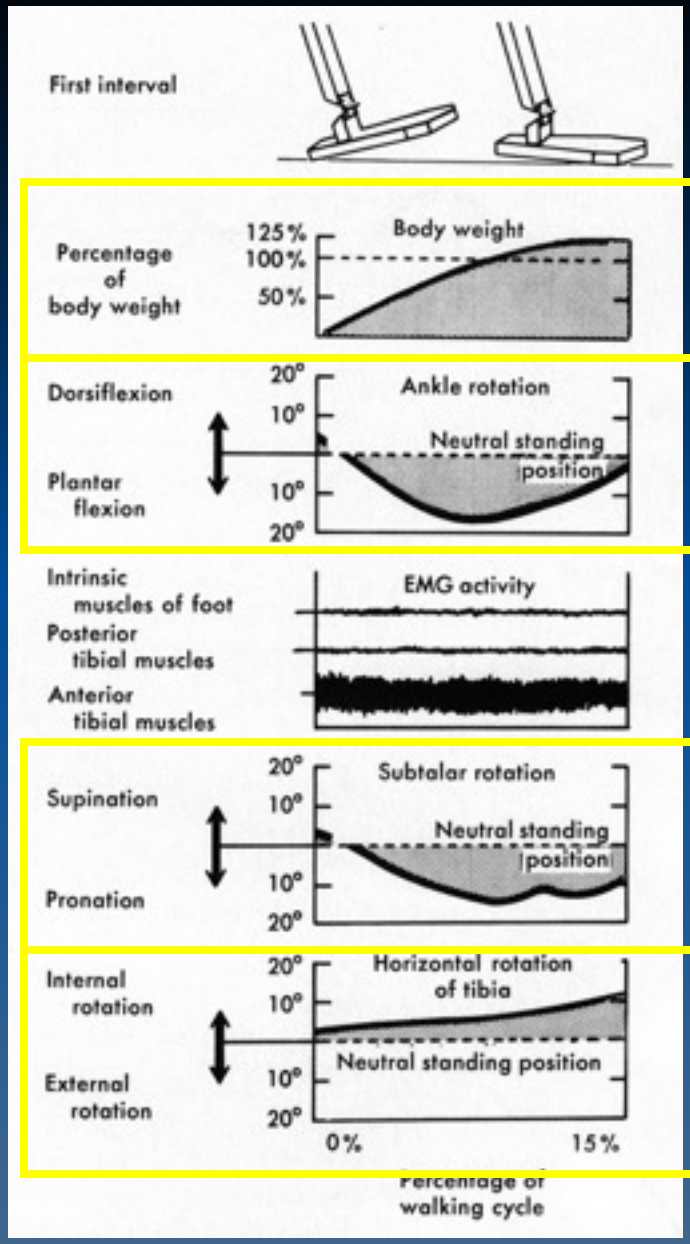

0
25%
Stance
50%
75%
100%
Swing
Contact
Propulsive
Midstance
Heel contact
Forefoot contact
Middle of midstance
Heel off
Toe off
Heel contact

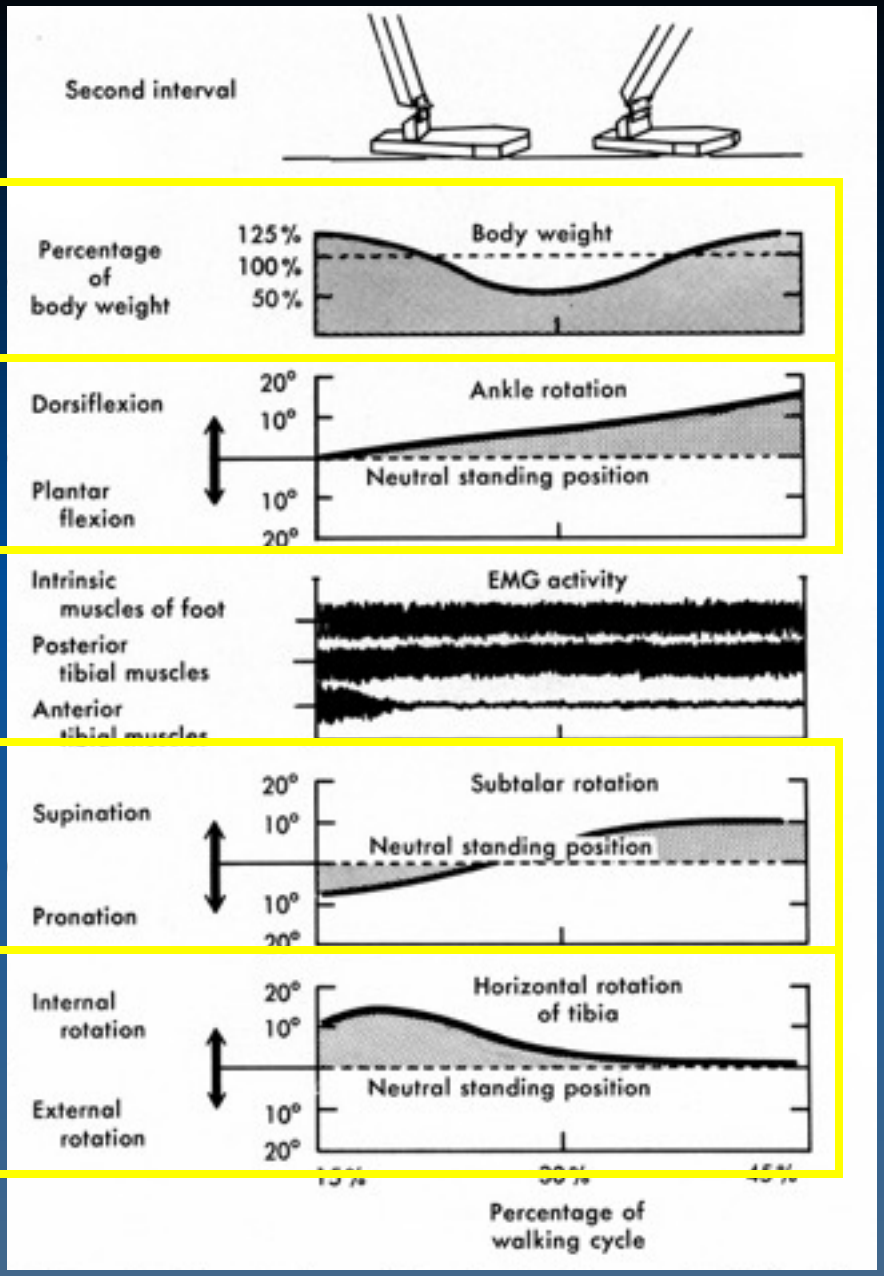
Events of Walking Cycle

- First Interval
  - Deceleration, heel-strike to foot-flat
    - Ankle rapid plantarflexion
    - Foot loaded in pronation – subtalar joint eversion
    - Lower leg internally rotates
    - Eversion unlocks transverse tarsal joint
  - Main thrust force absorption and dissipation

Events of Walking Cycle

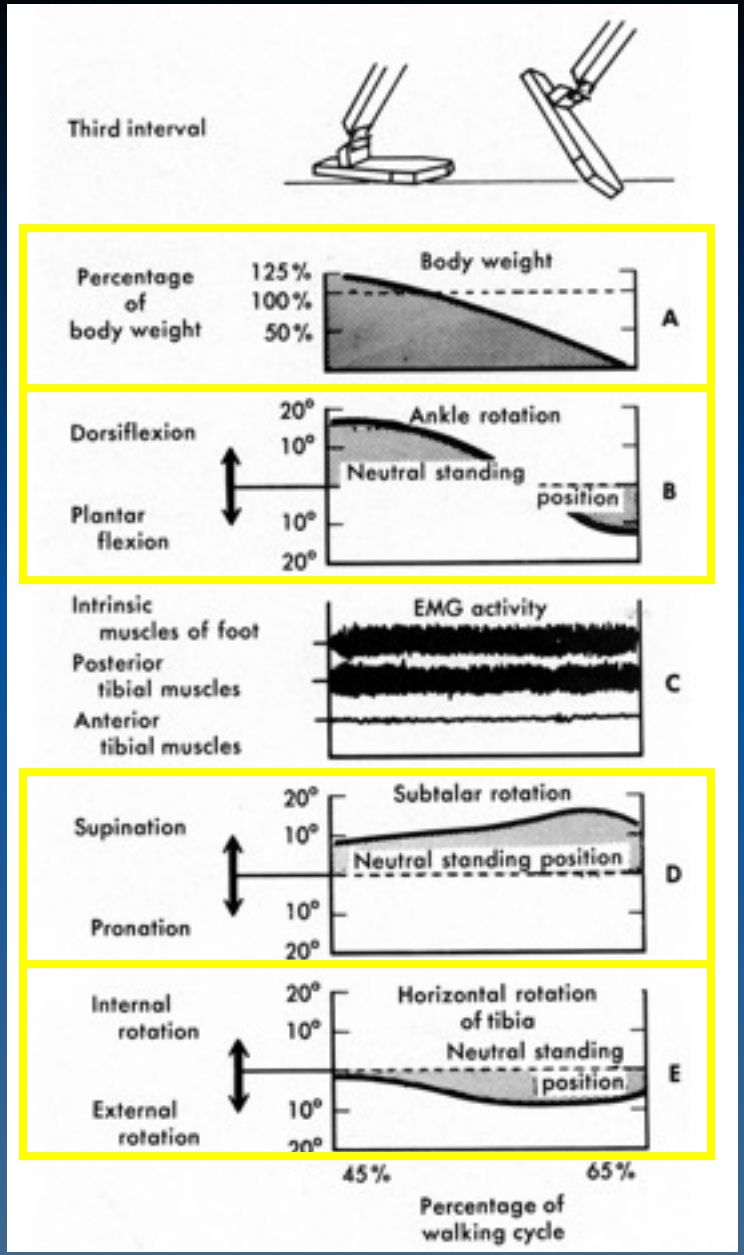
- **Second Interval**
  - Foot-flat to heel-lift
    - Ankle dorsiflexes
    - Subtalar joint inverts
    - Lower limb external rotation
    - Inversion due to ankle oblique axis and plantar aponeurosis and metatarsal break
    - Stability of transverse tarsal joint increased by inversion
  - Mid-foot goes from flexible to rigid


First interval
Percentage of body weight
125%
100%
50%
Body weight
Dorsiflexion
Plantar flexion
20°
10°
10°
20°
Ankle rotation
Neutral standing position
Intrinsic muscles of foot
Posterior tibial muscles
Anterior tibial muscles
EMG activity
Supination
Pronation
Subtalar rotation
Neutral standing position
Internal rotation
External rotation
Horizontal rotation of tibia
Neutral standing position
0%
15%
Percentage of walking cycle

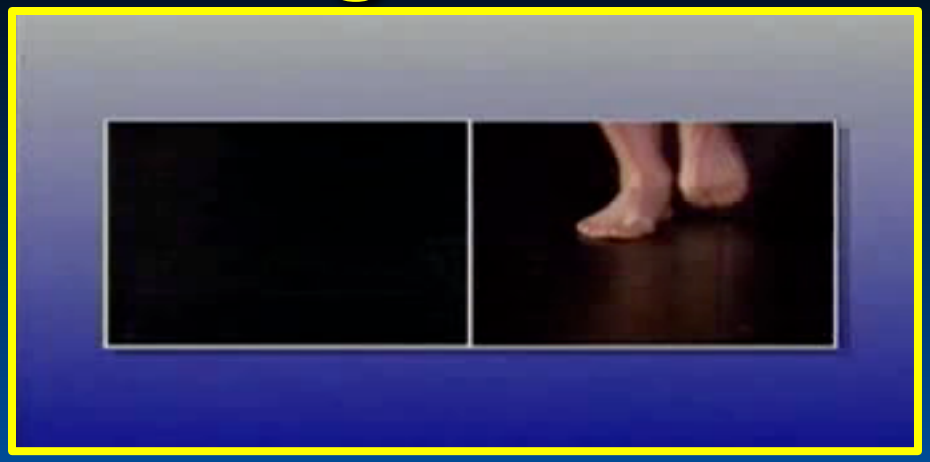

Second interval
Percentage of body weight
125%
100%
50%
Body weight
Dorsiflexion
Plantar flexion
20°
10°
10°
20°
Ankle rotation
Neutral standing position
Intrinsic muscles of foot
Posterior tibial muscles
Anterior
EMG activity
Supination
Pronation
Subtalar rotation
Neutral standing position
Internal rotation
External rotation
Horizontal rotation of tibia
Neutral standing position
Percentage of walking cycle

Events of Walking Cycle

- Third Interval
  - Heel-lift to Toe-off
    - Ankle rapid plantarflexion
    - Windlass effect of plantar aponeurosis stabilizes longitudinal arch
    - Subtalar joint inverts to maximize rigidity of transverse tarsal joint
  - Body propelled forward


Third interval
Percentage of body weight
125%
100%
50%
Body weight
A
Dorsiflexion
Plantar flexion
20°
10°
10°
20°
Ankle rotation
Neutral standing position
B
Intrinsic muscles of foot
Posterior tibial muscles
Anterior tibial muscles
EMG activity
C
Supination
Pronation
20°
10°
10°
20°
Subtalar rotation
Neutral standing position
D
Internal rotation
External rotation
20°
10°
10°
20°
Horizontal rotation of tibia
Neutral standing position
E
45%
65%
Percentage of walking cycle

Third Interval: create rigid lever for push-off



- Ankle undergoes rapid plantarflexion
- Longitudinal arch stabilized by windlass effect of the plantar aponeurosis as toes are brought into dorsiflexion
- Subtalar joint continues to invert (enhanced by obliquity of the ankle joint) maximizing rigidity of the transverse tarsal joint at toe off

During gait: coupled motion between ankle and subtalar joints

- First
  - Tibial internal rotation
  - Talar eversion
  - Foot pronation
- Third
  - Tibial external rotation
  - Talar inversion
  - Foot supination



Normal Gait is a Controlled Fall
What happens to the Joints with Foot On Ground

Foot	Tibia	Talus	Foot
Dorsiflexion	Internally Rotates	Everts	Pronation
D	IR	E	P
Plantarflexion	Externally Rotates	Inverts	Supination
P	ER	I	S

Gait analysis posterior view

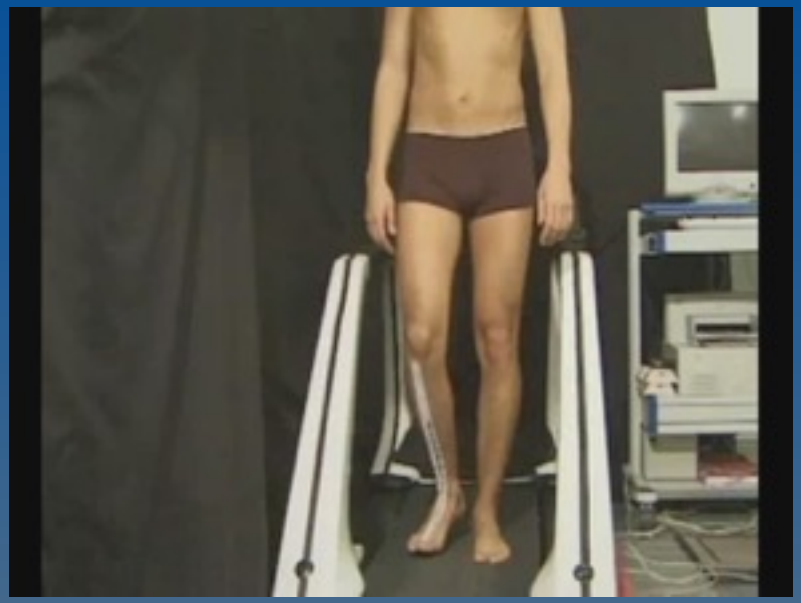


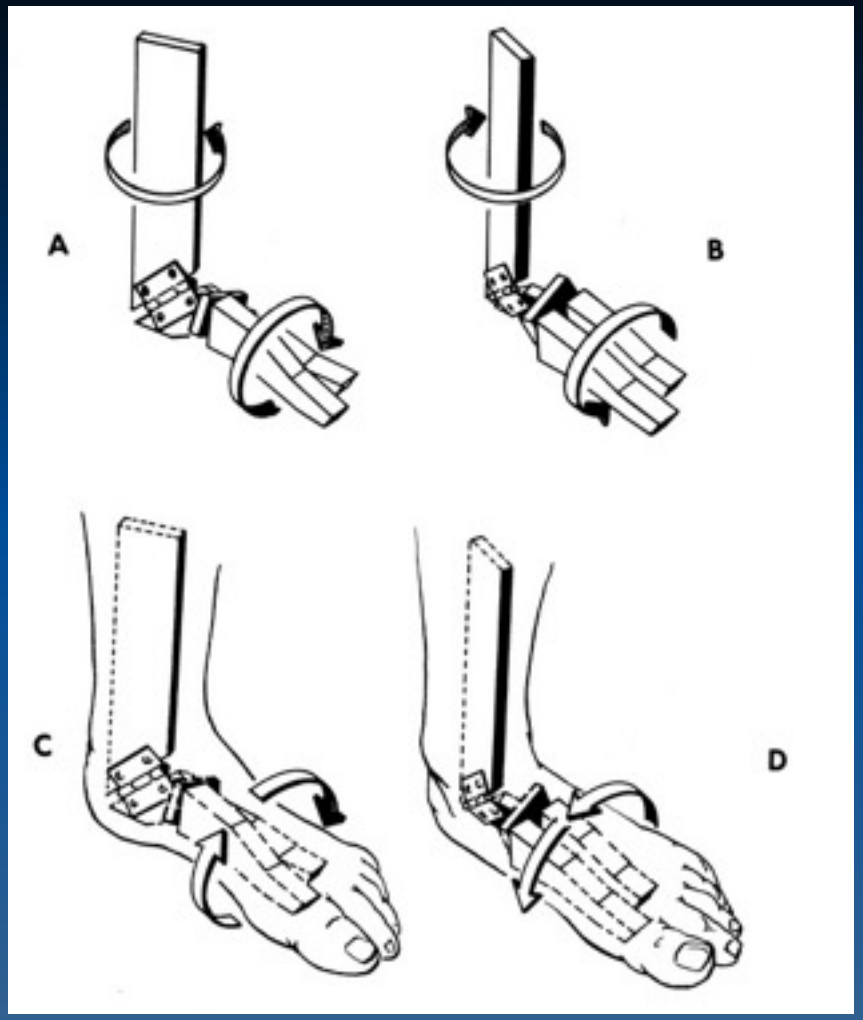






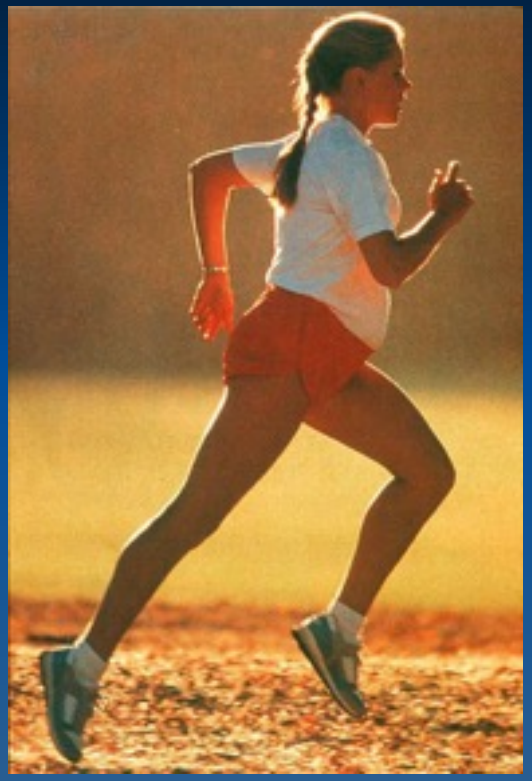





A
B
C
D

Mechanics of Running

- Basic kinematics of the foot and ankle not significantly altered
- Gait cycle shortened
- Stance phase shortened
- Vertical forces during stance phase increase to 2.5 - 3 times body weight
- ROM of joints is increased 50%
- Phasic activity of the lower extremity muscles altered



The End — Thank You!

